1. Introduction

Experts across many disciplines are currently focused on smart grid related issues. Engineers, sociologists, and economists all emphasize different aspects of the emerging smart grid and its users. As smart meters bring up regulatory and policy aspects as well as purely technical ones, diverse questions are now sought answered, such as how to define the economic value of surplus power arising from demand response activities (Borlick 2011); what types of ethical and privacy concerns need to be considered when smart meters gather information about electricity consumption (Cavoukian 2010); if lower-income households perhaps must be approached differently in the smart grid (Faruqui 2010, Felder 2012, Darby 2012); and what level of regulatory involvement, if any, should be advocated (Nichols and Stutz 2001). Among these perspectives there are wide differences in how users are imagined in the future smart grid.

Actual development projects, often called pilot or demo projects, are also taking place around the world. For instance, widely cross disciplinary and multi-nationally EU funded ERA-Net projects seek to test and verify actual smart grid technologies – often in an operational context which includes end users. These ventures see experts utilise technological and scientific knowledge to create best practice models for smart grid implementations, which demonstrate live and working versions of the smart grid which inform political decision making and large scale commercial endeavours. But they are also sites where expert skills and know how are shaped to continue shaping smart grid efforts in the future. Nyborg and Røpke (2013) have shown that industry driven projects on smart grid use tend to construct and naturalise certain futures that fit the agenda of strategic system builders (c.f. Abi Gahnem and Mander 2014).

This paper posits this assertion to examine how technology expectations (Borup et al. 2006, van Lente 2006) contained within smart grid research correspond with actual technology designs manifest in pilot projects and contribute to shape smart grid futures. The user is widely held to be integral to the smart grid as a whole, and the smart grid itself a society wide infrastructure. A premise for this paper therefore, is that understanding how the user gets configured (Woolgar 1991) into early smart grid conceptualization is instructive of how energy end use can be conceived within the larger context of what we can call the political economy of the electricity network of the future. The question this paper will seek to answer is thus; how are researchers and experts within smart grid projects dealing with problem questions related to the future end users, and how do they suggest solving them? Focusing on the research and pilot venues both of smart grid construction, the first aim of this paper is to map out how users are dealt with in the current smart grid literature. The second is to trace how these users do or do not enter into the concrete work of technology developing and testing arenas like the EU funded pilot projects.

2. Technology expectations, imagined publics

While researching computer hardware developers Woolgar (1991) suggested that machines can be thought of as texts in the way described by Smith (1978, in Woolgar 1991). Machines, as do texts, set the parameters for use (readership) and, by so doing, effectively perform some of the work of configuring their users. This suggested that machine text is organised in such a way that its purpose is available as a reading to its user. Dealing with the machine reveals for the user an “adequate puzzle” by which is offered the solution for its use. And because texts may be designed in any which way, they are always and ultimately produced for a certain reader, a certain user (1991: 68-69).Hence, a reading of the machine requires certain semiotic skills from the user. Investigating the implications of this, with expanded interest in the dynamic relationships between objects both human and non-human, Akrich (1992) have also engaged a semiotic framework. Dialectic and reciprocal relationships between these objects are theorised as functioning on the basis of scripts created by designers of technological artefacts, which is subsequently de-scripted by users in the use context. Designers define users and their worlds and inscribe them into the technical content. Finally, in the use situation, the user's reaction to the object materializes the designer's project, which in turn displaces the world of the user. So with this dynamic in mind, what will the study of visions, designs and expert's expectations about technology tell us about the future role of users?

Artefacts are created with the help of sociotechnical imaginaries (Jasanoff and Kim 2009). The public understanding of science (PUS) literature has considered imagined or constructed publics to a fair extent with regards to for instance how experts attempt to make scientific knowledge socially robust through the help of Imagined Lay Persons (ILPs) (Maranta et al., 2003). Applying this concept, Walker et al. (2010) found that the public opinion on the technological development of renewables raised concerns in experts, making them incorporate in their projects a semi-real but very significant subjectivity based on a mix of direct interactions with and anticipations about the public. The consequences specific imaginaries may have on urban planning processes have also been examined by Ivory (2013), which found that narratives of the public often posited them as reluctant. However, despite a great deal of focus on the relationship between expertise and its publics, there seem to be fairly few endeavours that look at how user constructs are mobilised by researchers within scientific work itself, and how their various representations are conjured (be that 'real' or otherwise) to affect scientific arguments. To gain insight into this, we need to attend to how users are represented in research literature, what problems are posed, and how they are suggested solved.

On the other hand, the sociology of expectations is a strand of research which looks into how specific versions of the future can be narrated and maintained in order to provide direction for innovation projects. The idea is that narratives of the future are performative, and that when futures are described by various experts they contribute in making the very future they are describing reality (Brown and Michael 2003, Borup et al. 2006). Van Lente (2000:45) has argued that words which are capable of "doing things", so called ideographs (McGee 1980, in Van Lente 2000), are important in giving these narratives of the future a shaping force. These words are characterised by being higher order abstractions like "progress" or "empowerment", spacious in terms of meaning and usually positively reinforcing. Skjølsvold (2014) has examined the "virtual domestication" of the Norwegian smart grid through the policy and regulatory processes which led up to the political decision to make smart meter roll out mandatory there. Therein he argued that these separate approaches of technology expectations and imagined publics could be usefully combined since, when the technology imagined is pervasive enough, imagining its future can entail constructing a whole new society.

This is applied in the following analysis of smart grid research and pilot project reports. Different expectations about technology and imagined users/publics are identified in the research literature, making it possible to examine how they reappear within the operational context of piloting. This can tell us how expectations and prescriptions of science literature may have been performative, and in which instances they have not. This also provides an overview of the solutions which are brought out of the pilot context, which problems prevail, and which versions of the future we may expect has performative influence on current smart grid development.

3. Methods

The first part of this study is a review of research papers about smart metering that were gathered from a database search of Science Direct and the (former) ISI Web of Knowledge in the spring of 2013. 124 papers were initially retrieved using the search parameters 'smart grid + smart meter' and 'user'. Subsequently 40 relevant papers were extracted based on a reading of the abstracts to single out those which contained keywords such as users, consumers, customers, practices, behavior, households, everyday practices, residential, active demand, demand (side) response, privacy, etc. Text analysis was undertaken by close reading of all the papers, marking the passages which explicitly described users or expectations of users. Categories were then formed separating the papers by whether the research in question a) leaned towards economic theories or incentives, b) focused on technological issues and solutions, or c) constituted a critique of these two approaches as well as soliciting cultural, social or "everyday" emphasis. An overview of the final selection of papers, type and category is provided in Appendix A.

