Smart Grid- Smart Thinking?

Exploring the construction of end-users in Danish Smart Grid pilot projects

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Supervisor: Susse Georg
Student: Laura Bothilde Taisbak Jørgensen
Student number: 20151854

Abstract

The research conducted in this thesis aims at exploring the way in which private household consumers and their consumption constructed in the Danish smart grid demonstration projects, eFlex and EcoGrid EU, as well as discuss what the implications of this construction are, in regards to future smart grid development. This research is conducted in a exploratory and primarily inductive way, in which a concluding report from each project undergoes a process of document analysis to investigate the way in which the consumer role was understood and simultaneously constructed. Following this, a literature review is presented in which the findings made in the document analysis is held up against findings made within the scientific community. The findings made both in regards to the document analysis and the literature review are then discussed in regards to their implications in relation to a future national implementation. Finally, a collective conclusion of the research is made. The thesis concludes that the projects' approached consumption as being the result of conscious decisions made by the consumer and could therefore be changed, were the right information and incentive found. This framing of consumption was questioned by the thesis, primarily in light of the limited success achieved on the basis of this individualistic approach. Furthermore, the projects' focus on automated consumption change is critically reviewed in light of the limited impact in contemporary Denmark.

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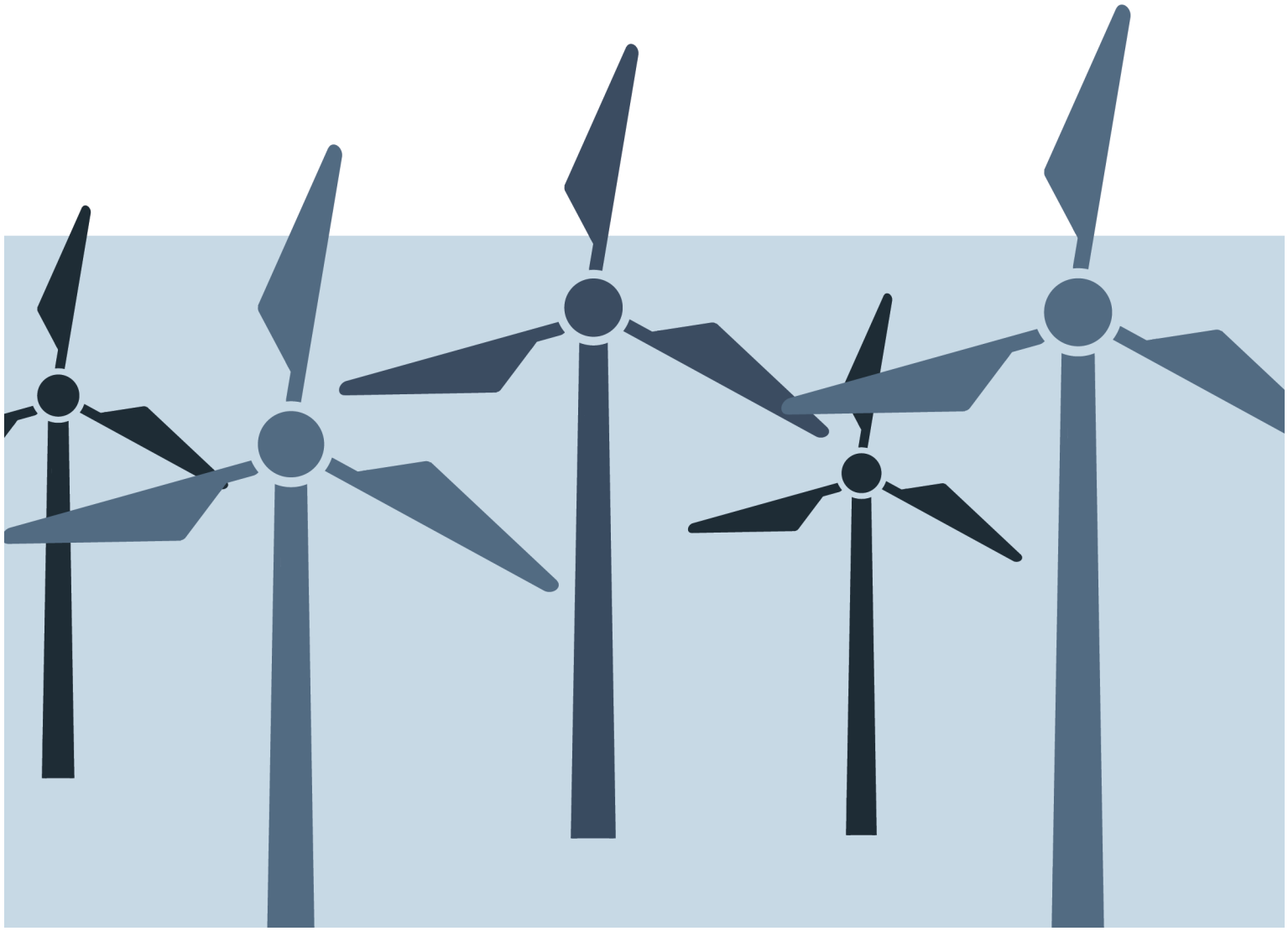
1. Introduction



1.1 Problem area

According to the OECD (OECD in Klima - og Energiministeriet, 2011), the world's population will increase up to 9 billion by 2050. In addition to this, an increasing number of the world population are becoming richer and demands energy for electricity, heating, transport and industry. The International Energy Agency projects that by 2035 the world's collective energy consumption will have increased by 35%; a development primarily fuelled by a growing demand from developing countries and the rapidly growing economies such as China and India (Klima - og Energiministeriet, 2011). However, the demand for energy is increasing at a higher rate than new energy deposits of non-renewable energy sources, such as oil and coal, are found (Klima - og Energiministeriet, 2011). Not only are these energy sources becoming scarcer, the deposits are also getting more concentrated in politically unstable nations, making dependency on these resource increasingly risky (Klima - og Energiministeriet, 2011). Furthermore, especially the oil and coal industries are inherently connected to environmental difficulties that directly conflict with EU's environmental goals and global responsibility in regards to minimizing climate change. Due to the aforementioned factors, it is vital to effectively explore alternative and renewable energy resources to ensure the stability of future energy systems and climate.

In a Danish context, this is addressed in the government's ambitious 2050 goals of becoming independent from coal, oil and gas by 2050 (Klima - og Energiministeriet, 2011). In order to obtain this, it is key that sectors such as transportation and heating to a large extent be fuelled by electricity generated from renewable resources such as wind and solar. However, despite the Danish electricity grid being very developed, transitioning these sectors to electricity will create a significant strain on the grid, requiring costly investments in grid improvements and reinforcements (Energinet & Danish Energy Association, 2012). In addition to this, energy production from renewable resources like wind and solar, are innately unstable, as it cannot be controlled when the wind blows or the sun shines. Therefore, new ways of storing the energy, as well as an increased flexibility in energy consumption is needed (Energinet & Danish Energy Association, 2012). Especially flexibility becomes essential, as fitting consumption to production is needed to support a successful transition to renewables. Furthermore, flexible consumption could potentially play a crucial role in postponing the impending need for grid improvements through peak shaving (Energinet & Danish Energy Association, 2012). In order to achieve said flexibility, all households are by law required to have intelligent meters installed by 2020 (Larsen & Jensen, 2013). This was decided, as intelligent meters that can be remotely controlled first of all opens up for a better understanding of the dynamics of consumption, as well as permits

for the needed communication to individual households and potentially individual electrical items to take place, allowing for strategic turning on and off of items when attempting to shave peaks or fit consumption to production (Redaktionen, 2013). In connection with the government decision to install these meters, it was also decided that the grid companies would be allowed to charge the expenses associated with the new meters to the end users of the electricity, through tariffs (Larsen & Jensen, 2013).

In the light of smart grid's focus on flexible consumption, the consumer stands to potentially get a completely new role in the energy system. Opposed to the current energy system, the smart grid consumer now has a product to offer the distribution system operators (DSO) and transition system operators (TSO), in the form of flexibility (Energinet & Danish Energy Association, 2012). Therefore, getting a better understanding of the consumer and actively shaping the user role is a crucial stepping-stone in achieving smart grid objectives of demand side management (Energinet & Danish Energy Association, 2012). In this regard, the concept of users refers both to business and private household consumers. However, as the Danish domestic energy consumption in 2015 accounted for approximately 30% of the collective Danish energy use (Energistyrelsen, 2016), this user segment can potentially serve as a powerful resource for peak shaving through flexible consumption. Out of the 30%, approximately 20% of the domestic energy consumption was used on electricity (Energistyrelsen, 2016). This number can however be expected to increase, due to the previously mentioned future electrification of the transport and heating sector. Furthermore, the fact that the current consumer funded implementation of intelligent meters is to be completed within the next three years, means that strategies addressing how to effectively achieve flexible consumption from private consumers is to be decided in the near future (Thornbjerg, 2017). Therefore, the potential in regards to flexibility within the domestic segment, combined with the impending shaping of strategies to achieve this flexibility in 'real life', makes research within this area highly relevant.

Prior to costly nationwide implementation of new technologies and concepts, demonstration and pilot projects can be powerful tools for testing out options in an attempt to minimize uncertainties and increase chances of success in later large-scale implementation (Harborne & Hendry 2009; Klitkou, 2016). Such projects are often governmentally driven and are especially used in regards to sustainable energy technology, where investment costs are high, market demand has yet to emerge, and returns longsighted (Brown & Hendry 2009). In line with this, the Danish Energy Strategy 2050 also stresses the importance of supporting and encouraging demonstration projects within the smart grid area (Klima - og Energiministeriet, 2011). As demonstration and pilot projects serve as a space for testing out

technology and concepts, their findings and recommendations can play an instrumental role in future large scale implementation (Harborne & Hendry, 2009). Therefore the way in which the understanding of consumers is navigated and the user role defined within such projects, can potentially serve as the foundation for real life implementation strategies. In light of this, this thesis aims at exploring the way in which private household consumption and the consumer role is constructed within two key demonstration and pilot projects: EcoGrid EU and eFlex, as well as discuss the implication of these findings in regards to future large scale implementation. This investigation will be exploratory in nature and the construction of the consumer role will be analyzed through document analysis of the concluding report produced by the two projects respectively.

1.2 Problem formulation

How are private household consumers and their consumption constructed in the Danish smart grid demonstration projects, eFlex and EcoGrid EU, and what are the implications of this construction in regards to future smart grid development?

1.2.1 Research questions

In order to adequately answer the above problem formulation, a set of research questions will be addressed, which provides the basis for the thesis' analysis, as well as the general structure of the report.

- How is smart grid understood in a Danish context?
- How are consumers and consumption understood in reports produced in relation to the chosen demonstration projects?
- How are consumers and consumption viewed in research within the smart grid literature?
- What shared tendencies and/or differences are there in the perception of consumers between the demonstration projects and research within the field?
- What are the possible implications of these tendencies/differences in perception of consumers in terms of large-scale implementation?

1.3 Delimitation and conceptual clarification

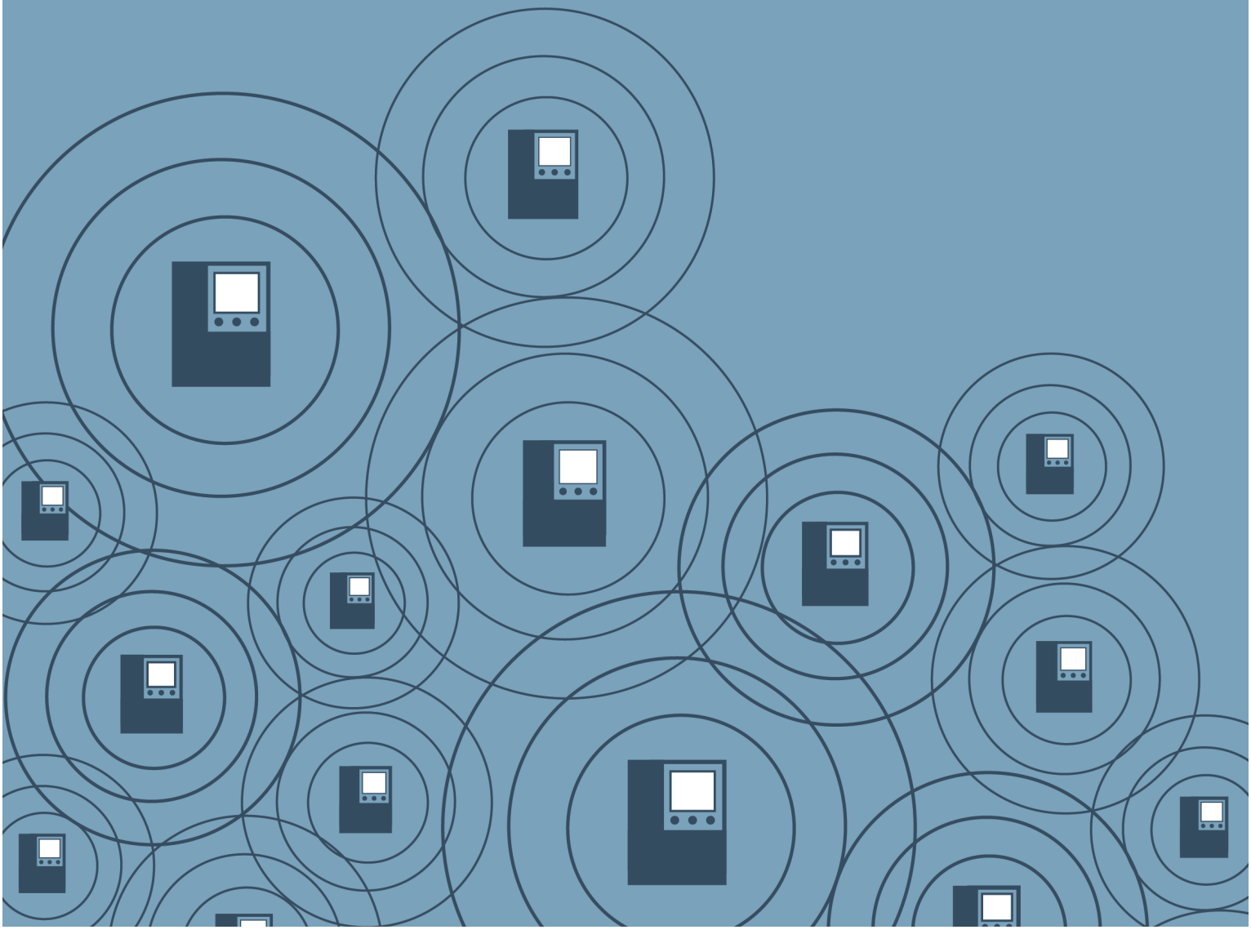
Given the thesis' focus on household consumption, the use of the terms users, consumers and consumption hereon in, is to be understood within the reference frame of domestic electricity consumption. Despite 'users' within the smart grid concept also referring to any segment that consumes electricity (i.e. businesses etc), these will not be included in the following.

Furthermore, this thesis only focuses on the understanding presented in the two documents analyzed. Therefore, alternative understandings in other reports produced by the projects are not included. In regards to eFlex the implications of this were minimal, as only two report has been published. One by a hired consultancy, antropologerne.com, and one by Dong Energy, which concluded on all findings made in connection to the project, the latter being chosen for analysis. In regards to the EcoGrid EU project, numerous reports have been produced throughout the duration of the project. The selected report for the EcoGrid project however aims at reporting on the overall evaluation and conclusions, and is therefore considered a credible representation of the project's general approach to users (see *2.5 Approach to Sampling & Criteria for Selection*). Moreover, no additional communication with the project developers will be included. Therefore, the project developers will not be asked to elaborate on the perception on consumers, or the construction of their role. Instead, this thesis approaches the selected documents as being capable of holding their own weight, and able of communicating the projects' respective understanding and approach to the consumer.

1.4 Structure of Dissertation

As previously mentioned the research conducted in this thesis is done so in an exploratory manner. Furthermore, the research is conducted in a primarily inductive way, in which a concluding report from each project undergoes a process of document analysis, to investigate the way in which the consumer role was understood and simultaneously constructed. Following this, a literature review is presented in which the findings made in the document analysis is held up against findings made within the scientific community. The findings made both in regards to the document analysis and the literature review are then discussed in regards to their implications in relation to a future national implementation. Finally, a collective conclusion of the research is made.

2. Research Strategy



The following chapter aims at clarifying the thesis' research strategy, including considerations made in terms of research design, philosophy of science, relationship between theory and data, as well as methodology.

2.1 Exploratory Research Design

The aim of exploratory research is to "*observe and invent useful formulations about the situation and the elements in a research question"* (Olsen & Pedersen, 2011: p. 186) and is often conducted in cases where the scope of research in question is inadequately understood (Stebbins, 2008). According to Olsen & Pedersen (2011), the purpose of exploratory research is to develop ideas, concepts & theories, assess whether the question warrants further investigation, as well as shed light on the possible ways a certain issue can be explored. In this way, exploratory research task is to analyze observations made and convert them into concepts and study the relations between these identified concepts (Olsen & Pedersen, 2011: p. 187). In line with this, Reiter (2013) argues that exploratory studies hold an untapped potential in allowing researchers to pose new questions and provide new explanations, by looking at reality from a new angle. It is exactly this, that is at the heart of this research. Though user dynamics and smart grid are not per say unexplored areas of research, analyzing the way in which users and their associated consumption is constructed, viewed, and understood within the specific context of the selected cases, is new. Furthermore, as is also argued by Stebbins (2011), it is better to abide by the rule, when in doubt explore, rather than its opposite, when in doubt confirm. By following this rule, the researcher avoids premature theoretical closure and the risk of missing something important in the rush to confirm, this being a far more unfortunate situation than failing to initiate confirmation (Stebbins, 2011). This notion of adequately exploring before confirmation becomes increasingly relevant as social life changes more rapidly today than ever, making "*a program of continuous exploration a good practice even in well-explored fields, to ensure that new developments will find their way into established theory to avoid the narrowness that comes of syllogistic reasoning*" (Stebbins, 2011: p. 9).

