Consumer and Community in the Future Electricity Network: an Insight from Smart Grid Projects in Europe

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ABSTRACT

Integration of growing shares of renewable energy sources into the electricity networks have resulted in the need for electricity network upgrade through pervasive deployment of information and communication technologies. Having power sources close to the consumer premises and exploiting the potential of smart metering infrastructure may lead to consumers' empowerment and energy savings. Therefore, the consumer should be approached with clear engagement strategies in the early stages of the technological system development. The analysis of European smart grid projects points to an increasing interest in consumers and communities as focal players for the success of the future electricity system. This necessitates characterization of the consumer as well as the community from what concerns values, beliefs and goals that are culturally and geographically located. In this context, this contribution presents and discusses some EU smart grid projects with a focus on consumers and on their interactions within the community. The abstract also demonstrates successful consumers' engagement strategies in large-scale deployment of smart metering systems at national level, highlighting the need to address social needs and concerns at an early stage of the technological system development.

Keywords: Smart Grids, Consumer, Community, Social Aspects

INTRODUCTION

Growing concerns over climate change, security of power supply and market competitiveness have resulted in a need to integrate increasing shares of renewable energy resources close to the consumers' premises, thus allowing the electricity end-users to also operate and behave as energy producers. This may introduce additional flexibility into the system on one hand side and on the other impose increasing challenges for electricity system operators and energy providers in managing the power system operation and delivering secure and reliable power supply. As a result, the introduced system complexity would require an upgraded electricity network with two-way information and power exchange between the suppliers, distribution system operators (DSO) or any third-parties and the consumers through pervasive deployment of information and communication technologies. The adoption of such network infrastructure may theoretically lead to changes in the energy consumption, however, when customer behaviour is not aligned, potential energy gains may not be realized. To this end, despite the technical and technological challenges, the focus should be on new market structures, new services and primarily new social processes that demand the adoption of more intelligent electricity infrastructure. In this new perspective, it is important to understand and involve consumers and the communities within which they are acting in order for them to fully understand the smart grid potential and consciously assume their role as active participants in the future electricity system.

In light of the above and of the growing interest of researchers and policy makers on the role that consumers will play

in the future electricity system, this contribution will present findings of the analysis of the JRC European smart grid projects inventory, specifically focusing on projects that emphasize electricity consumer and community aspects. The discussion will further focus on smart metering infrastructure and consumers' social needs, highlighting the experience of few Member States' plans for national roll-out of smart metering systems and focusing on the values that such systems may bring to the consumers.

THE CONSUMER

The electricity consumers, their daily routines and the social context in which they operate are gaining increasing interest in policy and research. Many studies have been recently[1] published where consumers have been involved in interviews and studies to assess their perceptions, understanding and willingness to pay for the development of smart grids technologies. These studies acknowledge a consumer positive attitude towards smart grid technologies; however, they also recognize the need to further explore values, beliefs and goals in the context of these new technologies and to strive for trust, transparency and feedback to gain consumer involvement and acceptance[2]. Research on behavioural change in energy related behaviour has typically focused on motivating the consumers in their passive role. With smart grids the consumers will assume an active role as energy users and producers. Therefore, the challenge ahead is to understand the consumer active role and participation in smart grids, including the relation with the DSO and other service actors, and among and across the communities of consumers.

THE COMMUNITY

The actors who decide to integrate their distributed generation units in a cooperative micro grid constitute a community. Indeed, one of the biggest achievements of future smart grids will be their distributed mode of operation where the coordination of energy consumption will become first priority. A vision of "electricity community grid" that relies mostly on local energy sources and storage is gaining acceptance. In Figure 1 we present a simplified representation of a community electricity grid.