The second part of this study examines the question of how and in what form user representations contained within research papers actually inform smart grid implementations. It looks at some prominent European smart grid demonstration projects belonging to the ERA-Net funding programme under the European Research Framework Programmes 6 and 7. A report issued by ERA-Net (Prüggler et al., 2014) which provides a collection of snapshots of 34 regional and national key projects from 18 nations was utilised as an index for further inquiry. This part of the paper is a result of a study of the self-representations, reports and documents disseminated by these projects, accessible online during the autumn of 2014, with specific regard to how they incorporate the user within their project frameworks. The second part thus compares the user constructions within smart grid pilot projects, to those found in the first part. The next section however, starts out with the literature analysis.

4. User expectations in research literature

The papers were scrutinised for mentions of users and their practices, be they would-be or empirically observed. The analysis was attentive to representations of users' practices and the suggestions offered for changing these practices, as well as how change is described and/or explained and, finally, what (if any) meaning is attributed to certain kinds of consumption or to specific changes in behaviour related to consumption. Three different kinds of narratives were discovered, one arguing for an economic rationality, another for technological solutions, and a third critiquing the first two as well as arguing "softer" points, like ethics and social stratification. The categories have been described with the help of verbatim quotes from selected papers within the categories, however for natural reasons it was not possible to represent them all. For a detailed overview of the selected papers, see Appendix A. The following findings must be considered to be interpreted accounts that can be only be argued to further an economic, technical or a social science viewpoint on users in the smart grid; and they are by no means an attempt at classifying or analysing the "professions" themselves. Neither are they by any means exhaustive of the many disciplinary viewpoints which could be ascribed to categories such as those constructed herein. Similarly, a thorough definition of the various disciplines encountered in the data is beyond the scope of the paper. Some viewpoints would inevitably thus be argued as missing by some readers. Hopefully the three narratives, a snapshot of which is outlined in the following, provide a succinct general impression of a larger and still ongoing, cross-disciplinary discussion.

4.1 Demand response and market incentives

Economic rationality narratives treat consumer[1] behaviour as a function purely of electricity costs. They cater for increased price elasticity and that different price regimes will trigger changes in behaviour. There is an emphasis on how such developments will not be dramatically life altering, even though the need for some choices to be made is highlighted:

> It is important to clear up an important misconception. Under dynamic pricing, customers do not have to pull the plug on major end uses, live in the dark, or eliminate all peak usage in order to benefit. They simply have to reduce peak usage by some discretionary amount that does not compromise their lifestyle, threaten their well-being or endanger their health. Clearly, the more they reduce, the more they will save. But the choice is up to them. (Faruqui, 2010: 16)

This point outlines the negotiations between value of service and value of money in a typical fashion for narratives of economic rationality, which indicates there is evidence of sensitivity within them towards the end use context. Consumer practices are normatively suggested, as is supported here for instance, by empirical observations that people will turn off services during peak hours but use off-peak hours to recover their service losses owing to the offset such dynamic behaviour would create:

> Time-varying pricing programs are not very effective at reducing overall energy use. […] AC load curtailed on peak is often used at an equivalent level after the peak period to bring temperatures back to normal […] It is also conceivable that homeowners will pre-cool their houses prior to [critical price period] events. (Newsham and Bowker, 2010: 3301)

Thus, in contradiction to a common but faulty assumption, smart grids are not always understood as a tool for energy saving because the net energy spending; in the above case it is balanced out and remains the same without it posing a problem. Bringing about demand response flexibility is thus not necessarily expected to save energy, but is rather focused on peak shaving goals, grid cost reduction, and economic efficiency gains in a larger, social economic picture. Economic rationality analysis also acknowledges that user practices, when understood as demand response activities, are potentially something more than a sink for demand. Responsive customers are considered economically valuable. The smart grid is expected to provide tools for making visible for system builders the true demand for electricity by making possible better analysis of consumption, thus contributing to optimising the market. In this way, the user is absolutely expected to become an important and integral function of a more perfect market, as not only price signals improve, but demand signals as well:

> The obvious way to increase price responsiveness is to expose more retail customers to *dynamic pricing*, such as real-time pricing. Industry economists have long argued that consumers' resulting load changes will improve economic efficiency, reduce costs, and avoid unneeded generating capacity. (Braithwait, 2003: 52); […] Electricity suppliers, distribution system operators and end users are all of decisive influence in attaining increased customer flexibility, the latter of whom being the obvious key actors. It is, after all, electricity consumers who are supposed to ultimately make demand response happen. (Bartusch et al., 2011: 5009)

[1] The term "consumer" is often preferred over "user" within this narrative. In this paper they both refer to the residential type energy consumer.

But users are not always found to be aware of their integral role in smart grids, and are found to be confused about how they should contribute and the reasons with which they should tell themselves why. This is given attention in some studies, exemplified here by some misunderstandings that were found in a study of perceptions of new tariffs:

> A few of the informants even had a very high opinion of the new distribution tariffs, because they assumed it had been introduced in view of environmental considerations and they showed great anxiety to do their bit for the environment. […] It was furthermore evident from the interview that the informant in question had no conception of the units at hand, i.e. kilowatt and kilowatt-hour. Many electricity users have difficulty in understanding and relating to these terms and may therefore be more reluctant to accept changes. (Bartusch et al., 2011: 5012)

Even so, the prevailing expectation in these narratives is that changing markets is equal to changing behaviours. This arguably relies on "novel market models" which do not yet exist, aided by technological developments which are yet to be implemented. However, these accounts do indicate that while one may wish that users were rational, deviations from rational models by the users are not unexpected. But this lack of rationality may not be a serious problem, as long as an incentives structure is in place for everyone. The enrolment of a real and integrated customer in the market is a valued pursuit even if they turn out to be active or not. The ideal contribution by the user is cost reducing flexibility. By the development of economic incentives within a novel market structures based on demand response, unresponsive and inflexible customers will simply have to provide the value they are unwilling to create by paying the price.