The exploratory research conducted in this thesis is done by analyzing *repeating ideas* identified through qualitative document analysis (further elaborated in subchapter *2.4 Approach to Document Analysis*), with the aim of converting said *repeating ideas* into *themes* and study the relations between these *themes*. Thereby, this thesis sets out to explore and identify how consumers are understood and their role constructed within the selected projects, as well as the implication of these perceptions on the consumer's role in a

future smart grid. As exploratory research does not aim at making clear cut conclusions about a given phenomenon, but is rather driven by a, as previously mentioned, desire to shed light on a complex situation (Olsen & Pedersen, 2011: p. 187), this thesis does not aspire to provide 'rights' and 'wrongs', but rather wishes to identify and analyze commonalities and differences between approaches to understanding consumers. In addition to this, the author of this thesis hopes that the findings made throughout the research process will inspire further research and reflection by the Danish governmental body, as well as the scientific community, in regards to how to navigate the complexity of consumption and consumers in relation to smart grid.

Due to the open-endedness of exploratory research, it is natural to question when research of this nature can be considered finished. In this regard, Stebbins (2008) argues that ideally a field of research, approached by the canons of exploration, can be temporarily concluded when the exploration reaches a point at which a coherent grounded theory about a phenomenon has emerged. However in this regard, this thesis is more humble in its stance and does not expect to be able to propose a coherent theory, but instead offer valuable insights that can provide the foundation for further research with the possibility of theory development. Therefore, the research conducted in this thesis shall be considered concluded when the researchers believe that common trends and differences in the narratives on consumers presented in the documents, have been identified and analyzed to a satisfactory level, that allows for the findings made to begin moving from inductive exploring towards deductive confirmation. This understanding of completion of exploratory research is shared by Reiter (2013), who argues that "*exploratory research is over once the empirical reality referred to be a concept or theory is explained so that 'it makes sense' to the researcher"* (Reiter, 2013: p. 11).

Reiter (2013) argues that in order for exploratory research to live up to its potential to provide new and innovative ways of understanding reality, as well as to increase validity, it needs to be performed in a "*transparent, honest and self-reflexive way - and follow a set of guidelines that ensure its reliability*" (Reiter, 2013: p. 1). Here, Reiter refers to a solid reflective foundation grounded in philosophy of science, in combination with a comprehensive and well-justified methodological framework. Therefore, the following sub-chapters aim at addressing considerations made in this regard.

2.2 Considerations in Terms of Philosophy of Science

Considering one's ontological orientation when setting out on any academic journey is crucial, as decisions about what counts as real and what we accept as a fact inherently impact our strategy of investigation (Reiter, 2013: p. 1). This sentiment, is further supported by Bryman (2011), who argues that it is impossible to separate one's ontological stance from issues concerning the conduct of research, as the ontological understanding feeds into the ways in which research questions are formulated and answered. In regard to ontological orientation, this thesis sides with constructionism, which challenges the notion that social entities can be considered objective entities that exist externally from social actors (Bryman, 2011). Instead, constructionism believes said entities are social constructions built by the perceptions and actions of social actors (Bryman, 2011). In other words, there is no objective external truth in matters regarding the social world. Seen in the light of constructivism, social phenomena and their meanings are continually being produced and reproduced by social actors (Bryman, 2011). This implies that not only are social reality produced through social interaction, but they are in a constant state of flux. Therefore, researchers will always present a specific rendition of social reality, which can never be regarded as definitive (Bryman, 2011). This thesis' adopted ontology is also reflected in the problem formulation and associated research questions, as it is concerned with how the selected projects understand, and through their design of concepts construct, consumers and their role.

Reiter (2013) argues that to understand reality as being socially constructed "*means to be aware that there are no unmediated facts, that whatever action we can think of is first perceived by someone, then interpreted, and finally used in the perceiver's own effort to make sense of it by placing it within a framework of available reference"* (Reiter, 2013: p. 6). This quote epitomizes the importance of analyzing the way in which concepts are constructed, as these constructions serve as a reference frame for sensemaking attempts by actors within the social context. This is a crucial point, as it addresses the notion that despite social actors actively produce and reproduce social reality, they do so by reappropriating the ways in which the social world is currently understood and navigated. In other words, we cannot think about the world without using the very references we have created (Reiter, 2013). This then begs the question of how such references are conveyed and imprinted in the social world. One of the ways such understandings of social reality is conveyed is through the way in which we describe the social entities it consists of through words. On this matter, Reiter argues "*words not only help us explain and make sense of the world by ordering it, hierarchizing it, and putting it into neat categories to which we then attribute causal relationships; words also create realities and they restrict the possibilities of action"*

(Reiter, 2013: p 5). By wording things, we give them reality. This underlines why it is so crucial to analyze the way in which consumers are described and simultaneously constructed by demonstration projects, as construction of consumers can potentially play a defining role in the future legislation and market structures that will effectively shape the smart grid. In this regard, it is necessary to point out that when mentioning *descriptions* in relation to the construction of consumer's, these descriptions refer to written words found in official reports, papers, and documents, and thereby does not include spoken descriptions.

Upon having reflected on the thesis ontological position, it is relevant to also reflect the project's epistemological orientation. According to Bryman (2011), epistemology concerns the question of what is, or should be, regarded as acceptable knowledge in a discipline. In this regard, this research situates itself within interpretivism. Interpretivist work, can produce detailed examinations of causal mechanism in a specific case, and aims at explaining how particular variables within said case interact (Lin, 1998). Therefore, the research conducted in this thesis does not claim to make findings that are directly applicable to other cases, as the findings made are considered situated in the specific case context. However, this is not to say overarching themes cannot be shared across cases, as similarities between the two cases reviewed in the document analysis, as well as in studies used in the literature review, can be identified.

2.3 Conducting *Primarily* Inductive Research

Exploration and inductive reasoning are important in science, partly because conducting deductive research alone, can not bring to light new ideas and observations (Stebbins, 2008: p. 3). According to Stebbins (2008) the outcome of exploratory research is the "*production of inductively derived generalization about the group, process, activity, or situation under study"* (Stebbins, 2008: p. 2). As Stebbins illustrates with this quote, exploratory studies and inductive logic are closely intertwined. This is due to the nature of exploratory research, as outlined earlier in this chapter, especially in light of exploratory research's aim at making generalizations based on analysis of empirical data. In this way, exploration stands in stark contrast to deductive reasoning that aims at confirming, or disprove, hypothesis rooted in theory, through findings made in empirical data. In opposition, with an inductive stance, theory is the outcome of research (Bryman, 2011).

The research conducted in this thesis was done so in a *primarily* inductive manner. *Primarily* is stressed in this regard, because research cannot start from nowhere (Reiter, 2013). Who

we are, our backgrounds, interests, training, and culture will inherently influence not only the questions we ask, but how we ask them, and in what light we perceive the answers we get. This goes back to the thesis' aforementioned philosophical stance on objectivity in research within the social realm and underlines that our knowledge is unavoidably situated, and the worst thing researchers can do, is pretend that it is not (Reiter, 2013). Instead, any researcher needs to critically reflect on how their approach to their study of scope may be shaped by the situatedness of their knowledge. This reflection becomes crucial, since acknowledging that bias is unavoidable means that such bias can only be fought with transparency. Therefore, in the name of transparency I will now critically look at the ways in which my 'baggage' may influence the way I approach and conduct the following research. Here it should first and foremost be stressed that one of the primary foci of my educational background is environmental sustainability. This choice reflects not only on my theoretical and academic sensemaking tool box, but also on my approach to environmental matters. In regards to the latter, it can be described quite simply; I find environmental issues to be dire and one of the most important aspects faced by contemporary society. In light of this, and despite of my educational background emphasizes the importance of approaching matters critically, I stand at risk of being positively biased towards environmental solutions. Furthermore, in regards to the role of users, I am of the belief that actively involving users in co-creative activities can be highly beneficial. This also introduces a risk of bias when examining aspects such as user involvement in the concept designs tested in the case projects. However, these possible biases shall be continuously reflected upon in an attempt to minimize their impact on the conducted research.

The fact that inductive research within the social realm, cannot be completely 'theory-free', to be understood as the above mentioned situatedness of knowledge, also opens up for the notion that the findings made in any study of this kind, will be tentative. By admitting to the tentativeness of findings and explanations of social reality, "*exploratory research provides more or less plausible and hence fruitful ways to examine and explain reality that can be shared, if successful and plausible, after a critical evaluation"* (Reiter, 2013: p. 4). This understanding of inductive exploratory research thereby opens up for the possibility that competing and even rivaling explanations of the same phenomenon can co-exist (Reiter, 2013). Seen in this light, the research conducted in this thesis is one possible understanding of the dynamics at play. This is not to be understood as an attempt to question the quality of the findings made in this research, but instead a reflection of the nature of research within the social and socio-technical realm.

2.3.1 Conducting Qualitative Research

Within the scientific community, there seems to be an understanding that exploration is synonymous with qualitative research; this is however not always the case (Stebbins, 2011). In general terms, the first emphasizes the development of generalizations based on observations and ultimately the development of theory, whereas the latter is concerned with methodology and the collection of data, on which grounds these developments are made (Stebbins, 2011). This being said, in most exploratory studies, qualitative data predominate (Stebbins, 2011).

According to Bryman (2011), on the face of it, there seems to be little to the distinction between quantitative and qualitative research, except that the former employ measurements in the form of numbers, which the latter does not. In this way, qualitative research is primarily defined by what it is not; quantitative. However, Bryman goes on to argue that the distinction between the two can be used as a helpful umbrella that covers considerations in regards to both philosophy of science, research design, and methods. In this way, he sees the distinction as a general orientation to the conduct of research, that dictates the options within the aforementioned areas (Bryman, 2011). However, in this thesis, the qualitative/quantitative distinction is seen exclusively as referring to the nature of data collection and processing, chosen on the basis of philosophy of science and research strategy, thereby adhering more to the understanding provided by Stebbins (2011) above. In other words, it is the researcher's stance that one's research design, together with one's ontological and epistemological understanding, sets the stage for what methodology for collection of data is appropriate.

In the light of this thesis' philosophy of science orientation rooted in constructivism and interpretivism, as outlined earlier in the chapter, quantifying empirical data findings as a foundation for analysis, seems to be a gross simplification of an inherently complex social reality. This being said, certain findings will be presented in a quantitative manner in relation to the document analysis. These findings primarily relate to aspects such as how much literary space, in the form of written pages, identified aspects addressing consumers were given. However, such findings are never presented without an associated qualitative exploration of the nature of the finding. Therefore, the research conducted in relation to this thesis is considered to be conducted in a *primarily* qualitative manner in the shape of qualitative document analysis, which will be outlined below.

2.4 Approach to Document Analysis

Prior to embarking on document analysis, it is relevant to first reflect on what is perceived as being a 'document' within this research. In this regard, Bryman (2011) have provided a set of criteria for documents suitable for document analysis:

- *It can be read*. This is relevant as arguably images can also be considered documents, or a fundamental aspect of a larger document. However, in this research the criteria for readability is narrowed to only include written content.
- *The document has not been produced specifically for the purpose of research*. This implies that the document has not been produced with the aim of scientific scrutiny by external researchers.
- *The document is preserved so that they become available for analysis*; and
- *The document is relevant to the concerns of the research being conducted.*

These criteria serve as the minimum requirement in regards to the nature of the documents which will be analyzed in this thesis. Further criteria, that more narrowly specifies what is understood as a document that is '*relevant to the concerns of the research'*. However, these criteria will be elaborated in the subchapter *2.5 Approach to Sampling & Criteria for Selection*.

Coarsely explained, document analysis focuses on the searching-out of underlying themes in the material being analyzed (Bryman, 2011). The process through which these themes are extracted may vary, but in most cases trends and themes are identified through some level of coding (Bryman, 2011). However, the specific approach to this process of coding can differ drastically in their rigidity and their structure. This thesis' approach to the coding process will be discussed in detail in subchapter *2.4.1 Coding of Documents*.

The unobtrusiveness of document analysis is often stressed as being one of its key advantages (Bryman, 2011). This unobtrusiveness is tied to the second criteria in Bryman's above outlined framework; *the document has not been produced specifically for the purpose of research.* In this way, document analysis escapes the possible tainting of data introduced by changes in behavior due to being observed or questioned, which is a common threat to the validity of empirical data collected through, for example, interviews (Bryman, 2011). This being said, it is important to be mindful of the fact, that documents are never 'innocent' and unbiased (Bryman, 2011; Rapley, 2011). Though the researcher may avoid bias introduced by their mere presence in the data collection process, one cannot avoid the bias introduced by the author of the document's persuasive intention (Rapley, 2007). In this regard, Atkinson

and Coffey argue that document's and the reality that they represent, should not be taken as a transparent representation (Atkinson and Coffey in Bryman, 2011: p. 555). Here, the central point is that documents need to be acknowledged for what they are; texts written with distinctive motives in mind and not something that merely reflects reality (Bryman, 2011). In an attempt to minimize such bias, it is important to reflect on the sender, their intended receiver, as well as the sender's possible intentions in regards to the enrollment of their readers to a certain thought process or understanding (Rapley, 2011). Therefore, the sender of the documents and their intended receiver will be reflected on in subchapter *2.5.1.1 Selecting the Samples within the Cases*.

2.4.1 Coding of Documents

Coding, as an approach to data processing, provides the backbone of document analysis by allowing for analytical reflection through the revealing of themes within documents. Put simply, codes serves as shorthand devices to label, separate, compile and organize data (Bryman, 2011).

The inductive coding approach employed in this research is inspired by Auerbach & Silverstein (2003), which is comprised by three main steps. The first step includes cutting down the text to manageable proportions, as not to be overwhelmed by it (Auerbach & Silverstein, 2003). This is done by reading through the selected documents with my research concerns in mind and keeping text that is relevant for answering my research questions. This text is classified as *relevant text* (Auerbach & Silverstein, 2003). All *relevant text* is kept and the rest discarded, making the text easier to work with. At this point, the selection process is not too tightly defined and all text that seems interesting can be marked a *relevant text* for the time being. This allows for also keeping text that does not address users or consumption directly, but may still indirectly give clues to the pilot or demonstration projects representation of these elements.

Having now selected the *relevant text*, the texts are read through again and comments are added to specific words and sentences, reflecting on what the essence of the word or sentence is or can mean, with reference to the research question (Auerbach & Silverstein, 2003). At this point the researcher begins noticing that the documents often use the same or similar words and phrases to express the same idea (Auerbach & Silverstein, 2003). In this regard Rapley (2011) argues that it is important to reflect both on what is said; how a specific argument, idea or concept is developed, as well as not being said; the silences, gaps or omissions. These omissions are considered *noticeable absent features of a text* and are tied

into our culturally shared knowledge and expectations that we routinely seek for (Rapley, 2011). The aforementioned recurring ideas are called *repeating ideas* and with them, certain tendencies begin to emerge. At this point the essence of the *repeating ideas* is investigated, and based on this, a code is made. In other words, we begin the process of categorizing the different tendencies. These codes will be in a constant state of potential revision throughout the document analysis, as the researcher gets a deeper understanding of what the codes show, through the continuous appearance of texts that share the underlying meaning, as the codes already established (Bryman, 2011).

Once these *repeating ideas* are labeled as codes, we begin to understand the dynamics at play in regards to the construction of the user role in the cases, as groups of *repeating ideas,* that has something in common, emerges. These common denominators within these groupings are then considered a *theme* (Auerbach & Silverstein, 2003).

On the basis of this, it may become evident that the two cases share *themes* and even *repeating ideas*, presenting a form of framework for the navigation of the user role within the different cases. In this way, the overarching *themes* may be present in the different cases, despite the way in which they describe users (*repeating ideas)* within said *themes,* may be different.

When identifying codes and themes, one is actively engaging in interpreting the findings made within the chosen documents (Bryman, 2011). This is something many researchers are wary of, as they fear that they may not do justice to what is said within the documents; that they may contaminate the sources' words. In this regard, Bryman (2011) stresses that it is important not to simply say 'this is what my documents said, isn't that interesting?' It may very well be interesting, but it only holds any significance within an intellectual community, when you have reflected on, as well as interpreted, what is being said (Bryman, 2011). In other words; "*you are not a mere mouthpiece"* (Bryman, 2011: p. 578).

2.4.1.1 Criticism of Coding

According to Rapley (2007), one of the most commonly mentioned criticisms of the the coding approach to qualitative data analysis is the possibility of losing the context in which the selected chunks of text appeared. This is a valid critique, however here it seems relevant to once again stress that the documents are first read in full, and then selection of *relevant texts* are made. Thereby, it is the researcher's aim to be mindful of the context when analyzing the chosen bits.

2.5 Approach to Sampling & Criteria for Selection

When conducting document analysis, it is relevant to reflect on one's sample selection of documents, as well as the criteria that constitutes the grounds for such selection. In regards to the selection of cases and their corresponding documents used in this research, a purposive sampling approach was taken. A purposive sampling approach entails selecting samples with reference to the goals of the research (Bryman, 2011). In other words, the goal of purposive sampling is to sample cases in a strategic manner, so that their related documents, that are to be subjected to analysis, are selected in terms of criteria that will allow the problem formulation to be answered (Bryman, 2011). In this way, purposive sampling differs from a convenience sample in that it is not simply available by chance to the researcher, as is the case with the latter (Bryman, 2011). Hood has pointed out that there seems to be a tendency among researchers to identify all things qualitative with Grounded Theory (Hood, 2007 in Bryman, 2011: p. 442). This is, according to Hood, particularly the case in regards to purposive sampling, which is often treated as synonymous with theoretical sampling; a sampling approach that is a crucial part of the Grounded Theory framework. This however, Hood argues, is a faulty representation, as theoretical sampling is instead a form of purposive sampling (Hood, 2007 in Bryman, 2011: p. 442). Grounded Theory focuses heavily on the production of theory rooted in empirical findings and theoretical sampling therefore shares that focus (Bryman, 2011). Despite the research conducted in this thesis is, similarly to Grounded Theory, interested in generating themes, the aim is not to generate theory. This is also reflected in the chosen approach to sampling where, as opposed to Grounded Theory's iterative theoretical sampling, this research will rely on generic purposive sampling in which the researcher establishes criteria, concerning the kind of cases needed to be addressed to answer the problem formulation, identifies the cases, and then samples from those cases that have been identified (Bryman, 2011).

