Responsible Innovation in Energy Projects: Values in the Design of Technologies, Institutions and Stakeholder Interactions[1]
(Draft version for forthcoming book)

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Abstract

Projects that deal with unconventional ways to produce, store, or transport energy often give rise to resistance by local communities. The value-laden basis of such resistance is often ignored by decision makers. This chapter operationalizes the concept of Responsible Innovation by using and adapting the approach of value sensitive design. This approach holds that the variety of stakeholders' values might be taken as a point of departure for the (re)design of a technological system in such a way that divergent values can be accommodated. The scope of value sensitive design can be extended beyond the technology, however. Values are also embedded in the institutional context and in the processes of interaction between stakeholders. Hence, the prevention of controversies over conflicting values may be pursued by redesigning the institutional context, and by taking the dynamics of stakeholder interaction explicitly into account.

1. Introduction

The supply of energy is a fundamental prerequisite for the functioning of society. Yet, traditionally, the supply of energy is associated with many problems. Today, three principal problems can be identified. Firstly, 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 problem is that the uneven regional distribution of energy resources is causing international geopolitical and economic frictions.

Such problems foster new initiatives and technological developments to produce, store or transport energy in currently unconventional ways. Schemes to solve these problems include the development of wind, solar, thermal and other renewable forms of energy. Furthermore, there are new developments of advanced methods for exploring and producing hydrocarbon fuels from the deep sea, tar sands, and geological layers that, until recently, were considered too expensive and risky, or for which technologies simply were lacking. A completely new phenomenon is the underground disposal of CO_2, to reduce the emissions into the atmosphere.

New energy initiatives repeatedly give rise to problems of societal acceptance because their implementation and operation 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 local population, or even society at large. As a consequence, controversies between local populations, governments, and industry are always imminent.

[1] The work for this article has been funded by NWO (Netherlands Organization for Scientific Research) [grant number 313 99 007]

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). Apparently, it was not only the perceived risk, but also the lack of a serious consideration of people's concerns, both by the government and 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 partly depleted gas field beneath the municipality of Bergen, which was sold by BP to TAQA from Abu Dhabi to be used as an underground gas storage facility. Natural gas will be injected into the subsurface in the summer season and distributed among users in the Netherlands and North West Europe in the winter. Although not with the same vigor 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 an exploration license from the state and a municipal permit to conduct drillings, but this permit was successfully challenged in court by local inhabitants, together with the Dutch Rabobank, which has one of its data centers in the vicinity.

These examples demonstrate that the interaction between citizens, businesses, local authorities and environmental organizations may be, or become, problematic, turning energy projects into difficult and risky enterprises. The government and the energy industry therefore consider the antagonists in such cases as showstoppers. Thus, policies and communication are organized accordingly and the value-laden basis of controversies is ignored. Hence national authorities and energy companies complain that either the public is ill-informed (Wynne, 2001), resistant 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). Nevertheless, we do not suggest that simply adhering to the desire of local communities is the preferred solution. 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 avoid both pitfalls, by creating strategies and solutions that bridge the diversity in stakeholders' values. Different actors make different assessments of the costs and benefits of these projects. Gaining public acceptance not only requires more or better dissemination of information, or a more elaborate risk assessment. It also, as we argue, requires the acknowledgment of different (moral) viewpoints of stakeholders, which should be taken as a point of departure to identify and to construct shared solutions. A societally responsible development of energy projects requires the accommodation of the variety of stakeholders' values.

In this chapter, we will sketch the contours of a methodology that will open up the black box of this variety of values. In contrast to Blok and Lemmens (Chapter 2, this volume) and in line with Robaey and Simons (Chapter 5, this volume), we argue that this meta-insight is a fruitful entrance for creating a shared solution. Both historic examples and conceptual developments strengthen this viewpoint. We propose the application of *value sensitive design* (VSD) to such energy projects, in line with a product-based approach to responsible innovation as defined by Koops (Chapter 1, this volume) The VSD approach was originally developed to target the incorporation of a diverse range of values in information technology (Friedman and Kahn, 2000). Our aim is to extend the scope of VSD, not only by relating it to other technologies, but also by applying it to the institutional context in which such new technologies are implemented and/or used. In this regard we are aligned with Blok and Lemmens' views on the need to take a broad view of innovation when issues of responsibility are at stake (Chapter 2, this volume).