4.2 Technological fixes: "solving" the user

Contributions by technical accounts are somewhat less normative on behalf of user behaviour, and often just focus on expected possibilities related to smart metering technologies. Sometimes users step in as material objects when they are given the role of suppliers and generators in micro-grid constellations, especially in rural and disconnected areas that could make use of distributed generation systems. Thus, it is in these narratives we find expectations about "prosumers", contributing as they will to the energy market and to society in general. Here, as opposed to the above section, the idea of energy efficiency, understood as providing more service for less energy is upheld as a sound ideal both for environmental and economic reasons. However, with regard to the possibilities of technology itself, enthusiasm is sometimes left wholly uncurbed, skewing the academic genre into a sales pitch. The result is a string of ideograph-like jargon, which was discussed in section 2.:

> […] there are some other major driving forces [other than economy] to push [an Energy Management Control System]. First of all, it is an innovative hi-tech, smart home application and there is a strong positive attitude for such investments. It can easily be installed and uninstalled, even in rented houses. Finally it is possible to also provide advanced comfort and home safety services by the same system, thus also entering the safety system market, which has a growth rate pf 6%/year over the last 5 years and is considered to be very promising. (Papagiannis, 2008: 173)

Users are usually imagined as behaving according to what the technology is supposed to do. Technical expectations are rarely critical of technology in the use setting, and bringing about consumer behaviour changes are often not conveyed as unproblematic. Behaviour change according to technology once the technology is taken for granted. As such these narratives could sometimes be understood as rather innocent statements of potential (and, importantly, not a promise). These are not critical accounts; on behalf of the users they are purely functionalist:

It is agreed that a move towards an active demand side is valuable, and indeed necessary, if flexible networks are to become a reality. […] A collateral goal is to achieve these dynamic demand shifts transparently without significantly harming comfort and productivity. Technologies for making this happen, including demand-side management systems, smart meters and appliances are staring to appear […] (Bouffard and Kirschen, 2008: 4506).

Statements about achieving the shift "transparently" without "harming comfort and productivity", and with "technologies for making this happen", are common when users are configured in technical narratives. Arguably, these may be attempts at removing users from the equation altogether, and instead allow technology to meet demand response with as little interference by users as possible. Thus, ontologically speaking, technical contributions separate out the user as problem-to-be-solved, and lets it form a subcategory of the technology domain. Probably, users are not unintentionally disregarded, but rather are pragmatically collapsed into the technological domain and treated this way as just another demand specification of the technological solutions. Ultimately, if the technology is robust enough and solutions are integrated pervasively enough, they can be relied upon to run the smart grid by themselves:

Enabling technology is an absolute critical feature of the Smart Grid that the […] study demonstrated. Consumers must be given the ability to instantly respond to fluctuations in price without having to continuously monitor prices, call home in response to text messages, or even think about the question of what to do when prices rises and fall every few minutes. The fire-and-forget technology used in the demonstration plays a critical role in the success of effective electricity plans. *This is where the economics and the technology meet*. (Chassin 2010, emphasis added)

This is good news for those who woefully seek the active users of the smart grid, because in the instance automation takes over for providing load flexibility, we will not have to rely on the particularities of individual users. Technical accounts are concerned with demand response potential as well, but tend to use the term demand-side management, thus hinting at where the solutions should be targeted. Technical accounts are often positive, almost enthusiastic, when referring to potential, but when real users are involved, a certain sobriety takes over. As we can see, empirical studies find that users need "enabling" technology, giving them the ability to "respond" without having to "monitor". In dealing with users as a technical challenge, the solution sometimes seems to be to bypass them most of the time, rendering them passive, non-users.

4.3 Life for living and technological scepticism

As we have observed, technical and economic expectations are typically quite optimistic about markets and technology, which are seen as important arbiters that can take over when imagined and observed user shortcomings set in. This argument is not compelling in culturally oriented narratives, which can be argued to hold the most pessimism about users of the smart grid, both when critiquing existing "reductionist accounts" of other scholars and in their own empirical studies of actual users. They were found to be critical and largely sceptical, and they often distrust presuppositions about users' abilities and interest in any type of prolonged active participation. These accounts are often critical on behalf of other's expectations and imaginings, rather than producing their own:

Nonetheless, whilst a simple functionalist and linear model of individual and rational decision making resulting from the provision of feedback may be appealing to policy makers, our qualitative evidence suggests that no such simple-cause effect relationship exists. (Hargreaves et al., 2010: 6118)

Common as well is that many studies start off from the very beginning problematizing and framing the problem of users as more complex than has thus far been acknowledged and that this under-acknowledgement poses a threat to the successful configuration of the smart grid user:

The European directive on energy services generally rests upon the rational choice model and defines the user as well-informed and reacting to signals as prices (Prignot and Wallenborn, 2009). This kind of behaviourism precludes some important questions to be asked such as in the learning process involved in any experiment. (Wallenborn et al., 2011: 48)

These accounts fundamentally doubt the user's abilities or interests in active participation as it is offered, and this is considered a greater problem than decision makers realise. Everyday narratives also seem to find unintended and negative effects of technology or information mobilisation. It is shown that technology sometimes provides misinformation, and is often blamed for failure in user adoption:

Overall we found that current electricity displays are not well designed. For example, they only provide figures in kWh or Euros. Graphic representations are more useful for households to track down unsuspected consumption but are not easily understood without the explanations of an expert. We have also noticed counterproductive effects when users realize that some appliances consume little, and hence conclude they can use the device more. (Wallenborn et al., 2011: 151)

More than anything socially oriented narratives focus on the ineffectiveness of economic incentives for engaging users with the smart grid. Although a generally positive attitude towards smart metering potential can sometimes be found, the technology, if it's going to work at all, needs to be good enough from the point of view of the user:

[…] the relationship between consumers and energy use is a potentially fragile one. Positive technological advances can be unbalanced by wider shifts in consumer demand or preferences, as in the case of energy labelling or the rebound effect. More generally, a lack of reliable data or of the technological infrastructure for measuring energy inputs and outputs can damage the feasibility and credibility of an energy monitoring system. (Burgess and Nye, 2008: 4458)

Social science accounts are also, unsurprisingly perhaps, often concerned with ethics. Issues, such as welfare and poverty, are taken up and allowed to problematize the new configurations of the electricity grid and market.