2.5.1 Selecting the Cases

In line with the framework for making generic purposive sampling, as outlined above, the following section will address the criteria made for the selection of cases. In this regard, the following criterion for cases were made:

- The projects have to differ in sender (i.e. DSO, TSO, government agencies)
- The projects have to be concluded, and thereby fully reported on
- They have to be conducted in a Danish context (performed in Denmark)
- They have to involve actors relevant to a possible 'real life' smart grid (i.e. DSO, TSO, electricity sales companies, users)

The first criteria is chosen based on a desire to investigate the perspective of consumer construction by more than one relevant actor of a future Danish smart grid. The second criteria is selected based on an interest in investigating the final conclusions of the respective cases, which is only possible if the projects have been concluded. Finally, the third and fourth criteria relates to the interest in exploring cases most directly applicable to a future large scale Danish implementation of smart grid.

Therefore, eFlex; the product of the DSO company Dong Energy Eldistribution (now known as Radius), and EcoGrid; the product of a larger collaboration of actors are chosen as cases, as they both fulfill all four criteria.

2.5.1.1 Selecting the Samples within the Cases

The aforementioned interest in focusing on concluded projects is highly related to the document samples available for analysis. Reiter (2013) argues that the choice of samples should be predicated by the logic of which samples will provide the richest and most telling insights into the cases, thereby providing the sturdiest foundation possible for answering the problem formulation at hand. In this regard, the focus on concluding reports is connected to the role pilot and demonstration projects play in regards to future implementation strategies (elaborated in greater detail in *3.2 What Role Does Demonstration & Pilot Projects Play?*). As such projects potentially help shape implementation strategies, concluding reports should entail a collective summary of the projects' efforts, as well as overall recommendations. Therefore, in terms of discussing the projects possible implication on future implementations, concluding reports hold the richest insights. As previously mentioned, only two reports were published in regards to the eFlex project, making the selection process slightly easier. Out of the two reports, one was produced by the hired consultancy; antropologerne.com and primarily addressed the behavioral study made in connection to the project. The second report, was produced by the project responsible, Dong Energy, and concluded on all finding made in regards to the project. Based on the argumentation above, the concluding report was chosen out of the two. Furthermore, the concluding report was chosen based on the author. As this thesis is interested in exploring the understanding of users within the pilot and demonstration projects, it seems natural to look at the report that was written by the project owners. In addition to this, Dong Energy being a DSO, and therefore a possible actor in a real life smart grid implementation, made hearing their take on users even more interesting, as opposed to an external consultancy. In relation to EcoGrid, numerous reports were published throughout the duration of the project. Some of these documents may have addressed the user role more directly, however it was decided that the concluding report should effectively conclude on findings made in all areas of the project; including how the

project navigated consumers. In this regard, it could be argued that numerous documents from EcoGrid could be sampled, however in relation to this, this thesis was guided by Bryman (2011) understanding of *sample sizes in qualitative research.* Bryman (2011) argues that sample sizes should be large enough to achieve *data saturation*, but not so large that it is difficult to undertake *deep analysis*. Here, *saturation* is understood as an adequate amount of data to soundly answer the problem formulation. However, this sense of 'adequateness' is determined by how much can feasibly be processed through thorough analysis. Therefore, what constitute as an adequate sample size in qualitative research will inherently be a subjective evaluation by the researcher. In light of this, this thesis chooses to focus on two documents in total (one from each selected case). Furthermore, as two cases have been selected with the objective of identifying similarities and differences, choosing documents that are the closest in aim, should arguably provide the best foundation for such comparisons.

In reference to the above, the document samples chosen for the document analysis is for the eFlex project the report; *The eFlex Project* (Dong Energy Eldistribution A/S, 2012) and for the EcoGrid EU project; *EcoGrid EU- A prototype for European Smart Grids: Deliverable D6.7 Overall evaluation and conclusion* (Energinet, 2016).

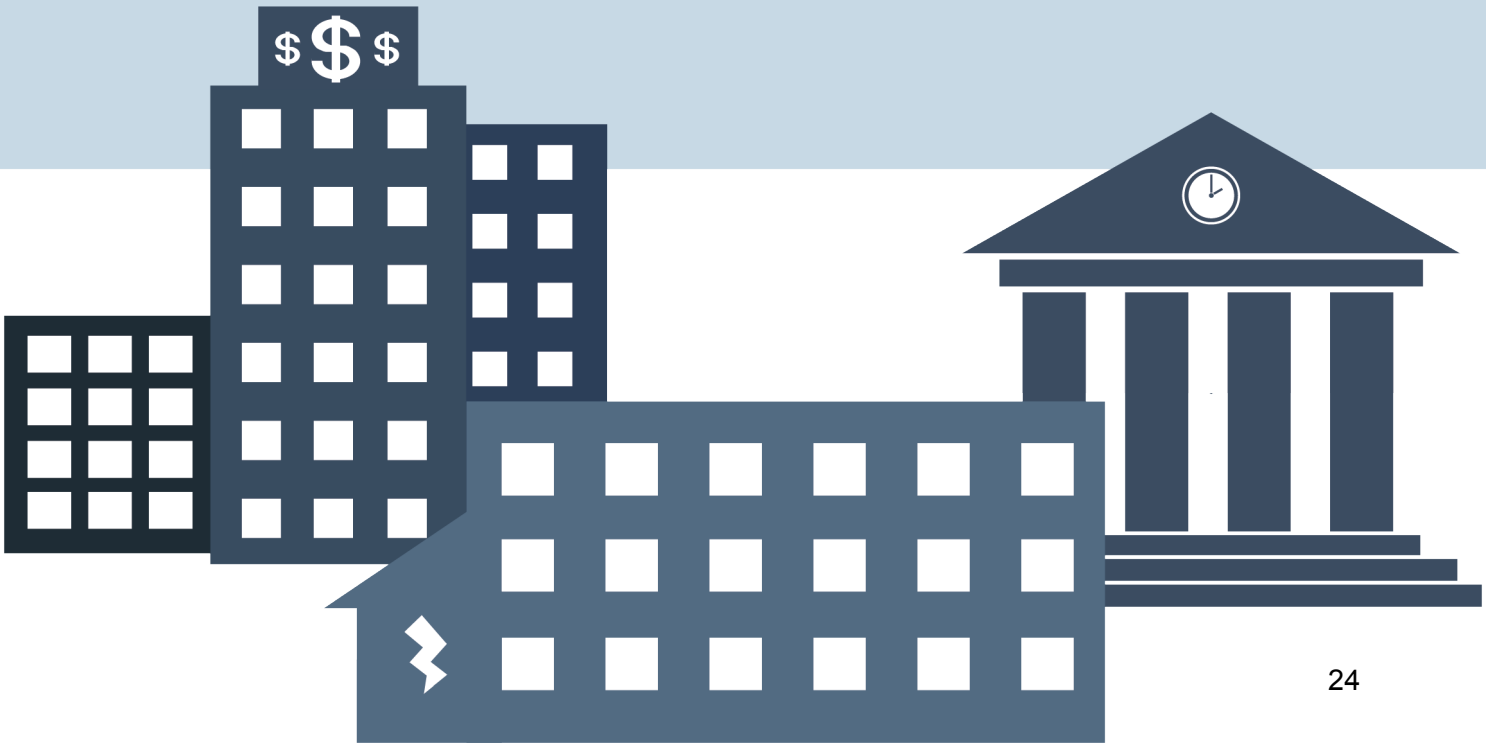
As previously stated, it is crucial to reflect upon the intentions of the sender, as well as the type of document being examined, prior to beginning document analysis as no document can be considered neutral. In this regard, it is to be expected that the reports may be positively biased towards the work conducted in the respective projects, as those reporting are the same as those that conducted the research. In extension of this, there is a chance that shortcomings of the project design may be minimized in the reports. Furthermore, the intended receiver should also be reflected on, as the *whom* the reports are written for can have an effect on *how* and *what* is written. EcoGrid's report is produced as a deliverable to the European Union's Seventh Framework Programme, from which the project received funding (Energinet.dk, 2016). Therefore, the findings reported may be presented more positively than what is actually perceived by the sender, to illustrate that the funding received was put to good use. In eFlex case, the report was produced as a part of an agreement with the Danish Energy Regulatory Authority (Energitilsynet, 2011). However, the project was self funded by DONG Energy Eldistribution (Energitilsynet, 2011) and therefore the report may not be as disposed to argue for the value of the research conducted, as compared to EcoGrid. This being said, it is impossible to know for certain to what degree, if any, these factors influenced reports. Despite this, the aforementioned factors shall be kept in mind when analyzing the reports.

2.6 Literature review

As a part of the analysis, a literature review was made to view the findings made through the document analysis, in the light of findings made in the scientific community. Therefore, the following will describe how this literature review was conducted.

When searching Google Scholar for the words 'smart grid', 'users', 'households', and 'consumption' there were ca. 22.300 hits. By a glance of the articles that appeared, it became clear that most focused exclusively, or primarily, on the technological aspect of smart grid. To align the literature more effectively with the focus of this thesis, the search was specified with the word 'social science'. This reduced the number to 1.320. As areas related to technology are in rapid change, it was decided to add a time interval, so that only articles written within the last five years (articles written 2013 or later) were included. This further reduced the number of articles to 912. I then looked at what journals were most apparent, and focused on the three most noticeable: Energy Efficiency, Energy Research & Social Science, and Renewable and Sustainable Energy Reviews. Given the above search words and the given timeframe, Renewable and Sustainable Energy Reviews had published 16 articles, Energy Efficiency had published 11, and Energy Research & Social Science had published 60. In total, that left me with 87 articles. In order to make my literature review more feasible, I selected all texts that had been cited by more than 20 times according to Google Scholar. This selection was made as a proxy of acceptability of the articles within the scientific community. This now left me with a total of 19 texts. The said texts were then, as inspired by Cecez-Kecmanovic et al.'s approach in their work (2014), categories in a grid, that outlined their primary focus, theoretical grounding, and research methods (see appendix 2). On the basis of this, texts were selected based on their closeness in scope of the research conducted in this thesis. Therefore, the selection was made based on the richness the texts provided in relation to the themes identified through the document analysis.

3. Research Context



3.1 Smart Grid in a Danish Context

Before we dive into the selected projects and the following analysis, some context into smart grid in Denmark will be given. The following will be primarily based on the smart grid concept proposed by the Danish Energy Association and the Danish TSO; Energinet.dk. Therefore, the following will only include one approach, out of many possible approaches, on how to navigate a future smart grid. However, the concept proposed by Energinet.dk and the Danish Energy Association is based on a set of recommendations published by the Smart Grid Network, which was set up by the Danish Minister for Climate and Energy (Energinet & Danish Energy Association, 2012), and is therefore considered a good proxy for the general political discourse on the smart grid matter.

According to Energinet.dk and the Danish Energy Association, the smart grid concept "... *mobilises and activates flexible electricity consumption and production from small customers. This happens through customers or appliances connected to the power system changing their behaviour – as and when requested – to fulfil the needs of the power system. For example, a heat pump might stop because a power line is overloaded, or an electric car adapts its charging pattern to balance out fluctuating wind power or solar energy levels*" (Energinet & Danish Energy Association, 2012: p. 5). This flexibility is, as previously mentioned, wanted by the DSOs to postpone investments in the distribution grid, and by Energinet.dk (TSO) to balance the entire power system. Following the passing of the wholesale model act, which addresses the distribution of roles within the electricity market, effectively resulting in the DSOs no longer have direct contact with individual customers (Energinet & Danish Energy Association, 2012). In relation to a future smart grid, this means that commercial players can "...*handle the flexibility, and compete on equal terms to deliver the most efficient*
and innovative product" (Energinet & Danish Energy Association, 2012: p. 5). The commercial players can then gather a sufficient volume of flexibility that can be offered to DSOs and Energinet.dk. This way, the DSOs and Energinet.dk only have to contact a limited number of commercial players to activate the flexibility when needed (Energinet & Danish Energy Association, 2012).

The concept distinguishes between two different mechanisms for activating flexibility. The first is through the use of price signals, which provides the consumers with a financial incentive to shift their consumption to beneficial times of the day, thereby avoiding grid congestion and providing balance in the grid (Energinet & Danish Energy Association, 2012). This is the mechanism that the eFlex and EcoGrid set out to test (see *3.3 Introducing the*

Projects). However, as flexibility based on response to price signals cannot be guaranteed, the second mechanism is flexibility products. Flexibility products are pre-arranged services, such as reducing loads in specific areas, that can be activated when needed by the TSO and DSOs for an agreed price (Energinet & Danish Energy Association, 2012).

In terms of the flexibility offered by private consumers, the concept primarily focuses on heat pumps and electric cars, though demand response in relation to other appliances are also mentioned (Energinet & Danish Energy Association, 2012). This focus is largely shared by EcoGrid EU and eFlex. Therefore, statistics based on data from Danmarks Statistik were made to get a better idea of the potential for flexibility from electricity based heating (see appendix 3). Between 2010 and 2017, the number of houses heated by heat pumps have more than tripled (appendix 3). However, the percentage of houses heated by heat pumps in 2017 is only 2.5%. In regards to electrical heating, the number has slightly decreased since 2010, going from constituting 10.4% of the total heating market in 2010, to 9.8% in 2017 (appendix 3). This means that in terms of the total amount of energy used on heating, only 12.3% are heated by options that could provide flexibility in regards to the distribution grid. Similarly, the amount of electric cars has come to a halt in Denmark (Dahlin, 2017), further questioning the potential for flexibility from this source. Though this implies limited potential for flexibility, this development simultaneously implies little strain to the distribution grid to begin with. As the shift towards electricity based heating and transport was identified as two of the necessary 'culprits' in straining the current grid while striving to fulfill the Danish 2050 goals (Klima - og Energiministeriet, 2011), the rather limited transition to such energy sources must also imply a limited associated strain to the grid. This presents an interesting dilemma as the lack of strain permits a lack of flexibility, seemingly sustaining the status quo.

3.2 What Role Does Demonstration & Pilot Projects Play?

Before proceeding to the analysis, it is relevant to first define what is meant by pilot and demonstration projects, as well as reflect on the role they play in development processes. Pilot projects and demonstration projects are closely related in terms of aim, in the sense that their main objective is to test technology, approaches, and concepts out prior to implementation (Turner, 2005; Harborne & Hendry, 2009). When new technology is to be implemented, it is common to perform some sort of pilot project, the idea being that "*the new technology is explored in an unobtrusive, experimental setting, where no harm can be done if the technology doesn't work and where best approaches to the use of the technology can be explored"* (Glass, 1997: p. 85). When such technology is to be implemented in socio-

technical settings, it would be natural to assume that pilot, as well as demonstration projects, also test out and explore user relations to the new technology, as is the case in the pilot and demonstration projects of interest in this research.

According to Turner (2005), pilot projects are crucial in terms of implementation, as they give insights, through the gathering of data, into how the element of study will function in practice, thereby facilitating decision making on a more knowledgeable foundation in regards to said implementation. Furthermore, by generating data through testing, the pilot studies can help reduce uncertainties in relation to the product or concept being implemented (Turner, 2005). In other words, the fundamental value obtained through pilot projects is learning, whether it be in terms of proving economic or technological feasibility of the element being implemented, or by uncovering risk, underlying dynamics, or needed improvements (Turner, 2005).

In terms of when a pilot study is performed, Turner's (2005) stance is that such projects take place as part of the introduction of something new, and therefore not as a part of routine operations. In regards to duration and nature, Turner argues that pilot projects are best described as a temporary organizations, with agency in their own right, under the umbrella of a larger programme (Turner, 2005). This understanding then ties back to the notion that these projects support decision making in a larger organ.

In regards to defining demonstration projects, many parallels to pilot projects can be drawn. According to Brown & Hendry (2009), demonstration projects, as is also true for pilot projects, appear in the 'preview' phase of development and innovation. However, demonstration projects often have a special focus on refining the commercial offering (Brown & Hendry, 2009). Brown & Hendry broaden the definition of demonstration projects to also include field trials, inspired by their understanding that these projects are performed out in the field. By field, they refer to operational environments in which the technology is used in customer installations, thereby making a I in the *field*. This can of course also apply to pilot project, but as opposed to the definition of a demonstration project, is not necessarily a requirement.

What is furthermore an interesting difference between the understanding of a pilot project and that of a demonstration project, is the emphasis given to *refining the commercial offering*. This aspect is further explored by Harborne & Hendry (2009) as referring to demonstration projects' focus on involving and enticing future adopters of technologies or concepts, being demonstrated in the projects. This present a new contrast to pilot projects,

which definition does not require the same involvement of varied actors. This difference may lie in the different funding, and therefore who acts as the primary drivers, of the two, as well as the role demonstration projects have previously played in regards to development of especially sustainable energy. Demonstration projects are, at least partially, funded by public funds, which in a European context either comes from the EU or specific nations governments (Brown & Hendry, 2009). In this regard, governmental organs often act as the primary drivers behind demonstration projects (Brown & Hendry, 2009). This is particularly true with sustainable energy technology, where the main driver for innovation is the public good, as market demands has yet to emerge, investment costs are high, and returns longsighted and uncertain at best (Brown & Hendry, 2009). In line with this, Hendry et al. (2010) argues that governmental intervention in the shape of demonstration projects, is especially important when the primary motivator behind development is not the market, but instead an urgent need to mitigate carbon emissions from fossil fuels to avert catastrophic climate change; a motivation that is arguably shared when discussing the development of the smart grid (Klima- og Energiministeriet, 2011).
Furthermore, this is not the first time a similar approach of field trials and demonstration projects has been used to stimulate sustainable development within the energy sector, as Harborne & Hendry (2009) argue that such initiatives played a crucial role in Denmark emerging from the 'California wind rush' victoriously.

Similarly to pilot projects, demonstration projects are temporary, and can help reduce uncertainties, by providing a low risk environment for the testing and development of technologies and concepts (Harborne & Hendry, 2009). Granted, and as illustrated above, demonstration projects do seem to have a more defined focus on the inclusion of varied actors and the building of supporting networks. What holds true for both pilot projects and demonstration projects is that they facilitate more informed decision making, through *learning by using* (Harborne & Hendry, 2009; Klitkou, 2016). This aspect makes these kind of projects especially relevant to study, as they hold the potential of influencing decision makers and thereby help shape a possible implementation model. In regards to the focus of this thesis, this means that the findings made, and approaches taken, in regards to end-users in the selected pilot and demonstration projects can have a defining impact on the approach taken to end-users in a future smart grid implementation.

For the research conducted in this thesis, one pilot project was examined (eFlex) and one demonstration project (EcoGrid). The two cases will be introduced in the following subchapter.