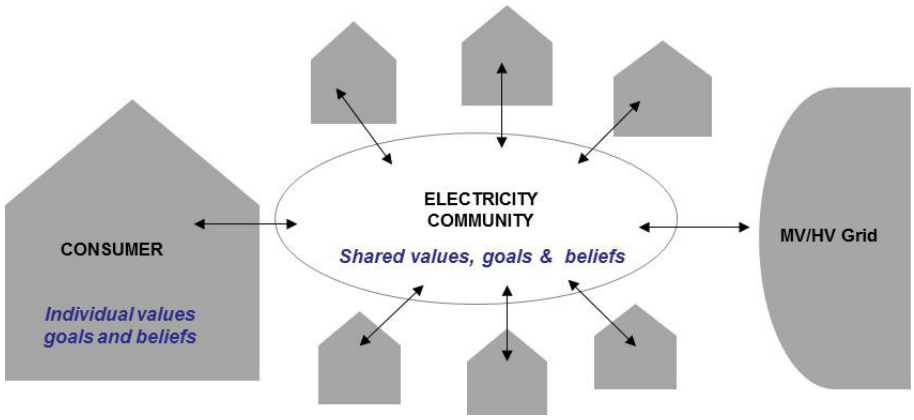

Figure 1: Smart grid framework at household and community level

Whilst conventional energy production capacity used to be predominantly owned by a small number of large utilities, an increasing number of installed renewables is now owned by citizens, farmers and energy cooperatives. Such cooperatives present an interesting form of social innovation in which citizens together develop completely new ways to organize the energy system driven by a sense of community and local ownership. Some studies argue that for the

1 Krishnamurti, T., Schwartz, D., Davis, A., Fischhoff, B., De Bruin, W.B., Lave, L., Wang, J., 2012. Preparing for smart grid technologies: A behavioral decision research approach to understanding consumer expectations about smart meters. Energy Policy 41

Diaz-Rainey, I., Ashton, J.K., 2008. Stuck between a ROC and a hard place? Barriers to the take up of green energy in the UK. Energy Policy 36

Ngar-yin Mah, D., Van der Vleuten, J.M., Hills, P., Tao, J., 2012b.Consumer perceptions of smart grid development: Results of a Hong Kong survey and policy implications. Energy Policy, 49

2 Gangale, F., Mengolini, A., Onyeji, I., 2013. Consumer Engagement: An insight from smart grid projects in Europe. Energy Policy 60, 621-628.

smart grid to be successful, policies should be designed to enhance the autonomy of communities (local group of end-users) to support them in applying renewable sources and limit the power supplied by central power plants[3]. The challenge will be to enable consumers into forming communities according to their energy consumption behaviour. Studies reporting about community engagement in renewable energy and smart grid projects highlight the essential role of building trust between local people and groups in taking projects forward[4]. Local cooperatives with groups of houses sharing micro-generator production are also emerging. Being part of communities should strengthen consumer's energy awareness by allowing comparisons of energy consumption data with other community members. However, some recent studies on community energy argue that there is a limit to how much groups can achieve on their own. Instead, external sources of support are required to succeed and this indicates the strong need for consistent policy support, as well as intermediary networks, to ensure community energy projects have the resources they need to progress and achieve their objectives[5].

Community based approaches to social changes are becoming an increasingly important part of the landscape of sustainable development. In particular, approaches that uses community based social marketing are gaining field. Social marketing is an approach that seeks to identify the barriers that people perceive when attempting to engage in a certain activity. Community based social market merge this approach with insight into the importance of social norms and community engagement in changing consumer behavior[6]. Successful examples of the application of this approach show that well designed community based social marketing strategies can have significant impact on routine behaviors and can offer effective paths towards pro-environmental and pro-social behavior[7]. It follows that communities may have an important role to play in mediating individual behavior.

Further research and analysis is needed to understand the attributes that define electricity community, identifying the strong elements that can make a community relevant in the development of future smart grids.

CLOSER INSIGHT INTO SMART GRID PROJECTS IN EU

The JRC Smart Grid inventory 2014[8] shows that the number of smart grid projects focusing on smart customer has been increasing since 2005. Out of total 459 Smart grid projects (R&D and Demonstration & Deployment), the JRC smart grid inventory identifies 148 projects having smart customer as one of the main project application. In particular, most of these projects indicate a focus on the residential sector that shows an increasing interest of energy providers to target household consumers. The geographical distribution of smart grid projects with focus on smart customer shows that the majority of the projects are located in EU15 Member States (Figure 2). In the EU 15, most of the projects are concentrated in a few countries; Denmark, France, UK and the Netherlands. However, if weighted by budget, it emerges that Spain and Italy have projects with bigger budgets.

The analysis of the JRC Smart Grid inventory shows an increasing number of smart grid projects focusing on consumer as part of a community, this being a neighbourhood, a city or in some cases a region. In particular, the analysis of multinationals smart grid projects started in 2013 that have a focus on smart consumers reveal an approach to smart grids as complex socio-technical systems emphasising the need to embed energy infrastructure in a broader context that goes beyond technological change. In this view, social dynamics are considered crucial in achieving a more efficient and environmentally compliant energy system. The integration of energy, information and social networks is seen as central to the success of smart grid deployment at energy community level.