[…] [Time of Use] and [Critical Peak Pricing] rate structures will adversely impact some residential customers and it is more likely than not that this group includes seniors who depend on electricity to run cooling systems that prevent the onset of hyperthermia or to operate medically required devices. Such customers may make inappropriate choices and fear the impact of the higher summer electricity bills if they do not take actions to avoid critical peak prices on very hot summer days, when it is during these same days that they need to run their fans and air conditioners to maintain proper body temperature. Heat waves constitute our most deadly environmental disaster. (Alexander, 2010: 41)

Another interesting issue that social scientists are more prone to raise is the life-is-for-living-argument (Hargreaves et al., 2010: 6117), in which they seek to gain an understanding for the presence in the everyday setting of the notion that sometimes life is for living – as opposed to being energy efficient. This puts questions about human qualities such as guilt and responsibility into the hitherto fundamentally economic and technological smart grid configuration:

[…] the additional information the devices offered seemed to create a sense of fatalism, despondency, anxiety and even guilt among interviewees that what they could do was futile in the face of huge social, political and environmental problems. Smart energy monitors, it would appear, are only as good as the household, social and political context in which they are used. (Hargreaves et al., 2010: 6119)

Social scientists talk a significant amount about households as black boxes, the contents of which we need to unravel to make sense of the moral economies inside (Silverstone et al., 1992), and that we also need to let these moral economies compete on level terms with the monetary one.

To summarize this last section it is evident that engineers and economists imagine users in distinct ways, although in different ways and under different pretexts. Economic rationality expectations understand users more integrated in the market and in an active demand response context, as individual consumption translates into information nodes for market enhancement. Technical accounts imagine users as in need of technological enabling, and expect that this technology will take care of most of the demand response underneath the nose of a happily ignorant user. Social science accounts seem to provide the most pessimistic view of the engaged smart grid consumer, and their main deliverable is often a critique of the expectations offered by others, maybe not providing imaginings of their own, but rather pointing out different ways of imagining – and perhaps most importantly, pointing out which users are in fact real and not. In the following, these very different emphasis will be traced through an analysis the demo projects figuring within the comprehensive and multi-national, interdisciplinary framework of the ERA-Net funding programme.

5. User expectations in pilot projects

The projects surveyed here are each an attempt at developing comprehensive smart grid solutions employing integrated approaches which often involve deep engagements with real users. All the projects give attention to several areas of the smart grid. Many include developments of every aspect, from high and medium voltage systems, via control systems and market mechanisms, down to the distributed levels of the households and accompanying electric vehicles, before entering even into the households themselves to cater for interactions between users and technological artefacts therein, and how they again couple with the workings of the larger grid. However, of the 34 projects surveyed, 15 of them were found to pay little or no attention to the role of users, mostly because the projects were focused on the larger architectural design aspects of the smart grid, which in their nature did not contain problem questions directly regarding everyday users.

5.1 Expectations of economic incentives

As was evident in the above section, the enrollment of users into a demand response regime was considered a matter of subjecting them to economic incentives through novel market models. Within this specific market rationale, the main expectation for smart grids in such a framework is more efficient markets, in which users ideally make use of every resource at their disposal in order to bring down the cost of the grid and increase the flexibility of the energy market. This expectation features in many ERA-Net projects as well. These are approaches defined by a close focus on demand-side management, where the idea of controlling household demand is prevalent, as shown in these four excerpts:

> Nordic electricity *wholesale prices* [… are] reflecting capacity usage and environmental impact […]. Nordic electricity *retail price* [displays] no dynamics […]. An integration of the retail and wholesale systems will transfer the price signals to the consumption (Wall, 2010:12-13).

> Energy consumption is still a low-interest product, but consumption is flexible with automated control/coordination. Consumer flexibility has become important in the power system, and every customer is active with the capabilities of consumption, production and storage of energy […] a broker will offer different service packages, and the customer chooses the one he/she wants based on what kind of profile he/she wants. Alternative service packages are "the environmentally friendly", "luxury", "practical", "busy", "the care package", etc." (DeVID, 2014).

The possible imbalances from intermittent generation could partly be compensated from a more dynamic demand side […] There is also a proposal for testing reinforced price signals, which need to be further investigated. The reinforced price signals are harder coupled to the local wind production (GEAB et al., 2011:10).

Additional services can be offered on these marketplaces, for example, necessary forecasts for promoting economical behaviour or programmes to raise efficiency in households and enterprises through smart maintenance and control of energy producing and energy consuming systems (B.A.U.M. Consult GmbH, 2012:15).

Other projects with the main focus on cost benefits included the EcoGrid project, which also states infrastructure and distribution challenges as a rationale (a domain mostly reserved in these findings to the economic rationality narrative). Nevertheless, the solutions suggested for the issue of grid congestion are oriented first towards construing the smart grid around an ideal energy market, where once again price incentives will provide the needed changes in behavior. Inasmuch as these projects ask why we need the "technology" it is because of the need for "real-time prices and flexible customers". This constitutes an amalgamation of technical and economic concerns, furthering a functional perspective:

Why a Real-time Market? [It is] an efficient way to meet the future challenge of balancing, high(er) demand of flexible consumption/production, high(er) volatility, high(er) balancing cost, [it is] an efficient instrument to wide spread adoption of small-scale end-users/prosumers in the power market(s), increasing competition on the power market(s), small scale end-users can attain economic benefits, TSOs get access to alternative balancing resources. Design of an EcoGrid prototype real-time market place is a realistic approach because it is 'just' widening the scope of the current power market systems (EcoGrid EU, 2014a:2).

Already visible are some quite relevant modern ideographs, like efficiency, competition, benefits, describing the expectations which lie at the heart of visions driving these pilots, easily recognizable from the literature analysis. When looking at the demonstration context, where projects grapple with the issue of economic incentives for enrolling end users as active participants in demand management programmes, some difficult issues arise. In order to get the user enrolled as the active participant in line with expectations from the literature, exploiting these benefits as incentives for imagined users still seems the obvious strategy. But high levels of uncertainty about the magnitude of these benefits, and therefore their efficacy as incentives are vocally addressed in every project that takes this matter seriously. It produces a case of cognitive dissonance:

In EcoGrid EU, the participants will have a radically different setup, as they not only get a lot of information about their consumption but they must make up their minds about whether they are willing to compromise their normal comfort level in the prospects of saving money. Another challenge is to explain to the participants that they certainly cannot expect reductions in their electricity bill, if any at all. (EcoGrid EU, 2013:28).