3.3 Introducing the Projects

Before a document analysis of the EcoGrid and eFlex projects can be conducted, an introduction of the projects has to be made first. The following introduction will include the objective, timeframe, scale, funding, number of actors, and conclusion of the projects. The introduction will give a basic insight into the EcoGrid and eFlex projects and provide a context for the analysis to be performed.

3.3.1 The eFlex Project

In the period from summer 2011 to summer 2012 Dong Energy Eldistribution (DEE) A/S, carried out the eFlex project in an attempt to investigate, what incentives could be applied to make private households participate in load shedding in the distribution grid (Dong Energy Eldistribution A/S, 2012). DEE wanted, through the eFlex project, to identify what incentives would lead to the greatest amount of flexibility in the form of load shedding, in order for DEE to postpone investments in grid capacity (Dong Energy Eldistribution A/S, 2012). The project was budgeted around 15 million Danish kroner, and was funded by DEE themselves as a part of the company's operating expenses (Energitilsynet, 2011).

The eFlex project was carried out using a sample size of 119 households located in the Dong Energy supply area in North Zealand and Copenhagen (Dong Energy Eldistribution A/S, 2012). The participating households were all volunteers, and were found "*partly through an advertising campaign and partly through an expression of interest in a public subsidy scheme for switching from oil-fired burners to heat pumps"* (Dong Energy Eldistribution A/S, 2012: p. 5). The majority of the participating households had heat pumps. As the number of heat pumps are expected to rise as a part of the electrification of the heating sector, they in part present some of the expected future strain on the distribution grid (Dong Energy Eldistribution A/S, 2012). However, the many heat pumps simultaneously present a significant flexibility potential.

As a part of the project, all participating households were provided with a home automation system with an integrated control unit, which would interrupt the heat pump during peak periods, and turn it back on when peak periods had passed (Dong Energy Eldistribution A/S, 2012). The automation systems were accompanied by a 'party button', which allowed for the participants to override the automatic control should they feel a need to do so. In addition to monitoring the heat pumps, the home automation system also offered the household the opportunity to closely monitor the energy consumption of various appliances, enabling the participants to switch appliances on/off either manually, or through a separate timer. Finally,

the households were also encouraged to use the social media, Podio, to share their tips and experiences with each other (Dong Energy Eldistribution A/S, 2012). The latter two options, monitoring other household appliances and sharing experiences on Podio, were aimed at increasing interest in energy consumption, within the participating households (Dong Energy Eldistribution A/S, 2012).

As previously mentioned, the heat pumps within the households were controlled by the automation system, which would shut them off during peak periods. The peak periods were identified using a price control scheme. The price was a combination of multiple factors, which included "*a spot market price, settled on North Pool day-a-head electricity market, a 3-step grid tariff, and the regular public service obligation and tax fees*" (Dong Energy Eldistribution A/S, 2012: p. 5). The automation system would then identify when the price was at the highest, shutting off the heat pumps, turning them on again when prices fell again. Also, as previously mentioned, it was possible for the households to shut off other appliances when prices were high, but this had to be done by the household itself and was therefore not automated.

As part of the eFlex project, an anthropological study of user behavior was also carried out by the consultancy firm antropologerne.com. The purpose of the anthropological study was to establish user profiles, *"characterized by a set of (partly overlapping) motivation drivers or incentives"* (Dong Energy Eldistribution A/S, 2012). The profiles identified in the anthropological study within the eFlex project showed, "*that although customers participated in the project on equal terms, they did so with different motives"* (Dong Energy Eldistribution A/S, 2012: p. 5). Four primary incentives were identified by the anthropological study: (1) financial gain, (2) technological interest, (3) resource optimization, and (4) concern for climate change (Dong Energy Eldistribution A/S, 2012). Based on these drivers, the anthropological study identified 5 different user profiles:

- The Technician
- The Economist
- The Curious
- The Sympathetic
- The Comfortable

(Dong Energy Eldistribution A/S, 2012)

In addition to the findings made in the anthropological study, conclusions made in the eFlex project were divided into two groups: technical project results and economic effect on the customer (Dong Energy Eldistribution A/S, 2012). In regards to the technical project results,

the eFlex project "*demonstrated that flexibility can be achieved in the private household without perceptible loss of comfort"* (Dong Energy Eldistribution A/S, 2012). However, the eFlex project was unable to generalize the aforementioned conclusion, since the flexibility depended on other factors such as the insulation of the house, the outdoor temperature, user behavior, and social conditions (Dong Energy Eldistribution A/S, 2012). Furthermore, it was concluded that the heat pumps could potentially be turned off for a longer period of time, than the one hour tested in the project, without the households overruling the automation control (Dong Energy Eldistribution A/S, 2012). During the project, the 'party button' was only used once every third month, which in turn indicated that the households comfort was not seriously challenged (Dong Energy Eldistribution A/S, 2012). A clear peak shaving effect was found in the project due to the automation of the control of the heat pumps, but compared to the remaining load on the grid generated by other household appliances, the significance of the achieved peak shaving was questioned (Dong Energy Eldistribution A/S, 2012). Furthermore, the project found that the period of time the heat pumps was interrupted, was too short compared to the average period of peak loads (Dong Energy Eldistribution A/S, 2012). Therefore, cascade control of the heat pumps was suggested as an approach to more effectively impact the peak periods. The last major technical finding made in the eFlex project was in relation to the expected thermal pattern. The project team expected, that after releasing an interrupted heat pump into normal operation, a so-called kick-back load would occur, as the heat pump recovered the missing energy supply (Dong Energy Eldistribution A/S, 2012). However, in the project though the kick-back load was not significant. The project team believed this to be the result of the households sustaining the temperature through other elements, such as cooking or using other heat generating appliances (i.e.wood stove furnaces), combined with heat from solar radiation (Dong Energy Eldistribution A/S, 2012).

The findings made with regard to the economic effect for the customer was that the eFlex participants had achieved an annual saving ranging from approximately DKK 250 to DKK 600 (Dong Energy Eldistribution A/S, 2012). The reason for the savings-span was mainly due to the level of insulation of the participants' houses and the degree of interest shown by the household (Dong Energy Eldistribution A/S, 2012). Furthermore, it was found that the "*... energy management practice provided by the home automation system enabled 10% savings on average as regards the electricity consumption"* (Dong Energy Eldistribution A/S, 2012: p. 7). The eFlex project team emphasizes though, that there cannot be made a generalized conclusion on this finding, since the result was "*generated under such conditions and on the basis of a group of customers with special interest in energy savings"* (Dong Energy Eldistribution A/S, 2012: p. 7).

Based on the findings made in the eFlex project, the project team presents a number of future perspectives. Firstly, the report emphasizes that it is possible to conclude that heat pumps in private households have a technical potential for delivering significant reduction of the peak load (Dong Energy Eldistribution A/S, 2012). Therefore, eFlex then argues that there is a potential for grid planning based on this, but it has to be done in a sophisticated way that cuts off heat pumps and other appliances like them in cascades (Dong Energy Eldistribution A/S, 2012). Furthermore, the project team argues that commercial actors can use the various customer motives identified in the eFlex project, in order to create new value propositions to flexible customers (Dong Energy Eldistribution A/S, 2012). However, the project team identifies a necessity for further development of the tariff concept, especially on a national scale, since this would "*spur all market actors – commercial and regulated – to work towards establishing the basis for creating value through harnessing flexibility"* (Dong Energy Eldistribution A/S, 2012: p. 8). Finally, the project framed automation as being the way forward, as consumers could not be expected to continuously react to price signals or other incentives (Dong Energy Eldistribution A/S, 2012).

3.3.2 The EcoGrid EU Project

The following introduction of the EcoGrid EU project will cover the same points as the introduction of the eFlex project, and will likewise give the reader an insight into the EcoGrid EU project.

The EcoGrid EU project was a research and demonstration project supported by the European Union, and spanned from March 2011 to August 2015 (Energinet, 2016). The total cost of the project was EUR 20.640.296,02 where the total contribution from the EU Commission Community Research and Development Information Service (CORDIS) was EUR 12.649.939,50, and the remaining cost was covered by the participating companies (CORDIS, 2014). The purpose of the EcoGrid EU project was *"to demonstrate the operation of a power system with high penetration of renewable and variable energy resources"* (Energinet, 2016: p. 8). The project was conducted on the Danish Island of Bornholm. This choice was based on the fact that more than 50% of the electricity consumption on Bornholm is covered by local renewable energy production (Energinet, 2016). In order to achieve its purpose, the EcoGrid EU project created a real-time market concept to activate small-scale distribution of energy resources and demand response (Energinet, 2016). The EcoGrid EU project therefore designed the market specifically to *"utilize small units down to household level installations in the balancing of the power system"* (Energinet, 2016: p. 8). Therefore,

the market architecture was based on a structure, where prices were published every 5 minutes for the participants' manual or automated response (Energinet, 2016).

As previously mentioned, the total project duration was approximately four and a half years. Out of this, two and a half years were intended as the demonstration period. However, due to unforeseen events, the total full-scale demonstration time only constituted of the two last month of the project (Energinet, 2016). The first big hurdle was to obtain enough participants to the project. This required a lot of effort but the EcoGrid EU project managed to enroll 10% of all residential electricity customers on Bornholm. This meant a total of 2000 households participated in the EcoGrid EU project (Energinet, 2016). The majority of the participating households had electric heating or heat pumps and constituted between 1300-1400 of the participant group. The remaining 500-600 households had other sources of heating (Energinet, 2016). The 2000 households were then divided into different customer segments. The majority of households had an automation systems installed from either Siemens or IBM to control their electric heating or heat pumps. The remaining households were split between a manual response group; manually responding to changing price signals, and a control group; meters were installed, but no price signals were sent (Energinet, 2016). In other words, the participating households were divided into four main groups, households with automation system from Siemens, households with automation system from IBM, households that manually changed consumption based on price signals, and lastly the control group.

Another reason for the relatively short period of full-scale demonstration was delay in the production and installation of the needed equipment, combined with a number of upgrades being needed, for the systems to operate satisfactory (Energinet, 2016). The biggest time-stealer when it came to producing and installing the equipment was the production of the Siemens automation system. The installation process was first completed in March 2015 (Energinet, 2016). Despite the many challenges and short full-scale demonstration period, EcoGrid reports that the process was a great learning experience for all parties involved, and gave insights into the complexity that exists when creating such systems (Energinet, 2016).

Even though the period of data collection was only two months, the EcoGrid EU project team managed to make a number of observations and conclusions. The two main ideas of the EcoGrid EU project was 1) "*activating demand response, or load shifting, due to a real time energy price in 5 minute intervals and energy savings by providing a feedback system in the form of an online platform which enables each and every participant household in the project check their energy consumption in near real time while this is happening"* (Energinet, 2016)

and 2) "*Showing that demand response is possible in a controllable way through issuing the real time price to automation systems controlling the heating unit(s) of a building – in the Bornholm demo site heat pumps (both air and ground source based) and electrical heating panels*" (Energinet, 2016: p. 54-55). Thereby, the EcoGrid EU project team concluded that the two main objectives of the project had been successfully demonstrated in the heating season 2014/2015 (Energinet, 2016). It was not possible to use the control group as a statistically reference for the findings made in the project. Instead the project group used statistical models for the energy consumption as a control reference (Energinet, 2016). The project group ultimately concluded, that the project successfully proved that *"an energy market using small customers and a very small time step has a significant impact on load distribution*" (Energinet, 2016: p. 57). However, this was only successfully proven for the households with automation systems installed and not for the households in the manual group. The project team was able to conclude that all the automation systems installed had worked satisfactory without sacrificing, at any time, the thermal comfort criteria within the households (Energinet, 2016). It was further discussed that the preferences put into the automation systems based on the household preferences, were very conservative. Therefore, it was speculated that introducing higher fluctuating prices, increasing the chances for real savings, would increase flexibility compared to what was found in the project (Energinet, 2016).

As mentioned, the project team found that the manual group did not respond as desired. This observation was attributed to a number of factors identified by the project team, and where:

- High frequency of changes in price
- The overall conditions of the experiment, with the premise that the customer will not pay more than their usual costs anyway
- Faults with the feedback systems at the start
- The times of the day with cheap and expensive energy
- The intangibility of the complex systems of today's electric grid, energy market and the transition to renewable energy sources

(Energinet, 2016).

Some of the more negative results of the EcoGrid EU project was the inability of the project to resolve distribution feeder congestion. The project team argues that this experiment was carried out last in the project, and therefore not enough time was allowed to fine-tune the system (Energinet, 2016). Furthermore, it was also expected by the research team, that the

project would lead to an overall reduction of energy consumption, but this was not the case. The automation systems installed in the majority of the households were not directly aimed at reducing energy consumption; instead they were aimed at using the same amount of energy, but at times where the price was low (Energinet, 2016). This meant that the households with automation systems, had to actively reduce their energy consumption through other ways, but due to a trust in the automation systems, they were even less motivated to do so than the manual group in the project (Energinet, 2016).

Finally, the project team acknowledged the importance of involving participants in the project. First and foremost, the team acknowledged the great amount of work put forth by the local energy and distribution company Østkraft, who managed to assemble the 2000 participating households. Moreover, the project team emphasized their own work keeping the participants involved in the project through surveys, that showed that participants were overall happy with their participation in the project (Energinet, 2016). The surveys showed that 78% would participate in a project like EcoGrid EU again, 76% would recommend others to participate, and 46% said that they had used less energy than they would have otherwise. It was also evident, that participants in the surveys were more positive at the end of the project than they were halfway through (Energinet, 2016). However, only half of the participating households answered the surveys. Furthermore 10% of the participation group, around 200 households decided to terminate their participation from the EcoGrid EU project, but no insight into why was presented (Energinet, 2016).

It is concluded by the project team, that further research and development has to be made when it comes to automation systems and smart meters. It is the understanding of the project team, that the systems and technology used in the project were satisfactory, but there is still a lot of potential in developing more sophisticated and better equipment, in order to achieve even better results (Energinet, 2016).

4. Analysis

The following analysis is structured in two main parts: first, the document analysis of the two documents will be made. Secondly, relevant articles from the scientific community will be reviewed to access the findings made through the document analysis.

4.1 Document analysis

The document analysis will be structured by the overarching *themes* identified through the coding process, with sub-headers addressing the various *repeating ideas* within the themes as outlined in *2.4.1 Coding of Documents*. In practice, this means that the analysis will continuously compare the way in which users are understood and simultaneously constructed by the two cases, EcoGrid & eFlex, in shared themes. In other words, the two cases will not be analyzed separately and then compared, but rather this comparison will be performed constantly throughout the analysis.

Prior to introducing the themes, certain general and more quantitative observations about the documents will be presented. As outlined in *2.5.1.1 Selecting Samples within the Cases*, one report from each case has been selected. The reports were almost equal in terms of length, EcoGrid's being 63 pages (appendix excluded) and eFlex's report being 62 pages (appendix excluded). However, the amount of text identified as being *relevant text* was quite significantly different. From the EcoGrid document approximately 14,5 pages (ca. ¼ of the collective document) were identified as being relevant, whereas approximately 30 pages (ca. ½ of the collective document) of relevant text was extracted from the eFlex document. The sheer difference in the amount of literary space, directly or indirectly dedicated to the notion of 'users' gives a, though perhaps slightly crude, insight into the focus given to users in the respective cases. In this regard, it should though be noted that the content being covered in the two texts are slightly different. Though both documents aim to evaluate and report conclusions made in the respective cases, the EcoGrid project included multiple different automation systems, whereas the eFlex projected only had to report on one. This therefore may account for some of the difference between the space allocated to users vs. technological aspects in the two reports.

To give a better insight into the data foundation on which the following analysis is built, a total of 44,5 pages were identified as relevant text. The relevant text then underwent a process of coding, which resulted in a collective coded document of 81 pages (see appendix 1). The significant increase of size between the relevant text and the document of coded text is due to many of the text excerpts relating to more than one code, resulting in these

excerpts being present numerous times throughout the coding document. The identified codes included both ideas, framing, and use of certain words in relation to consumers and their consumption within the documents. To ease the identification process of which quotes comes from which project, EcoGrid quotes will be displayed in black, whereas the eFlex quotes will be displayed in blue. The page numbers that accompanies the quotes refers to the page of the original documents.

4.1.1 The Importance of Users

Both cases asserted early on in their associated documents the importance of users in regards to the fulfilment of not only their project objectives, but also when creating flexibility in demand on a larger scale in general. However the way in which, as well as to what degree, they asserted this varied. When talking about the importance of users in relation to the fulfillment of project objectives EcoGrid write the following:

> *"Involving the participants was crucial to the success of the project. It took a large effort to fulfil the target of attracting almost 10% of all residential electricity customers on Bornholm as well as to identify and recruit industrial customers."* Pg. 8

Here, EcoGrid acknowledges that participants are crucial, but the focus in terms of their participation is primarily focused on their recruitment, and not necessarily their role, a point that is recurring throughout the document. In this sense, the users' importance seems to be primarily understood in the light that they are a piece of the puzzle that cannot be ignored, but this does not necessarily make any promises in regards to their agency as equal actors in terms of the project design, nor does it hint at the project giving a lot of thought to understanding the consumers and their consumption patterns, which the project aims to alter. However, throughout the document, the users are consistently referred to as *active,* signalling that they are an important asset in order for the project to succeed. Furthermore the users and their 'activeness' is directly included when describing the objective of the project:

> "*The objective of the project was to develop and demonstrate in large-scale a generally applicable real-time market concept for smart electricity distribution networks with high penetration of renewable energy sources and* ***active user participation***" Pg. 10

The project however does not directly address what this 'activeness' refers to.

In regards to asserting the importance of users, the eFlex project is more explicit in their approach:

> *"Flexible consumers are a cornerstone in a smart energy system where resources are utilized more efficiently – from the production assets, through the grid and to the customer"* Pg. 5

In the above quote, users and their possible flexibility are described as being a cornerstone, thereby rhetorically solidifying the users utmost importance in smart energy systems, and thereby also the project. How this importance of the users is translated in practice, will be further explored in the following sub-chapters.