Our focus is on projects that individually have a local impact, such as a wind park or a gas storage or production facility. However, in aggregation these projects have the potential to contribute greatly to the overall energy supply. Often, this potential is clearly voiced at the initiation of a single project. VSD aims to incorporate the values of all relevant stakeholders in the design process. For example, it includes the values that are articulated by local stakeholders regarding a specific project as well as possible large societal benefits or concerns.

Most approaches of VSD specifically focus on the design of technological artifacts or systems. However, in respect to 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, can be redesigned in order to accommodate divergent values. Also the way in which the project itself is arranged 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 essential for achieving public support of projects. Controversies around value sets may be prevented by considering the variety of values in the design processes.

In the next section, we will explore the way values are embedded in technological artifacts and systems. In section three, we will examine how economists specify values. We highlight the different perspectives of mainstream economics, most commonly applied in economic valuation, and institutional economics, which allows for a much wider conception of the role of values in social life. In section four, we will focus on processes of value specification, emerging in concrete interactions between the stakeholders in a specific project. To describe these processes, we will make use of insights from science and technology studies (STS) and participatory theory. Section five will present the approach of value sensitive design, providing an analytical framework for a "value hierarchy" that helps clarify the values that (should) underlie particular decisions or characteristics of a design. Based on our theoretical explorations, we will suggest that processes of value specification can be extended to not only include the design of technologies but can also include processes and institutions. This is argued in section six.

2. Values in technology

It is tempting to see technologies as value-neutral, identifying them as simply instrumental practical objects. However, research on the relation between technology and society reveals that this does not correspond to reality. In many ways, technologies are strongly value-laden (Winner, 1980), as they incorporate certain (often dominant) values while failing to represent other values. Furthermore, they may also give rise to new types of behavior, and with that they also lead to 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 artifact 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 artifacts and system, as was illustrated in Winner's article "Do artifacts have politics?" (1980). In this article, Winner claimed that the urban planner Robert Moses designed low overpasses over the parkways on Long Island, New York so that buses from New York City could not access the beaches. As a result, the urban poor, primarily African American population, dependent on the buses for transport, could not reach the shore. The beaches were therefore *de facto* only accessible for the white, upper and middle classes. Winner concludes that, values (or in his words "politics") are deliberately designed into technological artifacts. 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 have an implicit world view that drives their technological design. Oudshoorn *et al.* (2002) showed how different artifacts, such as electric shavers, bicycles, and microwave ovens, were specifically designed with a definite idea about how male and female users relate to such technological artifacts. Moreover, in the world of infrastructures and large socio-technical systems, much of the 'design process' constitutes a path dependent continuation of technical and socio-institutional habits, institutions and practices, which are adapted and expanded according to new insights where possible.

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 behavior. Values are not designed as such into a socio-technical system; instead they emerge as an outcome of the expansion and adaptation to heterogeneous activities and technical and social developments in and around the system. Hence, ideas about the 'right' behavior 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, the increasing spatial coverage, density and quality of energy infrastructures have given rise to specific public values. In industrialized regions of the world, citizens not only expect but also take for granted an unlimited, safe, inexpensive energy supply available 24 hours per day thereby constituting the value of security of supply. Gradually, increasingly stringent conditions have been formulated regarding the impact of energy supply on the environment and on energy resources we pass on to future generations, constituting the value of sustainability. It is clear that these values – so far – have not been fully embedded in technological and institutional design of these infrastructures. The least expensive energy technologies compromise 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 may be inevitable.