Here we see the monetary incentive imagined as crucial *and* useless almost in the same sentence. As the smart grid is inherently expected to be populated by active market participants, it seems the economic rationality expectation has become stuck in the current smart grid template, the one which experts employ in their construction work within these projects:

More than anything, consumers' interest will depend on the monetary savings. Small electricity consumption in practice means small possibility for savings. […] Monetary saving is the most powerful motive, but how much is enough? [It] depends on how [demand response] is executed (how much knowledge and effort is required from the consumers, are some investments required etc…). At least 10 % savings from the total bill (including supply, distribution and taxes) would sound "good enough", but often impossible to be achieved. Savings in euros are easier to understand and more concrete. 100 € might be enough for many (ABB & University of Vaasa, 2013:6-10).

The monetary incentive is established as the gold standard of user involvement, before one sentence later, it is reduced to the biggest "what if" of the entire smart grid project; i.e. "how much is enough? [It] depends," etc. This is disconcerting news for those imagining the active customer of the future smart grid. The figures resulting from the above mentioned investigations are familiar to the findings discussed in section 2. They recur here also in every study on savings resulting from the impact of smart metering technologies in households.

> Compared with the previous year, the average reduction in electricity consumption across all groups in the trial (including the control group with a standard yearly bill) was 6.7 %, with a minimum value of 2.5 % and a maximum value of 10.9 % (Reiter & Emmermacher, 2013:32).

> In the first pilot field trials of E-Energy, savings of up to 5 % were made in the private sector. In the large scale eTelligence field trial, savings have even been made of as much as 10 %. Transparent electricity consumption patterns alone are not enough to save on energy. Power consumers must be able to assess the relevant information and decide on the possible options. (B.A.U.M. Consult GmbH, 2012:17)

So even though the reality is brought to bear on the imagined efficacy of economic incentives, the expectation of them as an effective and important tool for user enrolment in the smart grid is surprisingly resistant. The monetary incentive is maintained, and instead more work on improving it usually suggested. But the user imagined as active and economically incentivized is not the only one with a burden of responsibility in the smart grid; there are also technological expectations which will be recounted in the following.

5.2 Expectations of technology and automated solutions

How do technical expectations aid in enrolling the ideal user needed to demonstrate smart grids in action? In line with findings of section 4.2, many cases cleanly admit that expectations of full participation from users in a way that would equal 100 % potential from the household are unrealistic. A suggested solution is to separate load profiles into a "stochastic" portion – which is considered unmalleable because of the aggregated whims of the user population, and therefore should simply be left alone "as a kind of base load" – as opposed to bigger loads which represent the "low hanging fruit":

> In general, these local plans [of the electricity market] do not specify the schedules of all devices, but mainly specify the schedules for the individual micro-generators or storage devices and maybe some 'large' devices like e.g. washing machines and electrical cars. The other devices are summarized in a sort of base load but are not precisely scheduled. If during the short term planning the reality differs too much from that schedule, the individual micro-generators or storage devices may need to be rescheduled compared to the master schedule. In this way we can cope for prediction errors and the stochastic nature of (e.g. human caused) demand. Furthermore, now also devices with long running times (e.g. washing machine or dish washer) can be scheduled. For this short term planning, not only the preferred planning from the global controller, but also the comfort level in the building (e.g. temperature in a room or fridge) has to be taken into account. (University of Twente, 2014)

Engineers are not used to dealing with the mass of users as the messy individuals of which it consists, rather they attempt to model and synthesize the many users into a sort of meta-user, or a kind of *stochastic man* (c.f. the concept of "Resource Man"[2], Strengers 2013), a representative of all users

---

[2] Strengers has in her book identified a small portion of smart meter users as "resource men", characterized by their special interest in (compared with the majority of end users) information about consumption and technological possibilities for controlling and monitoring it. In empirical terms they are more often found among men, thus the gender specific.

which the technological design can cater to, and in so doing provides a solution for many, but admittedly not all, of the loads in the system. After all, in this case they are committed to making “a” solution for all users, and as such they are not focused on “the” user, but rather what we could understand as the residual effects of all user activity. Take into consideration this excerpt from a paper stemming from the Finnish SGEM project:

This paper has presented several Linear Gaussian model-based load profiling techniques that compactly capture multiple behaviors exhibited by residential customers who have traditionally been assumed to be homogenous. The combination of the modeling strategy and the smart meter advance data has permitted a representation that expresses not only load magnitudes at given times of day but also their variability and how these variabilities influence other times of use. The mixture model framework in which this is embedded allows multiple behaviors to be assumed with the statistically most likely one being used to categorize a given residential customer on a given day. In this way, dynamic customer behavior changes can be captured as they evolve with season or changes in routine. (Stephen et al., 2014)

This contribution follows the user-less smart grid expectation we saw in section 4.2. It is meant to inform some hidden algorithm within the technological infrastructure that will procure an amount of flexibility without having to rely on the decision making of users in order to achieve it. Importantly, this means it is *intended* not to enroll anybody *at the same time* as it provides an infrastructure to all those actual users which it arguably does not enroll. This provides us with a new constructive enunciation of what the user may be in the smart grid, and it makes clear that the contribution pursued does not always have to be actively provided to be sufficient.

5.3 Non-technical and non-economic user enrollment

By now it is evident that the projects here studied have been operating on many of the expectations we saw in the literature analysis, and that some are encountered as dead ends and the pursuit of yet others are maintained with the help of novel work-arounds. But as we saw, having catered for the stochastic user, a portion consisting of actual users remain and their successful enrollment is still considered a central and vital expectation. Some of these projects involve entire cities or parts of them, and the enrolled number of households range from a tenfold of households, through a few hundred, to many thousand. The methods employed to enroll actual publics range from surveys to interviews, town meetings and even training programs:

Consumers who were involved in the project were asked to participate in interview with experts in the field of smart technologies. During the interview, consumers provided information about main electrical devices in the household and the behavior of users. […] Project activities included seminars and other dissemination activities. The communication with the target audience of the project provided a joint platform for discussions and exchange of experience on practical ways how to achieve more efficient use of energy by consumers. (Prüggler et al., 2014:17)

Apart from branding a seminar as a “dissemination activity”, this project clearly can be commended for allowing real user perspectives to contribute, and thus refrain from getting stuck with unhelpful imaginary users. In such events it becomes an issue of finding out just how active users can be. The results found resonate strongly with social science critiques which were reviewed in section 4.3 above, as exemplified by this quote:

Preliminary results show that the customer’s potential for load shaving and shifting are small […]. The result of the evaluation show that the customer found it hard to understand the idea of spread their consumption over time to reduce power peaks, compared to an overall reduction of consumption over a longer period. Many find it impossible to change their behavior due to every day demands like work, school, training and other activities.” (GEAB et al., 2011:41)