4.1.2 Understanding Consumption & Consumers

The following section aims at analyzing the way in which the documents, describe and thereby present their understanding of consumption and consumers. In this regard, both cases express that getting an understanding of the users is important:

> *"Understanding the dynamics of customers' flexibility is essential for realising such a smart energy system in which distribution companies can rely on flexibility"* Pg. 5

And:

> *"Therefore customer expectations and preferences and the capabilities to respond to different prices are key research elements driven by the demonstration needs"* Pg. 23

However, the focus of this understanding seems to primarily address the users' reasons to participate in the respective projects, as well as uncovering the users' motives, receptiveness, and the appropriate incentives to be used to encourage flexibility:

> *"...it is of utmost importance, to define customer segments and to determine and exploit their needs, receptiveness and incentive based motivation for active participation in a real time market in a Smart Grids system"* Pg. 11

In contrast little attention is given, or is at least not addressed in the selected documents, about exploring the users' relationship to their current electricity consumption, something that otherwise seems relevant to explore when identifying means of changing said consumption. This seems to be an especially interesting deselection by the projects, given the 'invisibility' of electricity consumption and the discrepancy between what consumers say and do; both of which will be addressed in more depth later on.

4.1.2.1 The Complexity of the Consumer

Having now established that both cases clearly communicate a desire to bring to light certain dynamics about the users, primarily concerning their motives for participating in the projects and their possibility for flexibility, this section will address some of the cases associated findings. In this regard, EcoGrid found that the expectation of the users in regards to their participation included numerous elements:

> *"… expectations with regard to the project were twofold: customers expected to learn more about their consumption patterns (and lowering consumption) and expected the project to contribute to a better environment and a more positive image of Bornholm. Although both insight in and lowering own consumption was mentioned also later in the project, focus seems to switch more to societal goals, such as a better environment or island image. Half-way through the project the three most important reasons for participating in the EcoGrid project were:*
> *1. doing something good for the environment,*
> *2. being part of a new and exciting project,*
> *3. lowering energy consumption."*
> Pg. 59-60

This is a crucial findings in terms of identifying possible incentives with the hope of encouraging a change in consumption. However, it is not specified in the document whether the above reasons are valued equally and if not, which reasons weighed heavier than others. The above quote does however give some insight into the notion that consumption or change thereof, is not driven by one incentive only. This notion is shared by findings made in the eFlex project:

> *"The opportunity for achieving financial savings through being flexible was one incentive that was investigated in the project. The project also showed that some customers engaged in the project first and foremost due to their interest in new technology (e.g. the home automation system) and the opportunities this would provide. A simple personal drive for optimising resource consumption vis-a-vis avoiding a loss (irrespective of the lack of reasonable balance between effort and savings) also showed to be an important incentive for many participants along with the opportunities for learning. One of the most important incentives showed out to be a concern for the climate change or environmental effects of energy consumption."*
> Pg. 5

The understanding that users are motivated by numerous elements, as identified in both texts, illustrates a sense of complexity about users. In addition to this, both text excerpts once again establishes that the primary focus is on determining incentives, and not on understanding electricity consumption in general. This may be a reflection of the primary

focus of the projects, which despite also dabbling into the realms of manual change of behavior, largely focuses on the notion of automation. This focus on automation has an effect on the way in which understandings of behavior change is translated into practice, something that will be explored further when discussing the agency of the user under *4.1.3.5 Automation*. However, the fact that attention is primarily given to uncovering drivers and incentives implies that the projects see consumption of electricity, and therefore the change of said consumption, as being based on rational choices; if this was not the case, incentives would not be of interest for the projects.

Beyond this point, little focus is given by the EcoGrid project on describing the way in which the concept of users are navigated, and focus on the users involvement is described primarily in relation to sending out surveys at three different times throughout the project duration. The aim of these surveys was to investigate the participants' sentiments in regards to their involvement in the project, and whether it meets their expectations. In addition to this, focus groups were conducted towards the conclusion of the project, in which the aforementioned aspects concerning motivations are further elaborated. However the findings of the workshops are not described in depth, leaving the reader in the dark in terms of possible findings regarding user understanding that these workshops may have brought to light. Therefore, the primary insight into user dynamics that is explicitly expressed to be explored in the project is limited to the parameters described in the quotation above. These exploratory efforts being focused on incentives and motivations for participating.

In contrast, the eFlex project document addresses behavior change and their understanding of the consumer in more depth. When talking about inciting change in consumption and describing user actions, the project uses an array of different terms that have ties to different theoretical framings. These terms includes practices, behavior, habits, scripting and domestication. Some of the terms seems to be used almost synonymously, especially habits, behavior, and practices. This is interesting, as theorist within the field would most likely argue that though the terms overlap in certain aspects, the terms as theoretical concepts include distinctively different framings of the nature of consumption. Despite this, little attention is given in making clear distinctions in regards to what dynamics each term aims at illuminating. In regards to transparent theoretical grounding when using these terms, the project only refers to actual theoretical frameworks in relation to practices and the notions of scripting and domestication rooted in actor-network theory. In this regard, practices, scripting and domestication are especially used when describing the users' interaction with the smart grid technology, whether it be the meter, online portal, or user community:

> *"As Lucy Suchman showed in her study of use and troubleshooting in the handling of copy machines, the use of technology is embedded in a conception of user practice in the head of the designer. Machines' interaction with the world and with people in particular, will be limited to the intentions of designers and their ability to anticipate and limit the users' actions.*
> *However, the users can be very creative in the use of technology; from time to time in particular their misunderstood use of the technology represents the breach in the borders of concept anticipated by the designers. 'Creative' use of technology is more a clash between mental models than a clash between humans and the technology."* Pg. 21

The first part of the above quote illustrates how *practices* are used to describe the users' interaction with the technology, the intentions of the designers relate to the *script* of the technology, and lastly the creative use of the technology addresses how well said technology has been scripted. In addition to this, the text except indicates an adherence of the project to the users being able to actively mold technology. In other words, it is not only the designers intention that is defining in terms of possibilities of use, but also the users themselves. In terms of the domestication process, which addresses the extent to which the technology is used, the following is said:

> *"The use of the equipment and the extent of its use depended very much on a negotiation in the homes between the man, the wife and the children. Different interests and life priorities became evident and the final instalment and use of the equipment were often a give-and-take situation. It is a valuable experience and maybe the most important that we obtained from the project that design and domestication of technology cannot ignore the internal culture and identities made up by the family, and that there is no linear and straightforward way to understand the domestication process. We cannot in any way limit our understanding of domestication of technology to the functionality of the technology. There are human factors behind this and that makes all the difference."* Pg. 22

The above quote give important insight into the eFlex's understanding of use, as it further solidifies the complexity of navigating users and their use, due to it being subjected to complex negotiation processes within the individual homes. In essence this means that though the users may be driven by a set of identified, though varied, rational drivers, these drivers are subjected to less rational social interactions with other users within the home that may be driven by other motives.
This new layer of complexity begins to give us some insight into the dynamics of why there can be a difference between rationally identified things said by users and what is actual

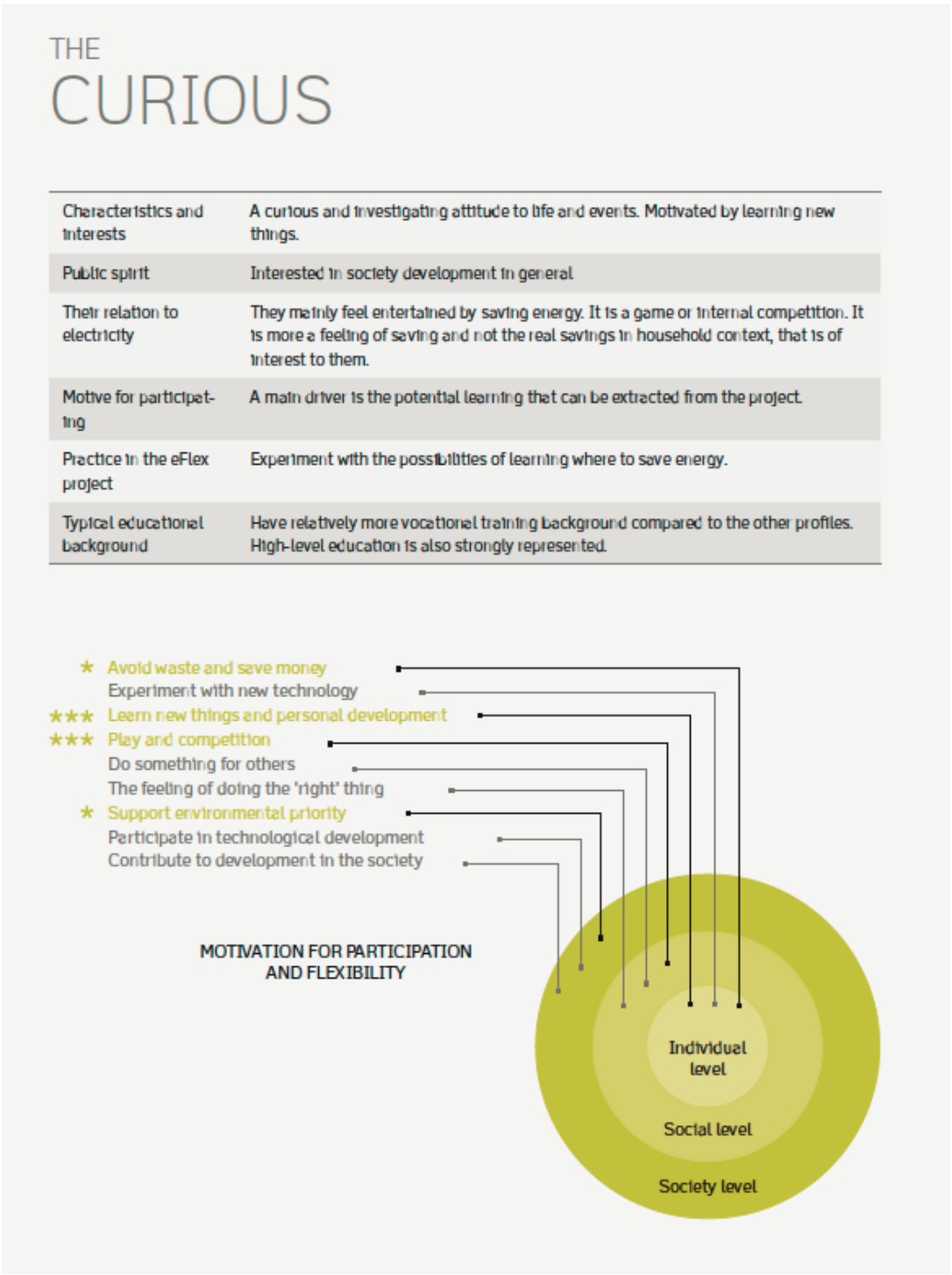
done. We shall return to this point a little later under *4.1.2.2 The Complexity of Consumption*, but for now we'll take a closer look at the projects' use of behavior and habits.

In regards to behavior, the EcoGrid project almost exclusively address this when referring to the manual reaction to information about changes in prices; the continues flow of information regarding changes in prices could incite behavior change in terms of electricity consumption, i.e. change their washing behavior to when the prices were low. Indirectly, this once again signals that the project adhere to the idea that users, at least to some degree, behave or have the capability to behave based on a rationally informed ground, fuelled by economics. Despite this framing of users being capable of rational decision making in regards to their consumption, the project address instances where they acknowledge the tacitness of behavior:

> *"As the room unit adjustment is easily done as a routine act, this did present the risk that the participant could make the adjustment without even reflecting on his/hers behaviour or on the fact that the temperature change/discomfort could be caused by changing prices"* Pg. 43

However, the implication of this on the projects' overall incentive driven approach to users, is not reflected on. Instead, the project uses the instance to exemplify a design flaw of the temperature button. In other words, the situation above, does not make the project reflect on the nature of consumption, but instead incite reflections in regards to whether they need to make adjustments to room units, so that becomes more difficult for such routine acts to occur. Likewise, little attention is given trying to decode the dynamics of this routine act, such as whether the user was participating in certain practices that made them turn up the temperature (i.e a social gathering), or whether it was 'just' a reflection of them feeling cold.

In regards to the use of behavior and habits, the eFlex project continuously refers to these concepts throughout the document. However, little insight is given in regards to nature of the participants behavior in relation to energy consumption and the results of these behavioral studies primarily address characteristics and drivers of different user profiles, as can be seen in the example of one of these profiles below:



Pg. 28

Therefore, the eFlex report does not give a lot of insight into behaviors in relation to electricity consumption, but yet again the focus seems to be on behavior in terms of the interaction with the technology, and the identification of drivers and incentives.

4.1.2.2 The Complexity of Consumption

The above has illustrated how both projects accept that consumers are complex and driven by a variety of motives that, according to the eFlex project, are subject to negotiation within the social structures of the home. The following sections aims at addressing the idea that though consumption is inherently attached to the consumer, it can be much more complex than its attachment to a rational consumer may imply. This can for example be seen by the eFlex model for translating flexibility potential into actual flexibility, something that can only

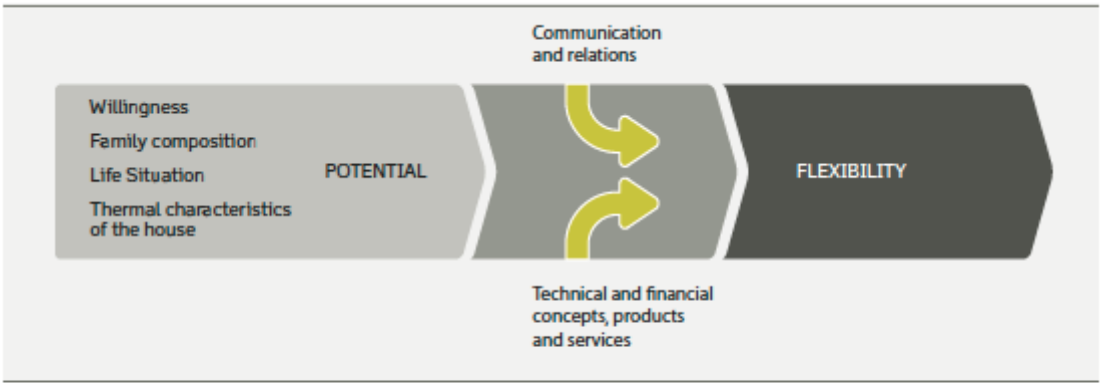


Figure 4.1 A model as starting point. We consider the customers to have various potentials for flexibility and the question is what kind of technical and financial propositions can be offered together with communication strategies and relations to the customers that can transform such potential to real flexibility.

be achieved by changes in consumption:

Pg. 31

In the above, it is clear that consumption is not solely dictated by the consumers, but is rather a reflection of numerous factors such as family composition and life situation.

The suggestion that other things influence consumers, despite what they identify as being drivers is further illustrated in the excerpt below:

> *"The difference between what a persons is thinking and what he does is a well-known dichotomy in social studies as well as in marketing studies. Several examples can be found to illustrate that people are occasionally acting in opposition to what they believe to be their values and priorities"* Pg. 21

The very notion of the discrepancy between what one thinks and what one does, implies that other factors must be in play when consuming and seriously questions the idea of conscious

consumers. One explanation offered by the project relates the notion of Household vs. Home:

> *"Household and Home are two distinct set of mental models in use at the same time. The household is the material and tangible life that has to do with exchange of values related to the infrastructure framing the practice of the family. In many ways, it could be said that household economy has to do with the basic needs of the household. It concerns the money flow in and out of the house and energy savings etc. are usually discussed within this reference system. Home refers to the construction of identity and the meaning ascribing to actions in view of the family culture. It is a phenomenological term and reference system where money is used for exchange in a way that does not appear rational in the formal economy"* Pg. 23

Here, the rationally identified drivers would be situated within the *household*, where other factors that may ultimately influence the consumption would be situated within the *home*. An example of this was presented where consumers invested in energy savings because it made sense on a *household* level, but simultaneously invested in energy consuming technology because it supported their understanding of their identity, which operates on a *home* level.

This discrepancy between what is said/thought and what is done is not directly addressed in the EcoGid project, but the fact that users manually reacting to information through price changes failed to achieve peak shaving, indirectly implies this, as the same users indicated to be motivated by the environment and financial gain. Granted, other influences could play a part in this regard, such as the chosen incentive of price not suiting the users' preferences, the financial benefits not being significant enough to incite change, or the wrong information strategy being chosen. However, these reasons are not really reflected upon and instead it is recommended that automation is focused as a means of achieving flexibility (further explored in *4.1.3.5 Automation*).

Even in light of the above, the projects still abstained from examining the practices that electricity consumption plays into. Something that otherwise seems beneficial when discussing change of said consumption. The key to unlocking the lack of effect in terms of active user change may lie in the practices in which electricity is consumed, something that would most likely be much less straightforward to change, than what merely finding the right incentive suggests. In other words; can electricity consumption ever be adequately simplified for it to be placed in an equation of 'would you consume less if..?', when electricity consumption is entangled in most aspects of everyday life? This certainly seems implausible if such consumption practices are not detangled first.

4.1.2.3 The Invisibility of Electricity

As mentioned above, electricity is intertwined with almost everything we do, however few are acutely aware of this in everyday life. In this regard, the eFlex report comments on the need to make consequences of action visible and tangible, thereby implying that this is not apparent currently:

> *"What is more important as regards demand response is that the visualisation of energy use also created a consciousness of electricity as an important commodity of life that unfolds in the household. Most customers were expected to have a more or less superficial relation to electricity use but the eFlex project, or rather the home automation equipment, no matter that most of the equipment's functionalities had no importance to load shedding, raised the consciousness of energy use. This was considered as a prerequisite to promote interest in the future intelligent energy system and load shedding."* Pg. 24

This understanding of visibility as being key, once again feeds into the notion that consumers consume consciously and that information, in this regards in terms of visibility of consumption, holds a potential for change. In other words, provided the knowledge, a consumer will consume differently.

This notion of lack of visibility, knowledge and transparency about electricity and its associated market, was also shared by EcoGrid:

> *"In general people do not know about the electricity market.."* pg. 23

And in extension of this, the eFlex project argues:

> *"The only other time that an ordinary household customer meets the distribution company is when power supply is down or when the customers have questions to the bill. It is no surprise that the ordinary household customer's relation to the use of electricity is superficial"* Pg. 32

However, when talking about making electricity consumption visible, the projects only express this in terms of showing how much is used and in comparison to others or own previous consumption, when is it used, and depending on technological equipment, by what electrical element. Here, it could, once again, be argued that the projects shy away from examining the practices or social settings in which electricity is consumed. Such considerations could otherwise provide crucial insights into the nature of consumption, which

could provide a more solid foundation for strategies and design of solutions aimed at shifting said consumption.