The explicit acknowledgment of values in technological design creates the opportunity to include deliberately a variety of public values in the design itself is referred to as "front-loaded" ethics (Van den Hoven, 2005). We see, for example, that an oil drilling installation or a gas storage facility are often considered by their functionality, whereby questions regarding the public's acceptance of the facility are often ignored. Our proposal is to consider the whole of the trajectory that has led to the realization of the drilling or storage facility, from the start of the project decision-making , its siting and its implementation, to identify the different values that are held by different stakeholders. Only by focusing on these diverse values and their background can we understand and assess the acceptability of the project.

Subsequently, by proactively including values in the design process of the technological artifacts and system, and also in the development of formal and informal institutions surrounding these systems, we aim to support the development of ethically acceptable technological projects that accommodate a plurality of stakeholder values and attenuate potential conflicts and contestation.

An example of such a project that considered various stakeholder values in the design process 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 have caused 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 flexible storm surge barrier. In this new design, a flexible barrier was developed. This barrier allowed water to pass through, only if the hinterland is threatened by a flood the barrier would be closed. This new design accommodated both safety and ecological values (Van de Poel, 2009a) (see also; Correljé and Broekhans, Forthcoming).

3. 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 is important for our analysis. Our lens focuses on how economic theories address private and public values in the wide societal context of energy systems. Schools of economic theory have different positions regarding the definition and incorporation of public values in their theories and methodologies. They also approach the safeguarding of public values by markets and governments differently (Correlje and Groenewegen, 2009). Here we focus on two mainstream schools: *neoclassical economics* (NCE) and *new institutional economics* (NIE). NCE is founded on the premise of an ideal market in which private stakeholders[2] 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. All values are of an individual nature. However, as is acknowledged by mainstream economists, markets rarely function ideally. Classic cases of market failure, involving natural monopolies, public goods

[2] Although economists use the word 'actor' rather than 'stakeholder' in this context, we use the word 'stakeholder' throughout this chapter 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.

and externalities, justify government intervention. Environmental and safety aspects of (unconventional forms of) energy development are clear examples of negative external effects. Yet, at the same time such projects also make a potentially positive contribution to security of energy supply. In case of market failures through such externalities, NCE theory suggests that governments should intervene and internalize the external costs and benefits by correcting the prices. Unwanted effects, such as harmful emissions, can be taxed while desired developments can be supported by subsidies. This would imply that authorities are able to value external societal costs and benefits unequivocally, attributing them to the appropriate actors to achieve the optimal outcome for society. This is a fairly abstract perspective on the role of economic science in policy-making far away from the complex social reality.

Also NIE recognizes that actions of stakeholders can have positive or negative consequences for stakeholders who are indirectly involved in the activities. Energy projects that, for instance, cause health risks to the people living nearby may cause a negative externality. Essential in the NIE approach are 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 compensation by the facility's owner to accept the risk. Alternatively, the operator may take appropriate measures to minimize the potential impact of its activities. NIE suggests that private stakeholders will negotiate changes in their behavior and should make adequate contracts and agreements. When formal institutions are "right", then the conditions are set for efficient contracting, as postulated by Coase (1960). In principle, the stakeholders will then internalize all consequences of their transactions and the externalities will disappear. Yet, as Coase explained, full internalization of all externalities will only be the case in a world with complete information, in the absence of transaction costs, and with fully rational actor behavior.

Negotiating, drafting, finalizing and monitoring contracts can be an extremely costly affair, taking place in uncertain conditions by actors who are boundedly rational. When transaction costs prevent private stakeholders from internalizing complex externalities, government intervention in (re)allocating rights and arranging compensation is legitimized providing the social benefits of the intervention are higher than the social costs. Both NCE and NIE are based on an individualistic, utilitarian conceptualization of the stakeholders, in which *all* values are eventually aggregated and added up into one price, whether or not they are part of specific transactional arrangements imposed by authorities. However, in our introduction, we proposed to open up this black box of aggregated values, focusing on the variety of stakeholders' values and the mechanisms to incorporate these values in processes of decision-making. This suggests that we have to look for an alternative economic approach.