Even so, the motivation to fulfill the expectation of active users sometimes invokes some strange and often conflicting views on the users in the smart grid. In line with the optimism of some technical expectations which were identified in the last section, here too jargon relating to the expected benefits that the smart grid will create for future energy consumers can be found. Such rhetoric exercises indicate that there are expectations in smart grid development projects too that users or publics will be reluctant to enrollment efforts. Some examples of the previously mentioned sales-pitch genre are compiled in the following excerpts:

The ability to include distributed generation not only applies on the driver to increase renewable energy generation, but also applies for another driver, the "**end-user empowerment through active participation** in the electricity market." (GEAB et al., 2011:10, original emphasis)

The customer will be able to not only consume electricity, but also produce and deliver electricity to the grid, thus achieving a more empowered position towards the electricity utilities. […] The customers can more actively choose to lower their electricity bill by participating in Demand Response activities and to a larger extent influence the electricity markets. (ibid:30)

The vision incorporates the basic thought of giving power to the people, not only literally, but by making everyone a part of the smart ecosystem of energy. This means that everyone will be able to affect and control their contribution and needs as Prosumers in the future marketplace. […] The SGEM project […] is generating a holistic picture of how smart grid technologies can work and leverage the liberalized energy market in ways that empower individuals and enterprises to make best use of smart grid resources. (Prüggler et al., 2014: 10)

These appliances will enable them to control their consumption more or less automatically down to a five-minute basis based on the principle: it must be smart, easy and convenient to be a price conscious and environmentally-friendly electricity consumer in the 'smart grid-society'. […] EcoGrid EU can create 'win-win' situation, enabling small and large electricity customers to save money on their electricity bill, while the power systems is relieved. And in the long-term, this will reduce society's investments in grid reinforcement and new grids. […] The future electricity customer will gain far more control of his electricity consumption and electricity bill (Prüggler et al., 2014:8).

Expectations within these projects state that it will bring about "emancipation" for consumers as they will be given "more control" over their own energy consumption, again clear examples of what Van Lente (2000) described above as ideographs. We know that it is expected that customers in some cases participate to a larger extent on smart grid markets, i.e. as prosumers. But what this means exactly may be too early to say. At any rate, to deal with the imagined reluctance of users, some of the projects have focused on what could be called *hard enrollment*, as customers are entered into training programs to get the "right" ideas and attitude about smart grids.

The EcoGrid EU test participants are invited to training sessions in Villa Smart. A communication and technical EcoGrid team in Oestkraft give individual advice regarding their particular role in the project and the new equipment. (EcoGrid EU, 2014a)

In the pilot projects, households usually receive specific advice from the electric utility company. Relevant and also government sponsored (here: KfW) advisory measures are conducted in enterprises. (B.A.U.M. Consult GmbH, 2012:17)

The purpose of the training session is to give the participants an understanding of Smart Grid in general and EcoGrid EU in particular. The concept of the real-time market is a complex topic to communicate, especially for the average power consumer. […] Therefore, it is important to tell the participants about the future benefits of EcoGrid EU and Smart Grid not only from an individual point of view, but also from the perspective of the society" (EcoGrid EU, 2013:28).

Emphasis was often given to the importance of "keeping up the pressure" to make sure the consumers' interest did not wane too quickly. In addition it was seen as important not to hype the smart grid and provide grounds for false hopes, but maybe undercut expectations slightly, in the interest of the reputation of the project. Finally, creating a sense of economic security in order to stave off concerns some may have about unfamiliar pricing regimes was a central ambition:

> During the entire recruitment process the communication with the public was focusing on the social values and environmental aspects rather than individual financial benefits of participating in the EcoGrid EU field-test. In addition, the participants are guaranteed that they will not 'lose money' by participating in EcoGrid EU. In total, the participants will never pay more for the electricity compared to what they pay according to their normal contract. (EcoGrid EU, 2014b)

Such sentiments prove that a smart grid project seeking out actual publics is not only deeply entangled with some highly private spheres of everyday life; it propagates a technological development that users know little about and which they could potentially be afraid of – and the experts involved in these projects are acutely aware of this. However, the expected importance of preempting hype would seem to be held as equally important, if not more so, than to prevent any kind of moral panic in the smart grid. At any rate, this work seems important in order for pilot projects to establish the distinction between imagined users and real publics.

6. Discussion

This paper has sought to examine technology expectations and the imagined users in smart grid literature and trace how it does or does not correspond to motivations and findings reported from pilot projects. As we saw in the beginning of this paper, it was held that technology design may configure users, and that expectations of technology may have performative influence on technology design. This allows us to evaluate expectations and imagined users in actual demo projects and in which way they may be different from the more abstract, theoretical deliberations found within research literature. Initially, expectations and imaginaries within the literature were found to fall into three categories, or narratives; those of economic rationalization, technological bypass, or social science critique. Secondly, the pilot context saw these same narratives reoccurring, but the reality of testing conditions were brought to bear on them, and they were sometimes affected by this. The economic rationality narrative was proven faulty, but resilient in the face of this. The technology bypass narrative was reinforced by a concretization of technological solutions to cater for this. In line with recommendations from social science critique, some projects also showcased comprehensive approaches to enrolling actual users. Even so, pilot projects were also heavily engaged in ideographic vision-making, seemingly under the influence of users imagined as reluctant towards smart metering.

This analysis suggests the case for expectations exerting clear performativity on pilot projects is not entirely clear cut. For instance, when imaginary users were compared with real users in the question on enrolling them on the basis of economic savings, the imagination, even though it clearly lost the argument with reality, prevailed. In lack of a better strategy, the one that remained was simply suggested improved. Even so, as we saw in the first part of the analysis, users are not always required to be passive for economic and technical expectations to be met. Unresponsive users within an economically rational narrative will be taxed and the value of flexibility obtained regardless; irrational users potentially imagined as obstacles within a technological expectation may simply get bypassed. In the first case expectations are performative even in the face of severe hindrances. In the second two cases, expectations were maintained but their basis modified. Social science narratives in the initial analysis proved useful in pointing out the possible diversity in the ways users can be imagined, but they also can prove useful in making obvious which users are in fact real, and which, it must be admitted are unhelpful imaginaries.