4.1.2.4 The Notion of Comfort

The notion of comfort/discomfort was referred to consistently throughout the reports of both projects. Despite what constitutes as 'comfort' never being defined, it is routinely used in relation discussing the possibility of flexibility. Consistently comfort is referred to as being the thing that is compromised when flexibility fails, due to for example the participants turning up the temperature, or something that is not compromised when flexibility is achieved:

> *"It could be argued in such a case that the initial temperature range set by the customer is then simply too wide and needs to be narrower or shifted to avoid customer **discomfort** and using the room unit to readjust"* Pg. 43

> *"The project demonstrated that flexibility can be achieved in the private households without perceptible loss of **comfort**"* pg. 6

Though it is not specified what comfort relates to, it is primarily used in regards to temperature, something that is undoubtedly related to the projects keen interest in electricity based heating. This being said, it is however also used when describing the liberty of using electrical items when convenient:

> "...the (non-thermal) **comfort**: the desire to use white goods when it is convenient" Pg. 58

The fact that this quite subjective notion of comfort seems so defining for the possibilities in terms of flexibility, getting a better understanding of the dynamics that constitute comfort and how such comfort is measured would be of great interest. For example, one could imagine that there may be a difference between what an individual considers as 'comfortable' in regards to indoor temperature in a poorly insulated house, as opposed to a well insulated house. If seen historically, there must also be a development in the notion of temperature comfort, as houses were generally poorly insulated as opposed to now. In this regard, the notion of comfort must therefore, at least to some extent, be socially constructed and not merely a question of bodily well-being. Navigating this understanding of comfort and its development could provide insights into whether comfort can only improve, or whether it for example once again could become acceptable to wear a thicker sweater in a well insulated house during winter, due to a lower indoor temperature. Such insights could help actors

within the flexibility field navigate the possibilities with regards to reframing the understanding of comfort, which in turn would allow a greater level of flexibility.

4.1.2.5 Consumers as Segments

Despite the fact that both projects, to varying degrees, acknowledge that consumers and their associated consumption are highly complex, with the eFlex even going as far as writing that:

> *"Customers are different in all aspects and not two customers can be said to have equal conditions, wishes or values. Therefore, it is very difficult to generalise observations and conclusions"* Pg. 21

both projects still identified the need for certain customer segments. The segments defined by the EcoGrid project seems to primarily be defined by the users technological equipment, as different home automation systems and meters tested in the project. However, EcoGrid still mentions the need to define segments with the aim of incentive identification and manipulation:

> *"...it is of utmost importance, to define customer segments and to determine and exploit their needs, receptiveness and incentive based motivation for active participation in a real time market in a Smart Grids system"* Pg. 11

This thereby solidifies EcoGrid's understanding of segment identification as crucial, despite it not being addressed in the report, whether they themselves made additional consumer groupings based on the factors outlined in the above excerpt.

In relation to the creation of consumer segments, eFlex, despite their continuous acknowledgement of consumers being highly complex, identified five different user profiles:

> *"The eFlex project identified five different user profiles. Although the customers displayed an impressive difference in behaviour and attitudes, it is possible to group them. However, the groups will not represent strong distinctions in behaviour and attitudes. There is some overlapping and many customers will only point to belonging to only one specific group when asked to choose only one"* Pg. 25

The profiles, as illustrated by the example of one of the profiles earlier, primarily focus on the drivers of the user in relation to flexibility, that are then mapped out on a 'wheel'. The project's argumentation for using such segmentation in the light of the understanding of users as being highly complex entities, is:

> *"...the wheel is an attempt to transfer the findings into a more sociological type of comparison and for further analysis"* Pg. 25

Unfortunately it is not specified what this further analysis refers to, but the argumentation also seems to be an extension of the project's finding that one of gravest mistakes to be made in regards to flexibility within smart grid, is to consider users as a uniform mass. In other words, the logic seems to be that it is better to have five different profiles that certain users may not find suitable in specific areas, than one uniform profile that most users may not find suitable. However, little is said in the report about how these profiles are used in practice, making it hard to assess their value in relation to achieving flexibility.

The profiles are assigned to households based on the identified drivers of 'the key customer in the family', who the project defines as being the person that usually communicated with the project. This choice is interesting when viewed in the light of the project's findings that rational drivers are subject to irrational social negotiation within the homes that can greatly impact the actual consumption. In this regard, the project argues that 'to some extent' these internal negotiations could be mapped on the wheel. Unfortunately exactly how to do so is not elaborated.

The above has showed that the projects generally seem to adhere to the understanding that consumers and their consumption is driven by rational choices or at least have the possibility to be, and change can therefore be induced through incentives. This is concluded by the projects despite both, to varying degrees, acknowledge the complexity and routined nature of consumption. Though this conclusion is not verbalised directly, it is on this premise that the design of flexibility inducing concepts tested in the project, are made. In addition to this, the users' consumption is exclusively explored in terms of drivers for change, and not in regards to notions such as the understanding of comfort and the invisibility of electricity consumption, that may otherwise play a crucial role in illuminating the discrepancy between what is thought and what is done. It is also illustrated by both projects that consumers are driven by an array of different motivations and a single incentive that addresses all consumers equally cannot be identified. Still, despite the complexity of consumers, both projects emphasize the usefulness of segmentation of users.

4.1.3 User Agency

Having now explored the projects general understanding of users, the following section aims at investigating the users' agency. This section will also, examine the way in which the understanding of users presented above has been translated into practice.

4.1.3.1 User Involvement in Design

In the above section, it has been clarified that both projects expressed that users are important, and that understanding the drivers behind their participation in regards to flexibility is crucial. Therefore, the following aims at addressing the way in which the users were involved in the design process.

In this regard, EcoGrid's involvement of the users were limited to asking about their expectations in regards to their participation and whether they felt these expectations were met. This stands in contrast with their declaration early in the report that:

> *"... the EcoGrid EU project has demonstrated a market concept that from the very beginning was designed for small-scale users by **actively involving them in the whole process**"* Pg. 11

Rather, the users involvement when outlined, was limited to their recruitment and following training:

> *"Before any demonstration activities could be initiated more prerequisites had to be fulfilled. The major prerequisites were:*
> - ***End user involvement:***
> - ***Recruitment of 2000 pilot customers***
> - ***Training of pilot customers***"
>
> Pg. 23

This signals a very low level of user agency in relation to the design process as they were not actively involved. Therefore, the users do not seem to have had a say in relation to the shaping of the design and nowhere in the report is it mentioned that they had an impact in regards to for example the layout of the user portals, with which they were to engage. In addition to this, the projects identification of training being a need, also support this lack of involvement, as the more training required for use, could indicate a lack of intuitiveness in design. Furthermore, when actually asked for their opinion in regards to what drives their participation, despite mentioning environmental reasons, and achieving a better understanding of own consumption, price was used as the incentive.

In contrast to this, the eFlex project focused on involving the users more actively in the design process, emphasizing in the text, that users were involved in assessing mock-up designs of user interfaces, and findings from the anthropological study about the users, were used in workshops that included actors from the Dong Energy project team. Furthermore, different user profiles were made that outlined user characteristics and drivers for participation. However, as previously mentioned, it is not addressed in the text whether, or to what extent, said profiles were included in the design of concepts. Therefore, despite the project stressing the importance of including users, and affirming that they have actively involved them in the design process, little insight is provided in regards to what degree this involvement was reflected in the final design. Therefore the level of user agency in terms of the design process is hard to adequately assess.

4.1.3.2 Creating a User Community

In addition to actively including the users in the design of the eFlex concept, the project also provided a user community through the social media platform PODIO, with the aim of:

> "...*increas*[ing] *interest in energy consumption through dialogue and inspiration*" Pg. 11

This gave the users a voice, not only throughout the design process, but also post implementation, and not just in relation to the designers, but also in relation to other users:

> *"The use of Podio for support had the positive effect that if one person had a question to or problems with the equipment, another customer could respond before the project team members. Podio certainly had a community building effect"* Pg. 19

However, the extent to which the design team incorporated suggestions made on PODIO in terms of possible change to design is not described in the report, and the volume of the users' voices in this regard, is therefore hard to assess.

4.1.3.3 Agency Through Use:

Related to eFlex previous mention of scripting of technology by the designers, the project mentions how,

> *"...the use of technology is embedded in a conception of user practice in the head of the designer. Machines' interaction with the world and with people in particular, will*

> *be limited to the intentions of designers and their ability to anticipate and limit the users' actions"* Pg. 21

In other words, well-scripted technology ensures that the technology is used as intended by the designer. In the case of smart grid, well-scripted technology would ensure that the home automation systems, despite being operated by users, still delivered the desired objective of flexibility. In relation to user agency, this implies that well scripted technology, not necessarily limits the users' agency, but certainly aims at directing their options for agency.

However, users' creativeness in regards to use is also reflected on by the eFlex project:

> *"...the users can be very creative in the use of technology; from time to time in particular their misunderstood use of the technology represents the breach in the borders of concept anticipated by the designers. 'Creative' use of technology is more a clash between mental models than a clash between humans and the technology"* Pg. 21

Here, eFlex address the notion that users can actively influence the technology through use. In this regard, the EcoGrid also reflected on the users' agency through use, or in the eyes of the designer, misuse. In relation to this, users were framed as being barriers in terms of achieving flexibility by making the temperature settings too strict:

> *"Additionally the participant could also cause the household to be unavailable through too strict temperature and/or flexibility settings; additionally they could of course always choose to opt out altogether"* Pg. 41

The project's assessment of this was to reevaluate whether the fact that it was possible to make the settings this strict was appropriate. In other words; whether this option should even be available to the users. In this example, the scripting process then seems to move away from directing users agency and instead move towards controlling the users' agency by actively limiting their options.

4.1.3.4 The 'Manual' Consumer

Arguably, the 'manual' consumer segments holds the most agency as opposed to 'automated' consumption, since the manual group is constantly acting on the basis of primarily price-fuelled information. However, the manual intervention was quite limitedly described by both projects. Despite both projects investigating manual changes to electricity consumption, this investigation seems to be done as an addition to their primary focus of automated consumption. This prioritization is also evident in regards to the amount of literary

space dedicated to the manual group as opposed to the automated group. In this regard, ca. six pages of directly relevant text was identified addressing automation pages as opposed to three pages of relevant text dedicated to manual change in consumption. However, in the EcoGrid project, an exclusively manual user segment is identified, as opposed to the eFlex project, where manual change is looked at in homes that also have automated systems in place. How exactly this manual change is incentivized is hard to deduce from the texts, as they are not explicitly described. In terms of the EcoGrid project, it seems that the primarily incentive for the manual group was price and the source a website:

> *"Website use is most important for this group of customers, because it provides the only available information on electricity prices and insight in consumption which is needed to adequately respond to price signals"* Pg. 60

In relation to incentives used by the eFlex document to stimulate manual change, less is known in regards to what information was shared with the participants. The project outlines that in regards to signals for the automated units, the participants could choose between, price, amount of wind in the electricity mix, and a mix of the two. However, whether more information was made available to the users to incite further manual change, is unknown.

In terms of the manual group's ability to change consumption patterns, the findings were mixed. According to the EcoGrid project:

> *"...the manual customer group did not respond as desired, and showed very little reaction to the varying prices"* Pg. 58

In contrast, the eFlex project observed a level of consumption change in connection to the raised awareness in regards to consumption:

> *"This insight resulted in a change of habits that many other projects believed to have proven impossible: change of habits based on information only. The difference to other project of information based behaviour modification is probably that in eFlex it was not just information but the system provided a learning of energy use. The insight and knowledge created an interest and boosted internal competition (or play) as regards what was possible in terms of saving energy. Use of dishwasher and washing machines was for some made dependent on the price forecast. Some customers also tried their best to change their habits in connection with cooking and taking showers. However, we will never know whether the changed pattern will last"* Pg. 22

However, eFlex themselves doubt whether this change will last:

> *"… even though eFlex made some customers react based on information only, it is far from sure that it would continue this way, if no further technical development took place that could sustain the interest. In addition, this behaviour change would probably not include all types of customers either. Anyway, it is widely recognised that information based behavioural modification is an unreliable approach that is likely not to work in the long run. The safe way to achieve a change in behaviour with regard to required load shedding is by providing some sort of technology that can apply the change according to a signal, ie. automatically. It simply cannot be expected that customers continue monitoring a price signal manually (or any other signal) and react accordingly; we need technology to do it for them"* Pg. 23

Furthermore, the above quote reveals that the project, despite having succeeded in some level of active behavioral change, still conclude that the way forward is automation of consumption. This understanding of automation being the way to proceed is also shared by EcoGrid that writes:

> *"In the end, the automated parts of the demand response system implemented within the EcoGrid project worked reliably, with (thermal) comfort criteria being satisfied using the thermal inertia of buildings. The manual contribution on the other hand was not statistically significant. The reasons for this are varied, but can be reduced mostly to the correlation of price, time of day and desired activities resulting in the actual saving potential being very low compared in the (non-thermal) comfort: the desire to use white goods when it is convenient"* Pg. 63

The failure to induce permanent manual change in consumption, questions the projects aforementioned understanding of rational and conscious consumption, in which incentives can change behavior. Thereby, the acceptance of automation seems, at least to some extent, to simultaneously accept that consumption patterns and their consumers are not so rational and straightforward after all. Granted, the lack of effective manual changes in consumption may to some extent be ascribed to inadequate choices of incentives and/or information strategies. However, the choice to recommend automation must to some degree be based on an assessment that changes to information strategies and incentives will not succeed in changing the consumption patterns adequately.

4.1.3.5 Automation

In the above, it was established that the projects identified automation as being the most successful approach to achieving peak shaving. Therefore, the following will aim at assessing user agency in relation to automation, as well as how the notion of automation aligns with the projects understanding of consumption and consumers, as previously outlined.

In regards to user agency, the automation systems used in both projects included the users creating a set of preferences that would then dictate the automated response. As the automation primarily concerned heating, these settings referred to a temperature, and in the eFlex project, also a choice of signal as previously mentioned. Therefore, the only times the user actively had to interact with the technology was when adjusting settings, which if the settings were suitable only had to be done once, and turning off the automation if needing to instantly adjust the temperature. Given the projects focus on not compromising 'comfort', this need to instantly adjust temperature should be quite limited. This notion of the customers not noticing due to their comfort not being compromised was directly described as a success by the EcoGrid project:

> *"Customers were moderately positive about automatic control of their heating; they indicated it was convenient, not very noticeable, and a slight increase in comfort as compared to before the project"* Pg. 60

This invisibility of change stands in stark contrast to the projects' approach to manual change, in which the visibility of change is alpha and omega. Furthermore, this element of invisible change makes one reflect on the role that incentives play. This was also reflected on by the eFlex project, that addresses that through automation the consumer becomes desensitized towards the incentive, in this case; price:

> *"The customers are becoming insensitive to the price by using the technology"* Pg. 23

Previously, it was established that great attention in both projects were given on the importance of identifying the right drivers for user participation, and translating these drivers into incentives. However, if the point of successful automation is changing consumption without it being noticed, then why do incentives for continuous participation, matter? This aspect, will be explored in greater detail in *4.1.4 Incentives.*

Seen in the light of the aforementioned focus on behavior change, practice change, and change of habits, as especially emphasized by the eFlex project, it seems relevant to question whether automation actually achieve this? Arguably, one cannot claim a change in consumption behavior if one is not actively a part of said change. In this regard, it seems appropriate to make a distinction between change in consumption, and change in consumption *behavior*, separated by conscious and unconscious change. Here it could be argued that automation achieves the former, rather than the latter. Furthermore, the focus of automation when keeping in mind EcoGrid's emphasis on 'active users', inherently seems

contradictory. In this regard, it appears that the users' 'activeness' is primarily rooted in flexibility becoming an available asset in the form of demand response, rather than a reflection of the users actively partaking.

The implications of the invisibility of consumption change induced by automation is also reflected on by the eFlex project:

> *"Automation will abate the lack of lasting behaviour modification. On the other hand, automation will also accelerate the loss of interest by the customer (they simply forget it), and if comfort is compromised later on, customers most likely will lack the interest required for staying committed to letting the appliance be available for automated interruption"* Pg 62

So not only, does automation take away agency as compared to manual change, desensitize the users to incentives, and make consumption change invisible, the above quote shows that it also introduces a risk of participants losing interest. In this case, the loss of interest is to be understood in relation to the automated change in consumption. However, EcoGrid also reflects on automation resulting in a loss of interest in regards to manual change:

> *"As the members of the households with automated heating units had even less reason to adjust or reduce their consumption due to their justified trust in the automation itself, there was no significant contribution to the reduction from this side as well"* Pg. 63

Here, EcoGrid argues that the automation systems created a sort of 'halo' effect, in which the participants did not see a need to further adjust their electricity consumption. Therefore, it can be argued that the automation actually assisted in keeping electricity consumption invisible and out of the participants minds. Referring back to the 'activeness' of participants, it seems that the 'active' automation to some extent creates 'passive' participants.

Since both projects seem to argue for automation as being the key for future smart grid development, it seems relevant to also reflect on what can be included in this automation. In relation to this, both eFlex and EcoGrid provided their participants with additional means of measuring consumption, and in some cases even automate, other electrical appliances within the homes (i.e. lighting, washing machine, television). However, both projects also reflected on the insufficiency of such elements in regards to peak shaving:

> *"On/off control of ordinary household appliances is not very interesting as regards load shedding because the energy consumption of most ordinary household appliances is insignificant"* Pg. 11

Instead, the projects argue that focusing on the automation of larger elements such as electrical cars and electricity based heating is a more efficient solution.

4.1.3.6 The Democratic Approach to Users

One thing that never seemed to be questioned by either project however, was the democratic approach to users. Never was it postulated that the users acceptance for peak shaving may not be needed, by for example legislatively 'demanding' that home automation system were installed in people's homes for remote controlling by the DSOs. Neither was it ever suggested that the users supply could simply be limited. In most other markets there is a balance between supply and demand, in which supply is sometimes limited. However, when speaking about the electricity market, users 'right' to supply seems unquestioned. This is undoubtedly connected to aspects such as security of supply, and legislation, but the introduction of the new intelligent meters technically enables the DSOs to completely or moderately limit supply to individual houses. If this was to be done, the use of incentives and/or navigating complex consumption patterns could ultimately be avoided. Granted, this would have significant implications on the users' agency, which would largely be eliminated.