3 Wolsink, M., 2012. The research agenda on social acceptance of distributed generation in smart grids: Renewable as common resources. Renewable and Sustainable Energy Review, 16

4 Alvial-Palavicino, C.,Garrido-Echeverria, N., Jimenez-Estevez, G., Reyes, L., Palma-Behnke, R., 2011. A methodology for community engagement in the introduction of renewables based smart microgird. Energy for Sustainable Development 15

5 Seyfang, G., Park, J.J., Smith, A., 2013. A thousand flower blooming? An examination of community energy in the UK. Energy Policy, 61

6 Jackson, T., 2005. Motivating Sustainable Consumption - a review of evidence on consumer behaviour and behavioural change. Centre for Environmental Strategy, University of Surrey

7 Anda, M., Temmen, J., 2014. Smart metering for residential energy efficiency: The use of community based social marketing for behavioural change in smart grid introduction, Renewable Energy, 67

8 JRC Science and Policy Reports, Smart Grids Projects Outlook 2014; http://ses.jrc.ec.europa.eu/reports-books-and-magazines

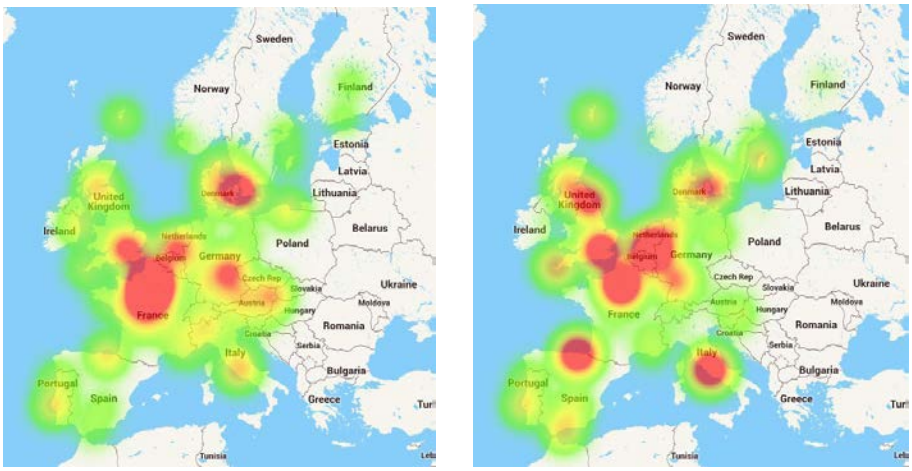

Figure 2: Geographical distribution of national smart grid projects with focus on smart customer. Left: number; right: weighted with the total budget

Among the multinational smart grid projects started in 2013, three show an approach that aims at harnessing the benefits that electricity community diffusion may bring about at consumer level (improvement of electricity quality and reliability, energy savings) and systemic level ("electricity system" and "social system")[9]. These projects are in their initial phase of development, therefore progress and results are not yet available. Nevertheless, from their conceptual framework some interesting concepts emerge. For example, the CIVIS project (*Cities as drivers of social change*) aims at enabling communities, interest groups, business and non-business players to decide how to allocate energy according to shared goals, intents and beliefs thus fostering the arising of new forms of social aggregations that can enact new forms of energy eco-systems. In a similar way, the CoSSMic project (*Collaborating Smart Solar-powered Micro-grids*) aims to develop the ICT tools needed to facilitate the sharing of renewable energy within a neighbourhood, investigating how to motivate people to participate in acquiring and sharing renewable energy in the neighbourhood. Finally, BESOS project (*Building Energy Decision Support Systems for Smart Cities – holistic approach to a community level dimension – research and demonstration project*) aims at enhancing existing neighbourhoods with a decision support system to provide coordinated management of public infrastructures in Smart Cities and at the same time to provide citizens with information to promote sustainability and energy efficiency.

These three projects are characterized by a common systemic approach where the interest is also on the social systems dynamics developed within the community. Values, goals and beliefs will need to be mediated and negotiated between the individual and the community. They also point to the need to characterize geographically and culturally a community and thus to the difficulties of scalability and applicability of a common approach throughout Europe.