We also saw some examples where hard enrollment was employed and actual users were meticulously brought on board the pilot projects. The EcoGrid EU project was quite user oriented, with its comprehensive training programs for enrollment which seemed helpful and informative for enrolling active users – even though from a constructivist camp the question of actual and mutual participation on part of the users could always be questioned. But even if a smart grid project does employ a hefty user focus, it may still be a strictly top-down project, and we saw some examples of widespread use of ideographs. Far from being provided more control by real time pricing or demand response management, it is quite possible to argue that what users would in fact be doing within a demand response framework is relinquish control over their energy consumption to market mechanisms. Stating the case for empowerment without addressing the ways in which it will come about is only getting half the job done – unless indeed the goal is intentional to have ideographic jargon serve as a rallying cry in a strategic game (see Geels and Smit, 2000). Additionally, the most unhelpful user imaginaries for constructive pilot activity can very well be the one which is thought to be reluctant and resistant to change, and thus needs to be met with what sometimes simply comes off as a sales pitch. Separating out techno-ideological jargon and other sales pitches from actually progressive programs that do enroll end users thus seems to be an important task, as there is evidence of these demo sites having potential for gathering deliberative publics in larger discussions on energy policy and climate issues (Throndsen and Ryghaug 2015).

The lesson so far for experts is to leave out actual user initiatives completely, or else be more specific about enrollment. For instance, Schick and Winthereik have recently argued that users should be included in the development processes, because users' not knowing about the smart grid is the main challenge for experts; this could in turn make experts unable to even understand the character of their problem (2013: 98). As the authors say, this implies that the problem of the user is actually a problem of publics and as such needs to be treated as a democratic challenge. This is where progressive and useful enrolment of users becomes important in the practical sense, along the lines of the comprehensive work on social acceptance of energy infrastructures (Cotton and Devine-Wright 2012). The workability of sustainable community participation itself has been exemplified for instance by the recent work by Burchell et al. (2014) in their Smart Communities Project. Seeking to generate more viewpoints on what the smart grid should be and how we understand in political terms its integral role in society is much needed, and more ways to create knowledge and opinion about smart grid should become an increasing concern.

Finally, a point about stochastic users. Most of the time, reductionism could be considered an unhelpful affliction of lazy development processes. Even so, we could attempt at opening up for an understanding of the opportunities in the smart grid for a shared workload between users and this stochastic man, meaning that the lion's share of demand response flexibility is provided by automation and algorithm. Arguably a reduction, such a result would be based on work that still deal very seriously with users even though one might need to hold an engineering degree to understand exactly how. This underlines the ubiquitous nature and therefore the heterogeneous kind of interdisciplinary action called for in scientific endeavours dealing with smart grids. Perhaps we need to get to know this construct of the stochastic man better, and learn to trust it more. What these examples really bring to the fore is not that engineers and economists are unable to imagine users and so are inherently unable to make a smart grid that will work as well as it should. The question could be posed if we have all fallen into a kind of trap set up by the lure of this all-encompassing nature inherent in many future visions of the smart grid, and that in an unpremeditated moment of the early conceptual stages of the smart grid this user categorically imagined as active was able to sneak in through the cracks of uncertainty. Now it seems to have lodged itself as an inevitable item on the agenda of any smart grid project. The reality thus far seems to be that many users may in fact never come on board. This leaves us with the biggest problem of this active user expectation, namely the irresistible idea that economic incentives alone can provide the solution. Incentivising all consumers will invariably fail to include everyone, and an incentive not reacted upon inverts to a penalty. Finally then, demand response not responded to becomes a burden of demand responsibility. In the face of such a future, it is quite imaginable that we are better off leaving it all to the machines.

7. References

ABB & University of Vaasa. (2013) *Customer behaviour and expectations.* Power point slides retrieved 1.07.14 http://www.cleen.fi/en/SitePages/resulthighlights.aspx?fileId=1963&webpartid=g_54fff7f1_3a28_4ce6_8ac0_81baa9f4eeac

Abi Ghanem, D., Mander, S. (2014). Designing consumer engagement with the smart grids of the future: bringing active demand technology to everyday life. Technology Analysis & Strategic Management 26, 1163–1175. doi:10.1080/09537325.2014.974531

Akrich, M. (1992). The de-scription of technical objects. In Bijker, E. W. and J. Law., 1994. *Shaping technology, building society.* London: The MIT Press (pp. 205-224)

Alexander, B.R. (2010). Dynamic Pricing? Not So Fast! A Residential Consumer Perspective. *The Electricity Journal,* 23, 39-49

Bartusch, C., F. Wallin, M. Odlare, I. Vassileva & L. Wester. (2011). *Introducing a demand-based electricity distribution tariff in the residential sector: Demand response and customer perception.* Energy Policy 39, 5008-5025

B.A.U.M. Consult GmbH. (2012). *Smart Energy made in Germany. Interim results of the E-Energy pilot projects towards the Internet of Energy*. Munich/Berlin. PDF retrieved 1.07.14 http://www.e-energy.de/documents/E-Energy_Interim_results_Feb_2012.pdf

Borlick, R. (2011) Paying for Demand-Side Response at the Wholesale Level: The Small Consumers' Perspective*. The Electricity Journal* 24, 8–19.

Borup, M., Brown, N., Konrad, K., Van Lente, H. (2006). The sociology of expectations in science and technology. Technology analysis & strategic management 18, 285–298.

Bouffard, S. & D. S. Kirschen. (2008). Centralised and distributed electricity systems*. Energy Policy,* 36, 4504-4508.

Braithwait, S. D. (2003). *Demand Response Is Important—However, Let's Not Oversell (or Over-Price) It.* The Electricity Journal 16, 52–64

Brown, N. & Michael, M. (2003). A sociology of expectations: Retrospecting prospects and prospecting retrospects. Technology Analysis & Strategic Management 15, 3–18.

Burchell, K., R. Rettie & T. Roberts. (2014). Working together to save energy? *Report of the smart communities project*, June 2014, Behaviour and Practice Research Group, Kingston University http://smartcommunities.org.uk/ and http://business.kingston.ac.uk/smartcommunities

Cavoukian, A., Polonetsky, J. & Wolf, C. (2010). SmartPrivacy for the Smart Grid: embedding privacy into the design of electricity conservation. *Identity in the Information Society.* 3, 275–294.

Chassin, D. P. (2010). What Can the Smart Grid Do for You? And What Can You Do for the Smart Grid? *The Electricity Journal.* 23, 57–63.

Cotton, M., and Devine-Wright, P. (2012). Making electricity networks "visible": industry actor representations of 'publics' and public engagement in infrastructure planning. *Public Understanding of Science* 21 (1):17-35.