This reframing would undoubtedly receive some kind of consumer resistance, as findings from the eFlex project show that even with the users acceptance of their elements being controlled by signals from the DSO, they still had a need to feel in control:

> *"Customers will inevitably see it as an intervention that 'someone' has taken control of various appliances. Naturally, they are in favour of this taking place as they have agreed to participate in the project but discussions on PODIO as well as observations in the homes indicate that the feeling of safety and being in control of the events are important. This becomes clear from the many suggestions of what should be available and visible on the portal and the more tangible action of directly overruling the eFlex control system"* Pg. 24

In this sense, the participants clearly signalled a need for a level of agency in regards to the automation, in the form of being able to stop the intervention temporarily or permanently.

4.1.4 Incentives

Having now analyzed the framing of agency in the respective projects, we will proceed to look closer at the incentives that played such a crucial role in both projects.

4.1.4.1 Moral Economy

As previously mentioned, both projects described that the participants were driven to participate in peak shaving by numerous reasons. In this regards, motivators were primarily split in two: economy and more social aspects; of which 'moral economy' is one. Motivators and their associated incentives in regards to moral economy, largely focused on the environment and climate change:

> *"One of the most important incentives showed out to be a concern for the climate change or environmental effects of energy consumption"* Pg. 5

Furthermore,

> *"...doing something good for the environment"* Pg. 60

Was similarly identified as one of the three main reasons why users participated in the EcoGrid project. However, only the eFlex project mentions attempts to directly translate environmental incentives into a signal for control of the automated response. This was done by making it possible for the eFlex participants to select a signal based on the amount of wind energy in the energy mix. However, using wind as a signal for automation proved to work poorly in regards to the objective of achieving load shedding:

> *"...correlation between wind energy and grid load is not apparent, and the wind energy signal cannot be used for load shedding in its simple form"* Pg. 59

Furthermore, despite approximately one third of the participants originally choosing a setting that combined price and wind, 20% later changed their settings to exclusively price. This change, eFlex ascribes to a combination of weather changes and that the,

> "*...wind+price optimisation part resulted in no logical control of the heat pumps depending on the wind regime. The customers may have had a more environmental friendly approach but as we have shown in Appendix A, use of wind energy as optimisation parameter is complicated seen from the customer's as well as the distribution utility's point of view"* Pg. 36

This notion of the 'environmental' signal of wind being too complicated combined with the significant switch from the 'environmental' signal to the price signal, could indicate that the consumer did not feel that this approach fulfilled their expectations in regards to their environmental impact. Interestingly, EcoGrid, who only expressed using price signals for their automation, reported that their participants largely felt that their expectations in regards to 'doing something good for the environment' was met by their participation in the project:

> *"In the half-way project survey and final survey respondents were asked to indicate whether they felt the project enabled them to achieve these goals. Results showed that customers felt able to contribute to a better environment and more positive island image through their participation in the project, but indicated that goals related to lowering energy consumption were achieved less"* Pg. 60

As there was no mention of the project attempting to satisfy the participants' interest in making an environmental impact through a thereto designated signal, the fact that the participants environmental expectations were met, could be related to the way in which the project managed to frame the impact of participation. Since the EcoGrid project did not employ an 'environmental' signal, the satisfaction of the users' environmental expectations must be a result of communicative efforts. Furthermore, as the project's primary aim was not to reduce consumption, but rather to move it, environmental impact can only be argued as being achieved if framed within the grander smart grid objectives; the transition to renewable energy sources, as well as electrical vehicles and heating. In this regard, it seems relevant to consider how identified drivers are best translated into incentives. In line with this, eFlex difficulties with translating drivers into incentives may be connected to their approach to incentives being in the form of the controlling signal, rather than, for example, a communication strategy emphasizing the role of flexibility in achieving climate goals. In relation to satisfying the environmental driver for participation, it seems that EcoGrid was more successful than eFlex. However, as little is revealed by EcoGrid's report in terms of how the participants' environmental expectations were met, it is hard to fully assess the approach chosen. Furthermore, the fact that the approach chosen by the project in regards to the environmental drivers is so scarcely described, it is hard to use it as a source of inspiration for future implementation strategies.

4.1.4.2 Gamification

In addition to the above mentioned incentives related to 'moral economy', The eFlex project also found that the users were motivated in terms of use, by the possibility of 'play' within the technology systems:

> *"The customers in eFlex volunteered for the project and were positively biased towards providing the flexibility. However, the conclusion of the impact of the home automation system is drawn from the interest apparently emerging from 'playing' with the opportunities that the system provided"* Pg. 34

However, this interest in 'playing' with the options within technology, and interest in technology in general may be related to the fact that people volunteered for the project. When eFlex tried to uncover the drivers behind the users' motivations for participating in the project, they found that:

> *"The project also showed that some customers engaged in the project first and foremost due to their interest in new technology (e.g. the home automation system) and the opportunities this would provide"* Pg. 5

The fact that participants in part volunteered, due to an interest in new technology could have an influence on the aforementioned interest in 'playing' with the technological options within the automation system. Therefore, it is questionable whether this finding of 'gamification' can be generalized in regards to a full-scale national implementation. Furthermore, as automation largely subdues the users' interaction with the equipment, it is questionable how long effects from a framing of gamification will last.

4.1.4.3 Economy

Despite EcoGrid identifying numerous drivers for participation, the signal used in EcoGrid was exclusively price. However, this seems to have been the objective from the beginning:

> *"The general concept is based on a real-time market approach that lets distributed energy resources and flexible electricity demand receive and react on variable electricity prices"* Pg. 12

Similarly, despite eFlex also attempting to use the aforementioned 'environmental signal', they also concluded that in terms of load shedding, the price signal was more effective. However, this does not necessarily relate to the consumers being more susceptive to price, as much as it was a reflection of the environmental signal based on wind in the mix not

necessarily correlating with the load peaks. Therefore, using such a signal was not appropriate for the objective of load shifting. In addition to this, eFlex argues that as opposed to an environmental signal, an economic signal is easier to ascribe meaning and is therefore more tangible for the consumer. However, eFlex themselves also reflect on consumers not being sensitive to variations in electricity pricing:

> *"In order to encourage load shedding in the consumer segment, price incentives become a natural choice. However, studies have revealed that a relatively large segment of customers is not sensitive to variations in electricity pricing, and other incentives may play a more influential role in customers' procurement behaviour"* Pg. 11

This insensitivity to electricity prices could be connected to the aforementioned invisibility of electricity, as it is hard to be sensitive to changes in price of something you are not sure what is being used for and that is so ingrained in aspects of your daily life. However, this possible connection is not explored in the project.

The manual trials in both projects firmly established that consumers can not be seen as homo economicus (rationally economic behaving individuals). In addition to this, as both projects suggest focusing on automation as a means of achieving peak shaving, which effectively desensitizes the consumer to the chosen incentive, the signal used begin to matter less in regards to continued participation by consumers and only seem relevant when discussing how to get the needed automation technology into the homes. Here, the eFlex project argues that using price as an incentive only makes sense in regards to framing the purchase of the needed automation systems as an investment:

> *"The savings which a varying price signal entails is only interesting when discussing the cost for the automatic control system"* Pg 34

However, as the project also showed, the annual savings that the automation could achieve were quite modest, ranging from approximately DKK 250 to DKK 600:

> *"The annual savings that the customers achieved by participating in the project range from approximately DKK 250 (~35 €) to DKK 600 (~80 €) depending on whether the house is well-insulated and the degree of interest of the household to participate in such programme. This was obtained using price jump in the 3-step grid tariff of DKK 0.60 from peak price to the next level. Another design of the grid tariff, e.g. including Saturdays and Sundays, could increase savings but it would probably not be significantly higher than indicated above"* Pg. 7

Whether such savings would be attractive enough for consumers to invest in the needed equipment is not addressed by either project. However, given the findings that the users participation was driven by numerous motivators, such as the aforementioned moral economy, it may be beneficial to target such aspects as well, when designing incentives for the procurement of automation equipment.
This need for framing as to why consumers should invest in the equipment, is however related to the aforementioned democratic approach to users. Should an alternative approach, such as governmental intervention, be attempted, the framing of incentives would inherently change from 'why you should get the automation system' to 'why you should accept the automation system'.

4.1.5 Summary of findings made in document analysis

Prior to proceeding to the literature review, the findings made in the document analysis will be shortly summarized.

Both projects seemed to adhere to the understanding of consumption as being the result of conscious decisions made by consumers. This in turn means that consumption can be changed by providing the consumers with the right information and incentives. Despite both projects acknowledging the tacitness of consumption to some extent, and the projects failing to ensure lasting changes to consumption through manual changes made by the consumers, this did not seem to make the projects critically reflect on the notion of the conscious consumer. Instead, the projects seem to simply conclude that automation has the largest potential in terms of achieving flexibility. In eFlex's case, it furthermore seems that the option of achieving manual consumption change is completely disregarded, not because the notion of the conscious consumer is actively questioned, but because it cannot be expected that consumers continuously act on information or price signals. This creates a rather paradoxical framing of 'it can be changed in theory, but it cannot actually be changed, therefore automation'. Furthermore, no focus seems to be given to investigating the actual consumption patterns, which are to be changed, or the nature of the consumption itself.

In lieu of the understanding of automation as being the way to proceed, the framing of incentives are slightly shifted by the eFlex project, that argue that incentives are primarily interesting in terms of getting the automation systems into the households. In this regard, it was not questioned that the consumers were to acquire such equipment voluntarily and the

possibility of governmental intervention through legislative demands, was therefore not discussed.

4.2 Literature Review

In the above document analysis an array of findings were made pertaining to the four overall themes identified. These findings will now be held up against literature from the scientific community. As outlined in the methods chapter, the literature review included a total of nineteen texts that have been outlined in a grid according to publication, author, focus, theoretical framework and research method (see appendix 2). The texts varied greatly in terms of focus and perspective, ranging from macro to micro with the first primarily focusing on infrastructure (centralized vs. decentralized) and the latter on approaches to behavioral change and user involvement. The documents varied in regards to research methods with articles using methods such as, literature review, case study, experimental case study and document analysis (appendix 2). Of the total nineteen texts reviewed, eight texts will be elaborated in the following. The texts were selected based on the focus of the study's relevance in relation to the focus of this thesis. Furthermore, the selection was made with the aim of showing as large a range as possible within the literature.

4.2.1 Approaches to Users

In regards to the understanding and simultaneous approach to consumers and consumption, the articles can roughly be placed within a spectrum of two opposing orientations; consumers as individualistic conscious actors that can consciously change consumption patterns, and consumption as best being understood within the framing of individual practices in which the consumption is embedded. If placing the EcoGrid and eFlex within this framing, they would appear to primarily adhere to the former. This understanding of consumers as conscious entities is shared by D'Oca et al (2014) and Vine et al. (2013). Both articles focus on the effectiveness and design of feedback functions within the smart grid, thereby simultaneously taking the stand that information is capable of changing consumption behavior. Their primary objectives therefore centers on exploring *what* information, as well as *how* such information is delivered in the most impactful manner (Vine et al. 2013; D'Oca et al. 2014). In this regard, both articles present a set of recommendations concerning the nature of impactful feedback strategies. The articles share common findings focusing on 'user-friendly' visualizations, delivered regularly, and preferably with reference frames for comparison (i.e. consumption compared to previous year, amount saved, and the user's

consumption compared to national average) (Vine et al. 2013; D'Oca et al. 2014). However, despite pertaining to the understanding of the 'informed consumer', the articles question the longevity of information-based change.

Towards the middle of the spectrum, Nachreiner et al. (2015) proposes using a comprehensive psychological model of self-regulated change to addressing behavioral change in smart grid designs. The model covers the complete process of behavior change, from choosing the new behavior, until it is implemented. Nachreiner et al. (2015) shares the previously mentioned articles' understanding that behavior change is fuelled by the consumer consciously reacting to information, but also acknowledges the routined nature of sustained behavior. The proposed model comprises of four stages: (1) predecision; forming a goal intention, (2) preaction; forming a behavioral intention, (3) action; forming an implementation intention and starting to implement the behavior, and (4) postaction; continuously carrying out the action (Nachreiner et al., 2015). Also similarly to the previously mentioned articles, Nachreiner et al. (2015) proposes an information framework, with recommendations to the nature of the information needed at the different stages. Thereby, the study aims to map out and ensure information-based change.

Further towards the other end of the spectrum, there are texts such as Goulden et al. (2014). Goulden et al. explores the role of users in demand side management by using practice theory "*as a means of unpacking the mundane, embedded use of day-to-day life*" (Goulden et al., 2014: p. 22). The article approaches consumption from the perspective that energy use is embedded in social and physical infrastructures of daily domestic life. The article does so, by using what it calls a 'weak' practice theory approach (Goulden et al., 2014). Opposed to traditional practice theory's approach to practices as the unit of enquiry, Goulden et al. (2014) uses an overarching frame of *energy consumer* and *energy citizen*. Keeping the human actor as their focus, is rooted in Goulden et al. (2014) not wanting to reduce "*the individual to a mule-like 'carrier' of practices*" (Goulden et al., 2014: p. 22). The *energy consumer* and *energy citizen* are used both to describe ways of framing, as well as personas, with *energy consumers* referring primarily to individualistic attitudes and choices, and *energy citizens* referring to consumers engaging with energy as a meaningful part of their practices (Goulden et al., 2014). Both personas often exist within consumers, with aspects such as financial savings appealing to the *energy consumer* persona, and aspects such as the consumer reflecting upon their consumption's negative impact on the environment operating on a *energy citizen* level. These two personas are often contradictory and ties into the discrepancy between what is said/thought and what is done, as also observed in eFlex and EcoGrid. Viewed within this framing, concept designs like the ones

tested in eFlex and EcoGrid seems to appeal mostly to the *energy consumer* persona, with the price signals providing the primary incentive of financial savings. This, Goulden et al. (2014) argues is something that most contemporary initiatives to energy demand issues do. However, success from this approach is deemed fleeting by Goulden et al. (2014) that instead argue that the most potential in regards to permanent changes lies with appealing to the *energy citizen*.

In light of the above, reframing the concept focus to appeal more to *energy citizens*, could potentially allow for a higher level of response from the 'manual' group. Furthermore, opting to follow a more traditional approach to practice theory, where the aim of the study is to follow the practices, rather than the practitioner, may allow for a better understanding of the dynamics that hinder changes to consumption with regard to the specific practices in which the consumption is embedded (i.e. comfort, mobility, etc.). This was also found by Nyborg & Røpke (2013) that, similarly to this thesis, investigated the user role in the eFlex project. They however did so primarily on the basis of the behavioral study conducted by antropologerne.com. Nyborg & Røpke (2013) found that when looking critically at the course of the behavioral study, it became apparent that having to deliver the many expected insights into the households' flexibility potential, energy behavior, motivators for participation, and usability of the automation equipment, resulted in a shallowness of findings. Furthermore, the article points out that despite Dong Energy's explicit interest in the flexibility potential of heat pumps and electric vehicles, little attention was given to unravel the practices in which these elements were embedded (Nyborg & Røpke, 2012). Instead, and in line with the findings made in the document analysis, the focus was primarily on communication, attitudes, values and motivations for participating in flexibility. The article argues that the behavioral study does bring forth some interesting findings in regards to other electricity consuming practices such as washing of clothes and dishes, and standby functions on electrical appliances such as TVs and computers (Nyborg & Røpke, 2012). However, given Dong Energy's disinterest in ordinary household appliances, this prioritization seems odd (Nyborg & Røpke, 2012). The lack of interest from the project responsible (Dong Energy) in this kind of consumption, may account for why such findings were not apparent in the concluding report examined in this thesis' document analysis.

In light of the above, it could be argued that additional research into the practices that shape electricity consumption could be useful. This would entail shifting the focus from the practitioner to the practices, allowing for a better understanding of the interplay of dynamics that simultaneously allow and limits changes in consumption. Doing so could provide a more informed foundation for developing strategies for change. Furthermore, shifting the focus

from the practitioners to the practices, could give way for an alternative grouping of consumers based on their engagement in specific practices, rather than the practitioner's characteristics. Such a framing could potentially minimize the difficulties associated with targeting individuals in terms of change, when the consumption to be changed is negotiated by numerous actors within the home (Goulden et al., 2014), as was also experienced by both projects examined in this thesis.

4.2.2 Limits to Automation

As was also apparent through this thesis' document analysis, automation over user-involvement desensitizes users to continuous information stream of signals (Goulden et al., 2014). When talking automation, the Goulden et al. (2014) makes a distinction between practices in which energy consumption is not point-of-use during the practice vs. practices in which energy consumption is point-of-use. The difference between the two is whether the practitioner can be separated from the actual process of electricity consumption. As an example, automated shifts of washing may be seen as an example of not point-of-use as loading and unloading the washing machine can be separated from the actual running of the washing machine. In contrast, cooking can typically not be separated from the practitioner's involvement, and is therefore harder to shift. This therefore presents limitations in regards to what can be automated with the acceptance of users. In extension of this, Goulden et al. (2014) argues that passive options created through automation activates only a fraction of the efficiency possibilities that the smart grid offers, and seen in the light of the ambitious carbon reduction targets set globally, such limited impact could prove disastrous.