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) is founded on a view of heterogeneous stakeholders who have mental maps and preferences that are influenced by formal (e.g. laws, property rights, bureaucracy) and informal institutions (e.g. customs, traditions, religion). OIE argues that public values reflect preferences of different, sometimes competing, groups in society regarding 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. Societal welfare is a phenomenon the constituent components and values of which are identified, articulated, developed and operationalized in the socio-political process. 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 time and location specific micro and macro-relationships between energy production and use in a particular society. Many positive and negative effects are external to today's markets and they will remain so, unless they are explicitly recognized by societies as important public values and deliberately internalized and institutionalized in their 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 such values, that are at first expressed at the level of individuals, evolve collectively 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 revision of the prevailing practices of project evaluation, particularly in respect to security of energy supply, safety, and social and environmental aspects. This is less far away from reality than it seems: labour relations, education, social security and external safety rules are all examples of direct and indirect economic, environmental, and social effects that were once fully external to market transactions. They are internalized as public values in today's economies and markets that embrace successfully seemingly divergent and conflicting values and interests.

OIE provides the foundation 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 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 that, in turn, allows the analytical connection with the value hierarchy, as presented below.

It will be the task of the researchers to identify the values that are embedded in the institutional environment that is comprised of formal and informal institutions as well as the (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 a variety of segments of civil society such as businesses, and realms of policy-making.

4. The specification of values in a project: Stakeholder interactions

Above, we have focused on the technology and the institutional environment as value-laden domains. Value conflicts among stakeholders may possibly intensify or decline. Still, one important ingredient is missing, namely if we want to give 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 involved. The rich body of literature on how the general public 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) demonstrates how 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 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 on public engagement with renewable energy projects. This framework schematically shows how public engagement with renewable energy projects results from the interaction between project developers and public stakeholders who have varying expectations of the technology, of each other, as well as of the process through which the project will be developed.

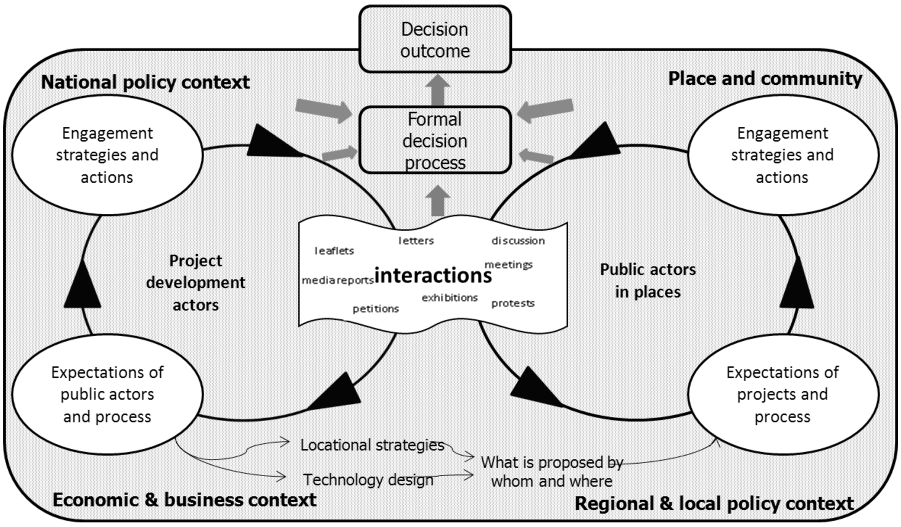

Figure 1: Public engagement with energy technologies (source: Walker (2011))