Darby, S. J. (2012). Metering: EU policy and implications for fuel poor households. *Energy Policy.* 49, 98-106

DeVID. (2014). *Newsletter December 2012*. PDF retrieved 1.07.14 http://www.sintef.no/project/DeVID/DeVID_Nyhetsbrev_3_2012.pdf

EcoGrid EU. (2013). *From Design to Implementation: A large scale demonstration of a real-time marketplace for Distributed Energy Resource.* PDF retrieved 1.07.14 http://eu-ecogrid.net/images/Documents/131120_ecogrid_popular-report.pdf

EcoGrid EU. (2014a). *The EcoGrid Real-time Market Concept*. Power point slides retrieved 1.07.14 http://eu-ecogrid.net/images/140123_Real-timemarket.pdf

EcoGrid EU. (2014b). *Meet your customers where they are…* Web page retrieved 1.07.2014. http://eu-ecogrid.net/

Faruqui, A. (2010). The Ethics of Dynamic Pricing. *The Electricity Journal.* 23, 13–27

Felder, F. (2012). Chapter 4 - The Equity Implications of Smart Grid: Questioning the Size and Distribution of Smart Grid Costs and Benefits, in *Smart Grid*. (Boston: Academic Press): 85–100.

GEAB, Vattenfall, ABB & KTH. (2011). *Smart Grid Gotland Pre-Study*. PDF retrieved 1.07.14 http://www.smartgridgotland.se/pdf/sgg_forstudie.pdf

Geels, F.W., Smit, W.A. (2000). Failed technology futures: pitfalls and lessons from a historical survey. Futures 32, 867–885.

Hargreaves, T., M. Nye & J. Burgess. (2010). Making energy visible. A qualitative field study of how householders interact with feedback from smart energy monitors. *Energy Policy.* 38, 6111–6119

Ivory, C. (2013). The role of the imagined user in planning and design narratives. *Planning Theory.* 12, 425-441

Jasanoff, S. & Kim, S-H. (2009). "Containing the Atom: Sociotechnical Imaginaries and Nuclear Power in the United States and South Korea." Minerva, 47 (2): 119-146.

Maranta, A., M. Guggenheim, P. Gisler & C. Pohl. (2003). The Reality of Experts and the Imagined Lay Person. *Acta Sociologica.* 46, 105-165

Newsham, G.R. & B.G. Bowker. (2010). The effect of utility time-varying pricing and load control strategies on residential summer peak electricity use: A review. *Energy Policy* 37, 3289-3296

Nichols, D. & Stutz, J. (2001). Load Response: New, or Déjà Vu? *The Electricity Journal* 14, 73–79.

Papagiannis, G., A. Dagoumas, N. Lettas, & P. Dokopoulos. (2008). Economic and environmental impacts from the implementation of an intelligent demand side management system at the European level. *Energy Policy* 36, 163-180

Reiter, D. & L. Emmermacher. (Eds). (2013). *Results & findings from the smart grids model region Salzburg*. PDF retrieved 01.07.14
http://www.smartgridsTosalzburg.at/fileadmin/user_upload/downloads/SGMS_Results_Findings_05-2013.pdf

Schick L. & B.R. Winthereik. (2013). Innovating Relations – or Why Smart Grid is not too Complex for the Public. *Science & Technology Studies.* 26, 82-102

Silverstone, R., Hirsch, E., & Morley, D. (1992). Consuming Technologies. Media and information in domestic spaces. London: Routledge

Skjølsvold, T.M. (2014). Back to the futures: Retrospecting the prospects of smart grid technology. Futures 63, 26–36. doi:10.1016/j.futures.2014.08.001

Stephen, B., A. J. Mutanen, S. Galloway, G. Burt & P. Järventausta. (2014). Enhanced Load Profiling for Residential Network Customers. *IEEE Transactions on Power Delivery.* 29, 88-96

Strengers, Y. (2013). *Smart Energy Technologies in Everyday Life. Smart Utopia?* Hampshire: Palgrave MacMillan

Prignot, N. & Wallenborn G. (2009). "Standardisation of practices and representations of users in the ecodesign Directive", Proceedings of ECEEE 2009 summer study, panel 8 : dynamics of consumption 1-6 June 2009, pp 1763-1772

Throndsen, W., Ryghaug, M. (2015). Material participation and the smart grid: Exploring different modes of articulation. Energy Research & Social Science, Special Issue on Smart Grids and the Social Sciences 9, 157–165. doi:10.1016/j.erss.2015.08.012

University of Twente. (2014). *DREAM: Dynamic real-time control of energy streams in buildings*. Webpage retrieved 1.07.2014.
http://www.utwente.nl/ctit/energy/projects/dream.html

Van Lente, H. (2000). Forceful futures: from promise to requirement. In Brown, N., Rappert, B., Webster, A. (eds). Contested futures. A sociology of prospective techno-science. Aldershot: Ashgate Publishing Ltd, pp. 43-64

Van Lente, H. (2006). Expected behavior, in: User Behavior and Technology Development. Springer, pp. 211–219.

Verboven, P. & M. Hübner. (Eds.). (2014). *Smart Grids Demo Snapshots 2013/2014. Collection of regional and national key projects as a starting point for the establishment of ERA-Net*

Walker, G., N. Cass, K. Burningham, & J. Barnett. (2010). Renewable energy and sociotechnical change: imagined subjectivities of 'the public' and their implications. *Environment and planning* A. 42, 931-941

Wall, T. (2010). *Stockholm Royal Seaport - a smart grid for a sustainable city project*. Power Point slides retrieved 1.07.2014
http://www.ieadsm.org/Files/Exco%20File%20Library/Workshop,%20Stockholm%20October%202010/Wall.pdf

Wallenborn, G., M. Orsini, & J. Vanhaverbeke. (2011). Household appropriation of electricity monitors. *International Journal of Consumer Studies.* 35, 146–152.

Woolgar, S. (1991). Configuring the user: the case of usability trials. In Law, J., ed. (1991) *A sociology of monsters: Essays on power, technology and domination.* London: Routledge (pp. 37-102)

Prüggler , N., Verboven, P., Hübner, M. (2014). Collection of regional and national key projects as a starting point for the establishment of ERA-Net Smart Grids Plus Smart Grids Demo Snapshots 2013/2014. *Smart Grids ERA-Net Deliverable D 4A.4.1*