On a national level, another interesting project addressing the community involvement is the MIETeC project[10] (Montdidier: Intelligence Energetique Territoriale pour la Collectivite) whose aim is to reach 100 % RES community for the region of Montdidier. The main tools to be developed within the project are a centralized data management system to balance the energy consumption across the town, coupled with storage solutions and demand side management along with an animation tool for consumers, based on different modes of communication (SMS, mails, community newsletters, etc.), to help them in managing their energy demand.

SMART GRID INFRASTRUCTURE – POLICY IMPLICATIONS AND SOCIAL NEEDS

Advances in EU Policy clearly play a significant role in the adoption of smart grids and smart grid technologies at a national scale. The Recommendation 2012/148/EU[11] on smart metering deployment further clarifies that the smart metering system should be defined through the functionalities it provides. In particular, in the case of electricity, the Recommendation identifies ten minimum functional requirements that the smart metering system should provide

9 Le prospettive di sviluppo delle Energy Community in Italia, Politecnico di Milano, 2014

10 http://www.smartgrids-cre.fr/index.php?p=mietec

11 Commission Recommendation 2012/148/EU, OJ L 73 p.9, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32012H0148:EN:NOT

in order to deliver full benefits to consumers and the energy grid while supporting technical and commercial interoperability and guarantee data privacy and security.

Member States such as the UK, Ireland and the Netherlands have placed the electricity consumer as focal point in their analysis of nation-wide smart metering deployment (above 80% of electricity consumers), addressing social acceptance and consumer engagement in the early stage of smart metering technological development. All three countries are proceeding with nation-wide roll-out of smart metering systems, to be completed by 2020[12].

The Department for Energy and Climate Change in UK has agreed on establishing a Central Delivery Body (CDB), a new independent organisation responsible for raising awareness and educating customers on smart metering alongside suppliers own campaigns. As a legally independent company with a Board of Directors made up of both, consumer and supplier representatives, one of the main activities of the CDB will be on building consumer confidence in the installation of smart metering systems by the electricity suppliers.

The Irish energy regulator CER established the Smart Metering Customer Behaviour Trials[13] as part of the much larger smart metering technology trial which remains to date one of the largest and most comprehensive in Europe. It attempted among other things to measure the potential of energy consumption reports to change the behaviour of electricity and gas consumers being assigned to different Time Of Use tariffs and having access to different communication feedback channels.

In the Netherlands, social acceptance of smart metering systems, mainly related to data privacy concerns, resulted in an amendment to the legislative proposal by means of an introduction of a voluntary approach for consumers' acceptance of smart metering systems. In this perspective, the evaluation of long-term costs and benefits[14] associated with national smart metering roll-out sheds particular light on three aspects as policy attention points in the early stage of system development: social acceptance, effective use and efficient large-scale roll-out of smart metering systems.

To this end, the success of the smart grid deployment will critically depend on the overall functioning of the power system as a socio-economic organisation, and not just on individual technologies. As a result, the most important challenge for policy makers over the next decade will likely be the shift away from a supply-driven perspective, to one that recognizes the need for integration of different dimensions and actors of the smart grid.

CONCLUSION

Integration of growing shares of renewable energy sources into the electricity networks results in the need for network upgrade through pervasive deployment of information and communication technologies. Having power sources close to the consumer premises and exploiting the potential of smart metering infrastructure may lead to consumers' empowerment and ultimately energy savings. Therefore, the consumer should be approached with clear engagement strategies and actively engaged in the early stages of the technological system development.

The analysis of the smart grid inventory points to an increasing interest in consumers and communities as focal players for the success of the future electricity system. This necessitates characterization of the consumer as well as the community from what concerns values, beliefs and goals that are culturally and geographically located. With an increasing trend of EU projects focusing on electricity consumers and communities, this contribution presented and discussed some EU smart grid projects that have a socio-technical system approach to smart grids with focus not only on consumers, but on their interactions within the community. Smart grid, integrating multiple layers, such as the energy, information and social networks is seen as focal to the success of renewable energy sources integration at community level. The abstract also demonstrates successful consumers' engagement strategies in large-scale deployment of smart metering systems at national level in few Member States, highlighting the need to address social needs and concerns at an early stage of the technological system development.

12 JRC Science and Policy Reports, Smart Grids Projects Outlook 2014; http://ses.jrc.ec.europa.eu/reports-books-and-magazines

13 The Commission for Energy Regulation, Electricity Smart Metering Customer Behaviour Trials Findings Report, May 2011.

14 Smart meters in the Netherlands – Revised financial analysis and policy advice, KEMA July 2010