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

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 flood safety is being reformulated as a reaction to both changes in the perceived threat and in the degree of acceptance of high dikes as the primary means of protection (Broekhans *et al.*, 2010). However, the value of flood safety could also be reshaped if it conflicted with another value; see the example of the Eastern Scheldt Estuary in section two. This demonstrates that the perception of what is acceptable may change over time. Aspects that may influence acceptance include the interaction between stakeholders, stakeholders' values, how conflicting values are addressed, the experiences of the stakeholders, and how these aspects are incorporated in the design of technology and surrounding institutions. Value specification thus takes place in an emergent and dynamic societal process, and the value specification itself can be 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 in which values are specified in technologies and institutions, on the other hand. A characteristic of technologies and institutions is their relatively fixed nature, that embeds and solidifies certain values in their design. The dynamic character of value specification between stakeholders 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 and transform 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. Such a conflict may be avoidable, however. If the process is managed well, the stakeholder interaction can increase understanding and trust. This implies that it is not possible to fully specify *ex ante* which values need to be taken into account. This aspect 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). that 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. It ignores the values, interests, and expectations that project stakeholders have despite the significant impact of how these stakeholders engage with local communities.

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 the proper and appropriate distribution of costs and benefits of a project. The project stakeholders have expectations about the public stakeholders and their responses to the project, on the one hand, and about the development and decision-making process on the other.

These expectations articulate specific values and therefore need consideration in the value-sensitive design of energy projects. For instance, imagine that a project developer announces his plan in a local newspaper, and citizens may respond to that plan based on their expectations of what the project entails and the consequences it may have to their living environment (*distributional* justice issues), whether they would have a voice in the decision-making processes, and how the project will be realized in their community (*procedural* justice issues). They may attend a public hearing and voice their ideas and concerns, to which, in turn, the project developer will respond. Stakeholders' expectations regarding each other, the technology and the decision-making procedure shape their specific values. This specification is a dynamic process; neither the specified values nor the operationalization of the values are fixed in the design process. The project developer may expect the public to be ill-informed and risk-averse; a deeply rooted belief (see Wynne, 1993, Wynne, 2001). Interaction is then likely to be geared towards providing technical facts that underscore the safety of a project. Yet, actually, the public may be more concerned about procedural issues, such as 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, by providing "the hard facts", may actually provoke public opposition.

The Not In My Backyard (NIMBY) label is another well-known example of framing that might increase the gap experienced between project stakeholders and local communities. This label is often used to explain public resistance to (local) technology projects. The NIMBY notion implies a social dilemma: it suggests that citizens have a favorable attitude towards a specific technology (e.g. wind energy) that becomes a negative attitude when the siting of that technology is "in their backyards". This is a simplistic understanding of public response that also proves to be invalid in many cases (Wolsink, 2000). The NIMBY label frames the public as concerned only with its own short-term interest. As such, the NIMBY label influences the dynamics of the debate by steering it 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'".

This example illustrates the dynamic nature of value specification through stakeholder interaction. This is an important notion for value sensitive design. The emergent and dynamic nature of value specification demonstrates that a full *ex ante* assessment of relevant and conflicting values is not possible. Designing for values requires a continuous and flexible participatory approach. If managed well, such a participatory approach can increase trust and mutual understanding between the stakeholders which is necessary to facilitate the shaping of widely supported technological and institutional designs. This approach should be symmetrical in its consideration of the values of the project stakeholders and those of the local communities affected by the project. It should also include the interaction between these groups of actors and the dynamics of value specification that results from this interaction process. The vales that are articulated by stakeholders shall incorporate expectations about the project and its impacts, about the decision-making procedure, and about the other stakeholders involved in the process. Finally, the approach should be sensitive to specific contextual factors which may render some values more salient in context A than in context B. Value sensitive design will never be a blueprint but it must target a specific context in which specific cultural, political and economic factors shape the process of value specification.

5. Value sensitive design

Value sensitive design aims at systematically incorporating diverse 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, Taebi and Kloosterman, Forthcoming). Scholars of VSD argue that the design process has value implications because 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 such as which values are affected in what way by technological design? Who is affected? 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 analyze the technical artifact or system to assess how they support or undermine certain values and inspire 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, once we are familiar with the conflicting values, it is not clear how trade-offs could be dealt with. 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 the case of the technological design of energy systems but also in institutional design and in designing public participation. As shown above, values are specified in dynamic social processes and are embedded in the formal and informal institutions that surround a major technological system. Hence, in the iterative approach of VSD, we will analyze 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 supposedly 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.

