Prosumers and smart grid technologies in Denmark: developing user competences in smart grid households

This paper explores and describes resident’s experiences from a smart grid project that involved 20 households in a rural area in Denmark and ran from 2014 to 2015. The study is based on qualitative data from the participating households, collected 6, 12 and 18 months after the start of the intervention. Drawing on theories of social practice and the three intertwined elements of a practice: competences, images and materials, the paper contributes with an in-depth analysis of a complex intervention, focusing on how the participants changed energy practices as a result of the installed smart grid technologies. Long-term studies on such comprehensive energy interventions and derived changes in domestic energy practices are exceptional. The results show that people relate to their natural environment in new ways and construct new practices according to the movements of the sun; that they gradually become skilled practitioners and prosumers; and that they also increase consumption and develop expectations towards the energy company, requesting better dialogue on energy consumption and control. The paper concludes with reflections and suggestions on how findings may be relevant to policy and research in the area.
Inclusive planning in transport and energy STI-policies

Transition to a more sustainable and fossil-free energy system is of global interest, and implies social challenges for the developed world including the European Union. In particular, the energy consumption related to transport constitutes a significant challenge. If not serious changes are made the transport sector can lead to more than a doubling of CO2 emissions by 2050 (Edenhofer et al., 2014). Transport in this context includes transport of both people and goods, and it includes transport on land, sea and air. Responsible research and innovation should take into account this large social challenge of securing a more sustainable and fossil-free energy system. Furthermore, responsible research and innovation should take into account both the required changes in all citizens' daily life due to this transition as well as the driving force of grassroot innovation movements.

Scripting, control, and privacy in domestic smart grid technologies: insights from a Danish pilot study

Smart grid research in Denmark has increasingly turned its focus on aggregator trading flexibility achieved by remotely controlling appliances, studying the technologies involved rather than the control. This paper investigates how different types of control were envisioned and designed for a two-year smart grid trial in Denmark with 20 private households. Using the notion of script, processes of in- and de-scription were used to gain insights into perceived and enacted control. Based on empirical data from 26 interviews and three workshops, we show how the in-scription process of control can be characterized as dynamic and includes negotiations between the residents and those responsible for the project. Second, we show how users de-script control, and third, we outline the project owners’ reaction to the user’s de-scription of control. The design of the remote control appears to have promoted a reference for ‘passive consumers’ within a smart grid. This design prompts questions about how the users in smart grid development are envisioned and configured using different ideas about control. With current development and the need for additional energy reductions, consumers who invest in photovoltaic solar cells and electric vehicles lose interest in delivering their energy to the system level.
Smart grid and households: How are household consumers represented in experimental projects?
This study contributes a comparative analysis of 11 Danish smart grid experimental projects with household involvement. The analysis describes the scripts for the future smart grid interaction investigated in the examined projects, the approaches to user representation, and the project findings concerning consumers and smart grids. Three main dimensions of the scripts are identified and discussed: economic incentives, automation, and information/visualisation. The methods employed for the development of user representations are primarily technical and techno-economic. While our analysis confirms previous findings that economic rationales and automation are central elements of smart grid scripts, the analysis also shows that there is considerable variation in the details of the scripts investigated. Our findings suggest that it may be useful for future smart grid projects to be more systematic and explicit in the analysis of household user perspectives and may consider a broader set of methods in this regard.

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Smart grids and households: how are household consumers represented in experimental projects?

This study contributes a comparative analysis of 11 Danish smart grid experimental projects with household involvement. The analysis describes the scripts for the future smart grid interaction investigated in the examined projects, the approaches to user representation, and the project findings concerning consumers and smart grids. Three main dimensions of the scripts are identified and discussed: economic incentives, automation, and information/visualisation. The methods employed for the development of user representations are primarily technical and techno-economic. While our analysis confirms previous findings that economic rationales and automation are central elements of smart grid scripts, the analysis also shows that there is considerable variation in the details of the scripts investigated. Our findings suggest that it may be useful for future smart grid projects to be more systematic and explicit in the analysis of household user perspectives and may consider a broader set of methods in this regard.
Socio-technical change: Developing narratives for the Danish energy and transport sector

The choices of more sustainable technologies for citizens are highly dependent on political processes (Kern 2015). To secure impact on actual policy making, stakeholder participation from for instance researchers, policy makers and citizen, is crucial (Volkery and Ribeiro 2009). Although Denmark has the past years done much to increase the amount in of renewable energy in the energy system, the transport sector has not yet been included in the greening process (Sovacool 2013). The transport sector is responsible for almost a quarter of greenhouse emissions in EU, where of two thirds originate from road transports (EU, 2014). Thus it is important to focus on political actors and processes within socio-technical transitions on this area.

The paper is based on the COMETS project, which main focus is policy advice in the Danish energy and transport sector to achieve a fossil-fuel free energy system in 2050. The data consists of workshops where scientists and stakeholders propose a set of narrative scenarios; a range of interviews; a citizen meeting, where a representative group of the public evaluates the proposed narratives; a future panel in the parliament where the energy groups evaluates scenarios.

Different actors can be enrolled into a coalition of change through narratives which include and organise visions and expectations (Smith, Stirling, and Berkhout 2005). Central to this study is the question of how different actors in the Danish energy and transport sector envision possible futures through a scenario planning process. This study investigates the disputes between actors and their conflicting interests in the political arena dedicated to the reproduction of the current regime with an actor-network approach.

In this study we conclude on how different actor groups create and evaluate future scenarios emphasizing the conflicts within the arena among the actor groups.