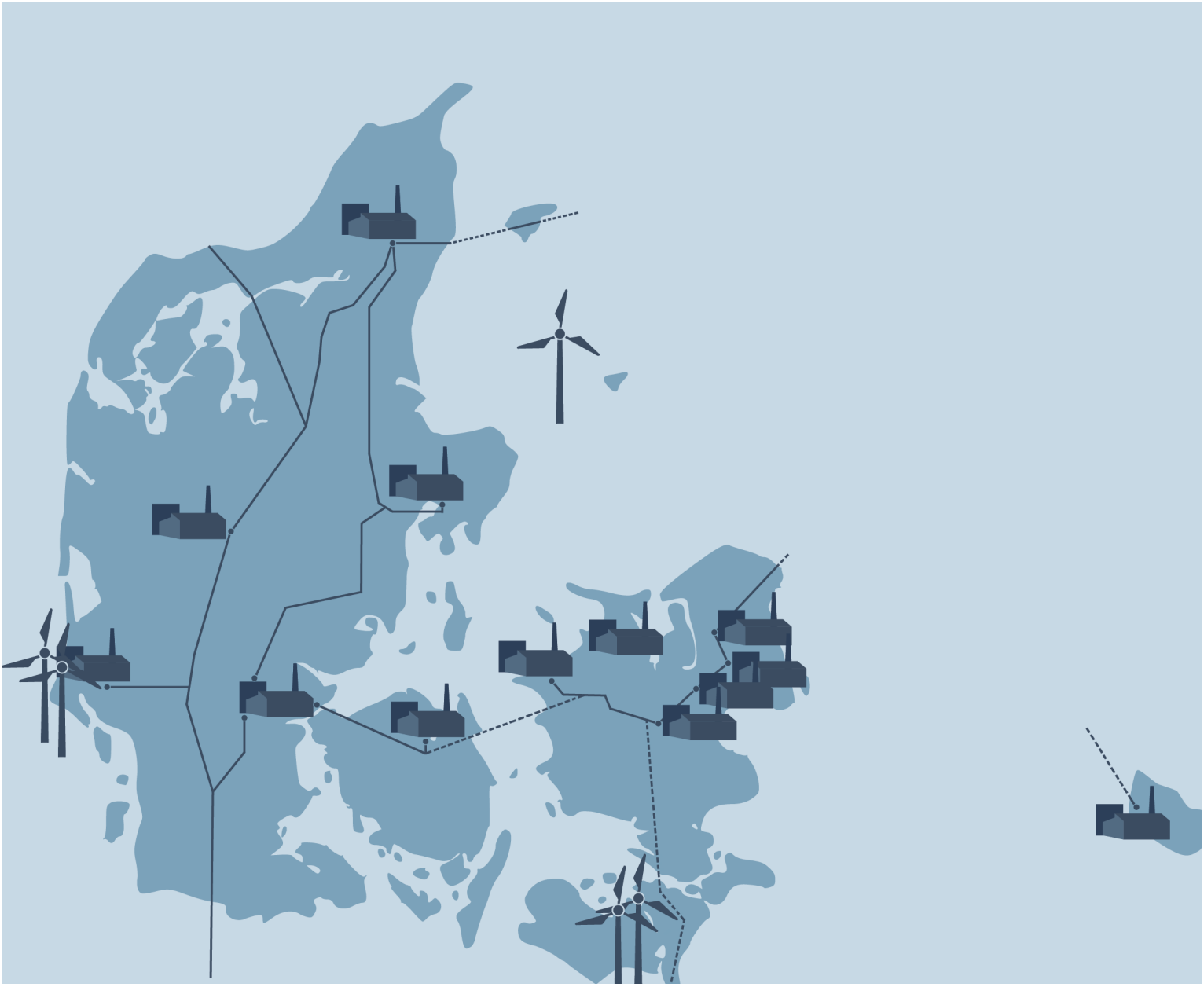
4.2.4 Pathways to Flexibility

As illustrated in the document analysis, it was never questioned whether acquiring the needed automation equipment to partake in demand response should be the consumer's choice. However, Goulden et al. (2014) reflect on the challenges in getting consumers to partake in automated control schemes led by DSOs, due to a general distrust fuelled by the seemingly contradiction of a distributor of electricity wanting them to consume less. Furthermore, Toft et al. (2014) reflect on the effectiveness of consumer participation in flexibility schemes offered through opt-in conditions, as opposed to opt-out conditions. Unsurprisingly, the study found that more consumers participated in flexibility schemes in which they actively had to opt-out to stop their participation. However, 'forcing' consumers to participate in demand response concepts, would most likely be met with resistance both in

terms of users uproar and legislation in relation to areas such as personal data. This being said, further research into the possibilities of centrally forced implementation, may still be beneficial if the smart grid concept is to work.

As mentioned in *3.1. Smart Grid in a Danish Context*, this centralized approach to flexibility is merely one of many different approaches. In relation to this, numerous articles reflected on the alternative of locally driven, decentralized approaches (Nyborg & Røpke, 2012; Schoor & Schotens, 2014; Adil & Ko, 2016). Decentralized Energy Systems (DES) suggest a paradigm shift in the way energy is produced, delivered, and consumed (Adil & Ko, 2016). DES largely focuses on local energy production through solar PV, solar thermal and small scale wind turbines (Adil & Ko, 2016). As an example of a DES concept, Adil & Ko (2016) introduces Smart MicroGrids that function as small semi-autonomous islands and acts as a single controllable entity with respect to the collective grid (Adib & Ko, 2016). Thereby, the Smart MicroGrids can be connected and disconnected to the grid on a need basis, allowing flexibility through clustering of both production and consumption that can be tapped into based on power and balancing needs. As opposed to traditional smart grid, that denotes a grid-wide network improvement, Smart MicroGrids can be seen as smart grid's urban scale counterparts (Adil & Ko, 2016). In this way, Smart Grid and Smart MicroGrids share the same vision, but Smart MicroGrids aim at achieving it from the ground up (Adil & Ko, 2016). Goulden et al. (2014) also reflects on the two opposing visions of centralized and decentralized energy systems, arguing that they are more accurately considered two poles of a continuum, rather than a binary choice (Goulden et al., 2014). Decentralized approaches could hold great potential for achieving environmental goals, and will most likely include a completely new userrole, where users act as both a flexible consumer and producer in relation to the grid.

5. Discussion

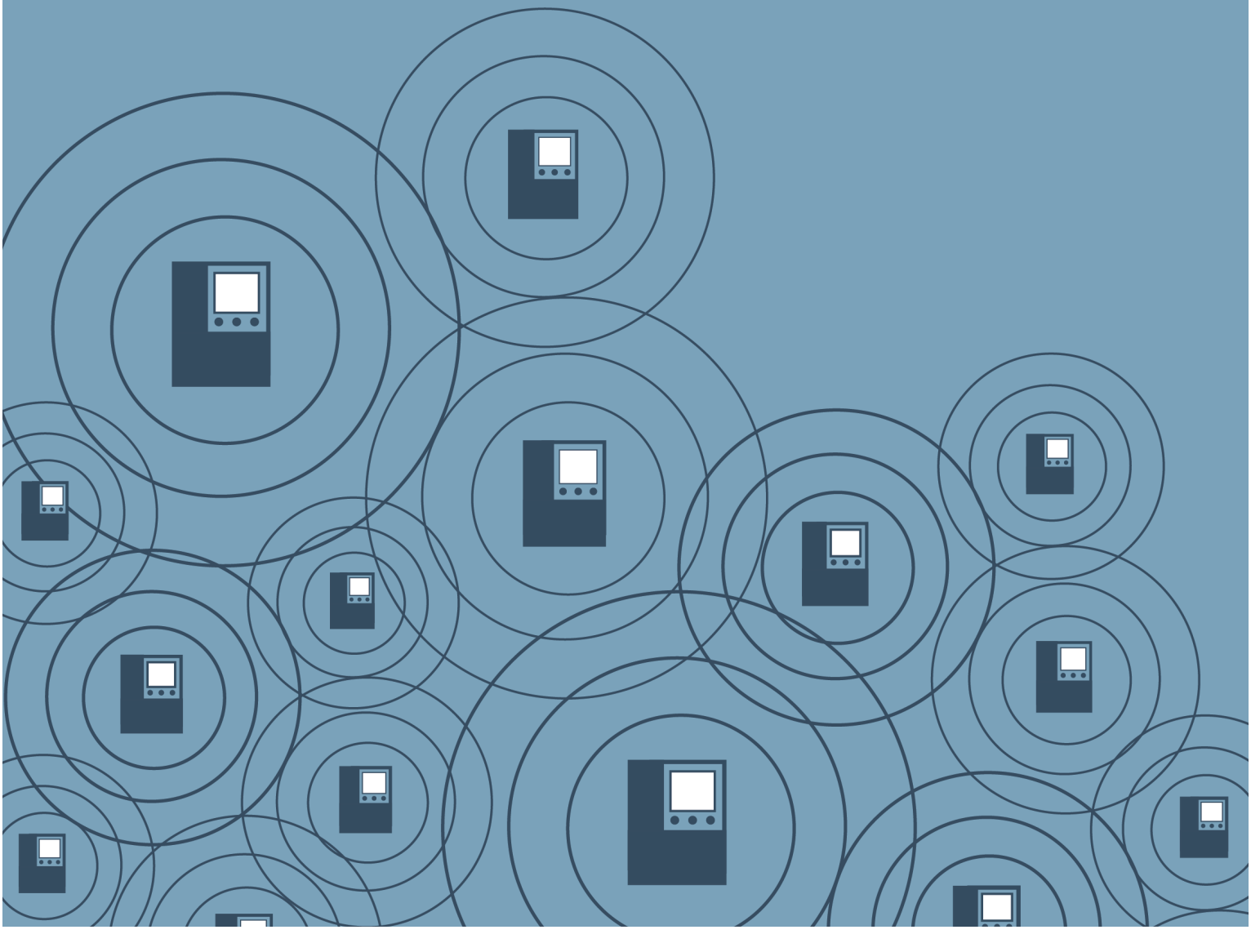


Based on the findings made in the demonstration and pilot projects, it seems relevant to zoom out and discuss the implication of these findings with regards to a possible smart grid implementation.

Both projects seemed to conclude that automation of electrical household elements is the only viable way to achieve peak shaving. In this regard, the projects focused primarily on the automation of larger electrical elements within households, these being; electric vehicles and electricity based heating (i.e. heat pumps). But where does such automation leave us? As outlined in *3.1 Smart Grid in a Danish Context*, the current impact of electricity based heating and electric vehicles is small, with a limited development being seen within the last seven years. This development, or lack thereof, seems to go against predictions made both in the Danish energy strategy 2050 and Energinet.dk & the Danish Energy Association's *Smart Grid in Denmark 2.0* report. Paradoxically enough, this lack of increase in electricity based heating and electric vehicles, identified by the demonstration projects as being key to flexibility, simultaneously means that the grid is not experiencing the anticipated amount of strain that resulted in the need for flexibility to begin with. However, the need for flexibility was only in part fuelled by load shedding. Flexible consumption is also crucial in terms of the transition towards renewable energy sources that to a higher degree needs consumption to be fitted to production, as opposed to conventional energy sources. This therefore begs the question of how flexibility then can be obtained if automation is 'the only way' and the items most easily and impactfully automatized in this regard, is not available to the expected degree in a national context? Here, it would be natural to then explore what other elements within the households could be automated. However, in relation to this the literature review presented certain limitation as to what can be automatized. According to Goulden et al. (2014) automation is limited to elements which energy consumption is not tied to the consumers active use (i.e. washing machines). Furthermore, Goulden et al. (2014) argues that such automation would not be sufficient compared to the potential for flexibility within households. This categorization of automation as being the 'savior' in terms of flexibility, seems to tie into the age old discussion of how we as a society perceive environmental solutions, specifically referring to the notions of 'engineering our way out of climate change' vs. 'changing our consumption practices out of climate change'. In this regards, the demonstration projects seems to adhere to the former. But where does that leave us when surrounding circumstances does not allow for such engineering? This seems to be a pressing question, especially in terms of climate degradations; an issue that is inherently time sensitive. In other words; can we afford to wait for engineering to catch up? The lack of transition towards electricity based heating and electric vehicles would suggest no. In light of this, it seems to easy to simply write off behavior change.

This then brings us to the next question; how can behavior be changed? In this regard, it seems to be proven by the demonstration projects that using financial incentives and information seems to provide only temporary results. This may be due to the way in which consumption is approached. In order to tackle the tacitness of consumption, following practices, rather than the practitioner, was proposed in the analysis. However, though such an approach may provide better insight into how and why electricity is consumed, it is not sure that such insights will be easily translated into incentives that are not financially based. This being said, the primarily individualistic financial approach taken in the projects may very well be a reflection of the interplay between actors in the smart grid concept. The smart grid concept proposed in the projects, as well as in *3.1 Smart Grid in a Danish Context*, seems based on a framing of a product being offered. This commercialized framing in which a commodity, in this regard flexibility, is being traded, has an impact on why, how, and which actors participate. Should this framing be changed to for example participating 'for the greater good of the planet' the specification of what is being traded, how, and with whom becomes more muddled. Therefore, if flexibility is something that is to be traded by consumers to commercial actors, it would seem natural for financial gains to the currency. As this approach has yet to prove successful despite numerous attempts, this gives rise to questioning whether this composition of the smart grid is the most effective. Here, alternative approaches including both more centralized, as well as decentralized options have been mentioned. A more centralized approach would reframe the interaction within smart grid from commercial actors - consumers, to government - consumers. In opposition, the decentralized approach would rely more on local community building and self-sufficient energy production, potentially reframing the interaction to be primarily producing consumer - producing consumer. The success of this, as compared to the traditional smart grid approach can however not be concluded on in this thesis.

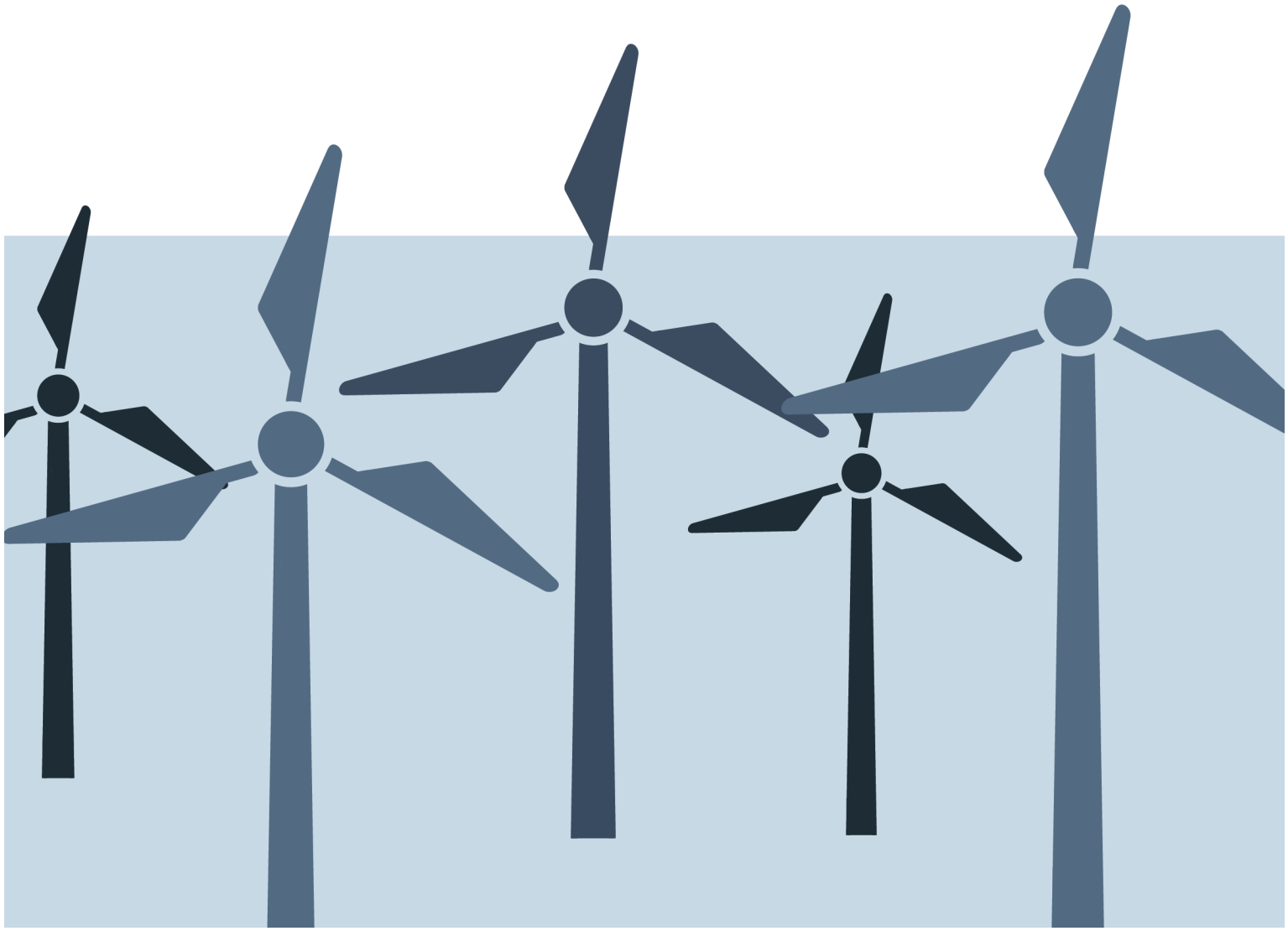
6. Conclusion



This thesis set out to explore the way in which household consumers and their consumption was constructed in the Danish smart grid demonstration projects, eFlex and EcoGrid EU, and the implications of this construction in regards to future smart grid development. Through document analysis of the concluding report of each project, four main themes associated with the projects' construction of consumers were identified; *the importance of users*, *understanding consumption & consumers, user agency*, and *incentives*. Both projects seemed to largely approach consumption as the result of rational and conscious choices made by the consumer. Therefore, both projects tested concepts rooted in the idea that if given the right incentives and information, consumers were able to change their consumption patterns. Based on the aforementioned premise, the projects tested the demand response, targeting both manual change of consumption and automated consumption change. The manual response proved insignificant, leading both projects to conclude that automation held the most potential in terms of providing flexibility. However, little focus seemed to be directed at manual response to begin with, making the findings come across as hasty. Furthermore, no attempts were reported by either project at investigating the dynamics of the very consumption that they were trying to change. The general focus on, and ultimate conclusion of, automation as being the way forward in regards to achieving smart grid objectives, seemed to stand in contrast with the projects' emphasis of the importance of active users, as the automation effectively pacified the consumers in the process of load shedding. Electric vehicles and electricity based heating (i.e. heat pumps) were both identified as primary elements suitable for automation. However, when seen in the light of the development, or lack thereof, of electricity based heating and electric vehicles, this focus of automation seems questionable in terms of achieving the environmental goals outlined in the Danish Energy Strategy 2050. Furthermore, through the literature review, the extent to which elements within households could be automated was questioned, and the disregard of active (manual) behavior change was seen as resulting in unutilized potential in the smart grid.

In lieu of the focus on automation, the way in which the needed automation equipment was to enter the households was discussed. Neither project questioned whether this equipment was to be acquired by the consumers themselves, however the possibility of legislative intervention was explored in the analysis. As opposed to this centralized approach to the smart grid, an alternative and more decentralized approach of Smart MicroGrids was also discussed. In this regard, the implications of such a decentralized approach on the user role was also discussed.

7. Bibliography



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