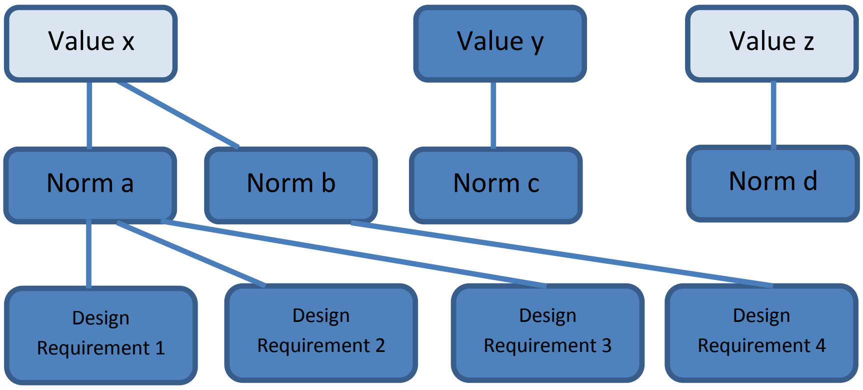

Figure 2: The three levels of value hierarchy: i.e. values, norms and design requirements.

The value hierarchy can be used both as an analytical tool and as a design tool. As an analytical tool, it can help to analyze *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 (analyze *why*) and it can help to illuminate controversies when values and/or norms were specified in the design process but not incorporated in the design (analyze *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 that 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 that 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 in future work is to identify and understand the conflicting values and controversies (see also Taebi et al., 2014). Then we will move on to apply the value hierarchy in the design tool fashion. In the design fashion, VSD will explore the potential for changing technological features or institutional design characteristics in a way that conflicts can be resolved. Indeed, controversies and conflicting values may fuel technological innovation as they did in the Eastern Scheldt Estuary. Moreover, controversies may also give rise to substantial changes in the institutional context including the rules for decision-making.

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

Energy projects are strongly driven by market incentives and regulation. However, for their successful implementation, a focus on market and regulatory incentives alone is insufficient. Even when externalities and transaction costs are effectively incorporated in the project design, economic evaluation ignores the dynamic in stakeholders' values. These omissions may cause trouble in the implementation of projects even though they may seem rational from an economic perspective. Stakeholders' values are also influenced by the specific process through which an energy project is initiated and licensed. So, for the successful initiation of an energy project, it is important to pay attention to the process through which the project becomes established and to the stakeholders' values that are addressed in this process.

Each design process embeds latent values in technologies and in its institutional environment. By making the potentially conflicting values explicit, they can be accommodated in the design of technologies and institutions. Anticipatory actions can be taken, so that the expensive and cumbersome management of potential public controversy can be avoided. The approach presented in this paper opens up the black-box of values and provides an analytical framework with which value conflicts around energy projects can be managed.

A challenge for VSD is how to use the identified value conflicts to (re)design technologies and institutions. The value hierarchy suggests that we first have to find out which values and norms are embedded in technologies and institutions and which are specified by the various stakeholders. Then the sets of values and norms have to be translated into design requirements. To do so, we will have to address the following questions:

- Are there any values and/or norms missing in the current *technological* design? How can these be specified into design requirements?
- Are there any values and/or norms missing in the current *institutional* context? How can these be specified into design requirements?
- Do the processes in which the different groups of stakeholders interact allow for the specification of all stakeholders' values?

Until now, the framework proposed in this paper has been based on theoretical notions. Empirical and contextual detail will shed light upon a number of important questions that as 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 satisfactory (re)design of both elements, which prompts questions such as: are people willing to accept a technological artifact in their backyard, if their values are taken seriously in a well-designed institutional context? Under what conditions would they do so? In other words, what determines the flexibility of public acceptance? This question cannot be answered theoretically; it clearly urges the operationalization and empirical testing of our framework. The framework we propose, promises an integral approach to manage value-laden conflicts in the development of new energy projects.

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