Contribution NEMoGrid to ERA-Net SES Working Group Consumer and Citizen Involvement: Conflicting user needs "degrees of freedom" and "ease of use"

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Introduction

A user-centered design is known to foster later usability and acceptance of a technical system [01]. In order to avoid resistance and to ensure users' future acceptance of and trust in technical infrastructure, *Privacy by Design* guidelines [03] postulate the specific incorporation of users' (privacy) requirements into system design, by claiming "*Keep it user-centric*". Therefore, user requirements and the context should be considered during the iterative design process of technical systems and their respective user interfaces.

As the energy production involves increasingly distributed energy resources local actors and consumers become more and more part of the energy production. Accordingly the involvement of their needs and their requirements become even more important. Apart from the technical requirements, consumer requirements have rarely been considered in the development of Smart Grid infrastructure to date [02].

Diverse smart grid stakeholders claim for a better incorporation of user perspectives, especially at the early stages of designing, in order to support active participation of consumers [04]. In contrast a technology-push approach will limit the adaption of end-users and therefore the success of future smart grid implementations [04]. Consumer resistance to the final roll-out of smart infrastructure raised already serious questions in terms of the protection of personal privacy.

To avoid resistance and foster active participation and involvement of consumers we think the facilitation of a scope of action is needed – in the following we call it "degrees of freedom". Additionally, the usability of Smart Grid applications is crucial to ensure acceptance and the seamless integration into daily life without high effort – in the following we call it "ease of use". We identified these two requirements during our NEMoGrid user research [05]. The ERA-Net working group discussions revealed that these requirements lead to contradictory designs of Smart Grids systems and applications.

Consumer require for "degrees of freedom"

First user research results [05] of the NEMoGrid project revealed that consumer appreciated an enhanced scope of action within different future energy business models. During our interview study $N = 21$ the interviewees highlight the increased *level of freedom* especially with regard to actively influence their consumption costs. This was the case especially for Voltage based tariffs and during the discussion of the *attitude* towards, the *usefulness* of and the *willingness to use* this model. Beside the possibilities to save money, the consumer statements entail aspects with regard to *self-efficacy,* which is known to have an influence on the choice of activities for all kinds of human behaviour [07]. The possibility that the own behavior has an impact on the grid status was positively mentioned frequently

during the Voltage-Tariff and the Peer-2-Peer model discussion. It can be concluded that providing degrees of freedom could foster consumer acceptance of Smart Grid Systems. With regard to the design of Smart Grid Systems this requirement necessarily leads to an increased complexity, which has a negative impact on the simplicity of the system. For example during a possible implementation of the Voltage-Tariff model a user interface on energy pricing and/or grid status would address the above mentioned user requirements. On the other hand additional information has to be processed and provided to the user and requires the consumer attention and will increase *cognitive effort*.

Consumer require for "ease of use"

The ease of use of a system is one of two aspects contributing to a positive attitude and subsequently technology acceptance [06]. The ease of use describes the believe of a person that a certain technology could be used easily and without effort [06]. During our NEMoGrid user research [05] we identified, that the interviewees worry about the "ease of use" with regard to future energy business models. In particular, this disadvantage was mentioned during the (Voltage-Tariff and the Peer-2-Peer) model evaluation, where "degrees of freedom" were appreciated most. We found a significant main effect for the model specific ease of use ratings. The Voltage-Tariff and the Peer-2-Peer model were rated least easy to use.

Conflicts between the two concepts

The above mentioned results indicate that "degrees of freedom" and "ease of use" seem to be two sides of the same coin. If a Smart Grid system enables an increased scope of action for the consumer, the complexity will increase as well and diminish the "ease of use". This leads to two contradictory requirements for Smart Grid system design. We postulate that this contradiction could not be dissolved by a static system implementation. Instead Smart Grid system implementation has to adopt step-wise to consumer requirements depending on their adoption status. For example, during the introduction of a Smart Grid system the degrees of freedom should be pointed out. Subsequently an optimal setting to their specific habits has to be identified in cooperation with the consumer for the implementation. During the usage in daily life cognitive effort has to be avoided and the "ease of use" should be paramount.

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