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Smart grid development and households in experimental projects

The use of renewable energy has become of great interest to the Danish government as it would allow Denmark to become independent of fossil fuels. One of the stated ambitions is that, in 2020, 50% of Denmark’s electricity will come from wind energy. Such changes constitute a significant challenge to the electricity grids and call for the development of smart grids. The Danish Smart Grid Strategy states that ‘flexible electricity consumption’ is the main purpose of smart grids in Denmark, envisioning that future consumers will have flexible consumption of electricity. Thus, they are expected to respond to the supply side and consume energy when it is available. The goal of this thesis is to investigate how
household consumers are integrated in smart grid development activities. More specifically, it focuses on household consumers, as they are represented in experimental projects in the smart grid area. This is done by building theoretically on the concept of scripts (Akrich, 1992) and on Practice theory (Shove et al., 2009; Schatzki, 2002; Reckwitz, 2002). Empirically, the focus is primarily on development activities in Denmark. The overall research question of the thesis is: How are households in the smart grid being envisioned in experimental projects, and how are they responding to these visions? This thesis increases the understanding of the visions of smart grids and household consumers and of how they actually are responding to smart grid technologies and concepts. Particular attention has been given to overall visions in experimental projects, the new emerging practices related to the new role of being a prosumer, and lastly, the issues of control. The results of the first paper show that, although flexible consumption may entail large changes in households’ everyday activities, there has been little research on the area in Danish smart grid experimental projects. Overall, the consumers are expected, to some extent, to provide flexibility by changing their energy-consuming practices because of economic incentives by means of manual or automated control of devices. Moreover, the Danish smart grid development community is not acknowledging the role of prosumers in the grid, although the perspective of prosumers might play a role in the transition towards a fossil-free energy system. The following two papers address the issue of household consumers and everyday life aspects in smart grid households and find that there is a contradiction between the common Danish smart grid script and the role of prosumers. Furthermore, the concept of ‘remote control’ contradicts the rhythm of the practices of everyday life that prosumers strive for in the current PV tariff structure.

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Script of Healthcare Technology: Do Designs of Robotic Beds Exclude or Include Users?
Many new product designs are currently being implemented in the healthcare sector, and this presents designers with challenges involved in socially innovative design. In this paper, we argue that designing assistive technologies requires focus on multiple users and use practices. We see the design of assistive technologies as design of socio-material assemblies, which include an analysis of the products already used in relation to multiple users, their practices and wishes. In the article we focus on the challenges in the implementation of two types of robotic beds used for disability care in a municipality in Denmark. We follow both the caregivers and disabled people’s daily practices. By using Actor Network Theory we explore the socio-material settings and the design challenges. The theoretical concept of ‘script’ is used to investigate how the artifacts (beds) and the multiple users go through a mutual adaptation process in their daily practice, and how this adaptation varies in different cases. The human/non-human actor perspective focuses on the relation between the designed artifact and the user in specific situations. The analysis leads to a central question: How does the scripting of the beds affect the beds usage and the different users?

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Smart grid and households: How are household consumers represented in experimental projects?

This paper investigates how smart grid experimental projects in Denmark envision the future role of the private consumers in the energy system. The smart grid development in Denmark can be characterised as compound where several diverse actors are trying to shape the future of the energy system (Nyborg & Repke, 2011). There are many visions of the content of a future smart grid. An active role of the users of electricity is a central difference between the current electricity system and the future smart grid. Analyses have shown that users are currently getting increasing attention in smart grid projects (Verbong, Beemsterboer, & Sengers, 2013, Hansen & Borup 2014).

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**Smart grid, household consumers and asymmetries: Energy visualization and scripting of technology**

This paper will focus on the asymmetries that occur when different consumer groups are presented to the same energy visualization equipment. The studied technology is home automation/control equipment, designed to contribute to the general set up of smart grid (facilitate a flexible use of electricity and accommodate demand response). Large smart grid pilot projects suggest that energy visualization technology will be a common part of households in the future. There exist numerous different visualization technologies within the area of electricity and private consumers today. This study seeks to contribute to the research on how shaping of technology affects consumers differently. In relation to the analysis of technology and consumers, I will draw upon the concept of script (Akrich 1992). The objective is to study how energy consumption is In-scripted in the objects (visualization-technologies applied in the human actor's homes) and how the consumers interpret the technology (the De-scription of the object). In relation to the general goals of smart grid to change the consumption of electricity into being more flexible, it is relevant to investigate if different consumer groups accept and assign to the technology (Pre-script) or if they work against it (De-inscription). The empirical data for the paper is retrieved from an experimental project including 30 private households. The collected data consists of consumption data and semi-structured interviews.

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**Survey of existing studies of smart grids and consumers - Nordic countries: Working Report WP6.5.1**

The objective of this survey is to map smart grid studies that address private consumers. The survey shall identify what knowledge there exists about consumer and user behaviour in connection to smart grids and, moreover, how consumers and users are approached in the studies made. The focus is on household consumers; not on industrial companies or other private or public organisations. The present report focuses on studies in the Nordic region, i.e., studies in Denmark, Finland, Iceland, Norway and Sweden. Initially this report was part of a dual delivery, where 1) focused on the Nordic countries; and 2) focused on selected projects in other countries. This present report is the work completed in relation to the first part.

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Phd Student:
Hansen, Meiken (Intern)
Main Supervisor:
Borup, Mads (Intern)
Examiner:
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Meiken Hansen (Speaker)
Per Dannemand Andersen (Other)
Department of Management Engineering
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Documents:
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4S/EASST 2017 Boston: Annual Meeting of the Society for Social Studies of Science (4S)
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Meiken Hansen (Participant)
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