Towards Smart Grid User Engagement Through Social Networking

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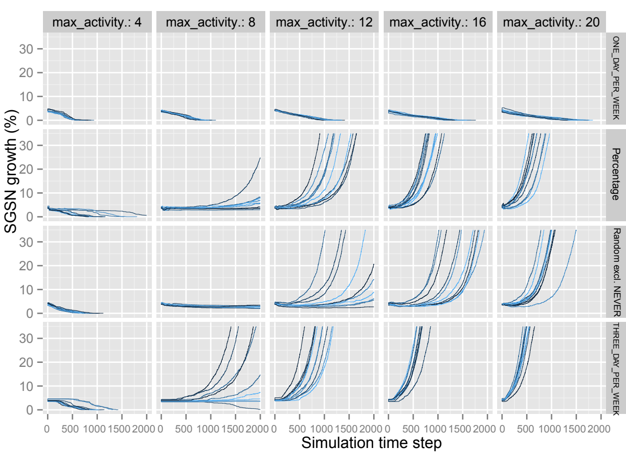
Smart grids have sparked a vast array of research and investment globally for their promising potentials in socio-economical and environmental benefits [1–3]. A recent trend is the expansion of research interests from the technological aspects, focusing mainly on hardware and software of grid infrastructures, towards the social dimension of the grid [4, 5]. The idea of linking smart grids with *Social Network*s (SNs) as a joint research topic has recently caught much attention in media [6–9]. There are many research efforts on either topics, but research on combining SNs with smart grids has just started.

Our research interest adds to the related work [10–17] in that it focuses on smart grid user communities, since the effectiveness of smart grid also largely depends on consumer engagement and action, where the emerging field of social computing will be central to its success [8]. An additional challenge is posed to our research by the difference in properties of technological networks, such as smart grid, and social networks [18]. The research is performed within the framework of the EU FP7 CIVIS project (`www.civisproject.eu`) which has a clear social component: consumers and small producers can form energy communities based on shared values such as sustainability and social cohesion. CIVIS has the vision that besides seeing grid users driven by economic considerations contributing individually to achieve energy goals [19–21], they also form social communities served by shared grid infrastructures and driven by joined social goals. This entails that more research attention is paid to potentials and challenges of users' collective action, pro-social values and sense of community. The goal in large is to provide ICT support for social participation in the smart grid to manage communities and support energy services. This naturally leads us to consider an ICT system that includes features of *Social Networking Site*s (SNSs). The idea is to offer grid users a web-based platform of "*Smart Grid Social Networks*" (SGSNs), as a part of the ICT system's functionality, where users can share interests and values, exchange experiences with the community, and compare (and compete) energy consumptions, etc.

As a first step towards this goal, we performed an exploratory study on the forming and evolution of SGSNs, and how this could have effect on user engagement and have impact on energy consumption. Energy communities are represented by an agent-based simulation model, where the frequencies of user activities and types of interactions in a SGSN may have positive or negative impact on energy related awareness and knowledge, which in turn influence user behavior and the energy efficiency of their households. Model conceptualization and configuration are based on studies of general SNs and SNSs when possible, assuming that these results apply to special purpose SNs and SNSs such as SGSNs [22–35]. This hypothesis needs further investigation with data collected from CIVIS pilot sites in Trento, Italy and Stockholm, Sweden in the next phases of the project. We defined parameter sweeping experiments (incomplete factorial experimental design [36]) to explore the parameter space of the model. Initial simulation experiments showed a number of interesting results. For example, compared to positive growth, negative SGSN growth is more easily triggered; a large community with members that are occasionally active forms a better predictor for successful energy communities than a smaller community of very active users (see the plot which shows the simulation of max user activity likelihood of 4, 8, 12, 16 or 20% vs. SGSN use frequency of 1 day per week, percentage per Facebook use, random or 3 days per week).

The results inform our future research and provide insights into the design of a social energy ICT system. We plan to achieve an agile two-way input and feedback



loop between simulation (which will be extended and refined along the course of CIVIS) and real world solutions (where new concepts and ideas will be tested with users and supported by energy providers in CIVIS pilot sites).

Concretely, we start with a few social networking models similar to the existing ones, e.g., a forum with crowd sourced energy efficiency discussions, tips and questions (represented by the current simulation model); a follower type of social network in which expert knowledge is made available and shared to the mass; and a bidirectional social network, where users become friends with each other and follow each others activities. In each case, we design solutions to address specific problems for target users. For example, how to use SGSN to help families shift their electricity load mainly to non-peak hours without requiring too much planning ahead; how to increase users' (particularly teenagers) energy-related knowledge and their access to more advanced information such as prosumption data, followed by their ability to use the information for consumption efficiency and load shifting. Several prototypes (for prosumption data visualization and comparison, energy advisor, consumption challenges and games) designed to address these problems will be tested in the pilot sites.

Future research will use the social data generated by piloting the prototypes and the prosumption data from the smart meters and smart plugs/sensors for further SGSN studies. The CIVIS project can be an interesting case for the social computing community to study special purpose SNs, SNs in general and their interplay with user behaviors, among others. From CIVIS perspective, we are particularly interested in exploring the social dimension in the smart grid to promote energy efficiency and to stimulate new forms of social innovation.

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