# Key success factors and barriers to end user engagement in smart grid projects

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## ABSTRACT

This paper is based on the assumption that besides technical innovations, a key aspect of meeting future energy challenges is to integrate end users through a more active position in the power system. However, a coherent view on end user engagement and effects derived from electricity consumption behaviour is still lacking. The paper aims at exploring end users' active participation in various European smart grid pilots by applying a newly developed conceptual framework. The purpose of the paper is to contribute to understanding what key success factors and barriers that exist for end user engagement in smart grids. To do this, a staged research methodology was applied: results and experiences were collected from 32 existing smart grid pilots followed by a multi-level analysis to identify best practices, success factors and pitfalls. Seven areas and actions characterizing successful implementation of pilots were identified, including understanding the target group, testing before roll-out, creating personal relations etc. The key barriers include technical problems, expectations, non-viable business cases and shared decision power. The main conclusions are that the end user is not a black box, and that context-sensitivity is crucial to succeed in end user engagement.

Currently, developers of smart grid products and services tend to apply drivers related to economy and technology to achieve end user behavioural change. To support and facilitate other creative engagement strategies, the results from this paper will be implemented in a toolkit for smart grid practitioners, which will be made available online.

## Introduction

A growing awareness concerning the scarcity of global resources and environmental issues has resulted in new conditions for the electricity industry. Future electric power systems will have to accommodate a much larger share of intermittent production than today, which puts new demands on the power system and/or the end-user electricity consumption. A trend of making the electricity grid "smarter" has evolved in order to master the future challenges, with actions such as improved grid, increased storage or better alignment of production and consumption patterns. Following this development, a large set of smart grid projects have emerged in Europe over the past decade. An overview of the status of European smart grid projects is found in [1].

Generally, the first generation of smart grid pilots focused on technology and the functioning of electricity grids. The technological infrastructure and technical possibilities and challenges are therefore comparatively well understood, while social factors in many cases have been disregarded or looked into on a less detailed level. Several smart grid case studies have shown short-term effects due to behavioural measures [2,3], such as awareness-raising activities, which indicates an untapped potential for energy efficiency and load shifting from behavioural change. Although there is literature emerging on the topic, a coherent view on end user engagement and effects derived from end user behaviour in smart grids is still lacking.

This paper is based on the assumption that besides technical innovations, a key aspect of making the energy system more efficient is to fully and dynamically integrate end users through a more central and active position in the future electricity system. The availability of appropriate, reliable and interoperable (smart grid) technologies thereby provides opportunities for end users to modify and adapt their energy behaviour and to claim more active roles in the energy system.

Creating a successful[1] smart grid project process requires knowledge on key challenges concerning end user engagement as well as knowledge on key success factors and barriers. This paper aims at exploring end users' active participation in various European pilots by applying a newly developed conceptual framework in a thorough review of existing demonstrations. The purpose of the paper is to contribute to understanding what key success factors and barriers that exist for smart grid development related to end user engagement.

The presented work was performed within the European research project S3C (Smart Consumer – Smart Customer – Smart Citizen). The project addresses the challenges concerning end user engagement in smart grid pilots with the aim to foster smart energy behaviour[2] of European households and SMEs (small and medium-sized enterprises) via end users' active participation, and to contribute to successful, long-term end user engagement in projects and programs.

## Conceptual framework

In order to further explore the drivers and barriers behind behavioural change of end users, a conceptual framework has been developed. The first element of this framework is to address end user engagement through three different roles [4]. Further, it includes nine current key challenges for understanding end user engagement in smart grid related projects. The three roles and the nine challenges constitute the foundation upon which the analyses and reviews of the selected European pilot projects were based.

### Three roles for end user engagement

Three ideal-typical roles were identified to illustrate the changing position of the end users in the future energy system. Moving from passive consumers of electricity supplied by central providers, a trend can be seen towards more active participation of end users through e.g. local generation, more prominent market positions, and energy communities.

1 Successful in this case refers to the active engagement of end users.

2 Smart energy behaviour is defined as behaviour that promotes the active participation of domestic and small commercial consumers in the power system markets and in the provision of services to the different power system participants.

The smart *Consumer* is defined as the most passive role of end users in the future smart grid, mostly interested in lowering the electricity bill, at least maintaining present levels of comfort, convenience and ease of use. The actions of the smart consumer are primarily determined by lifestyle routines.

The smart *Customer* takes an active role in the power system, eager to establish a position in the electricity market and offer consumption flexibility, provide energy services or become an energy prosumer. The smart customer acts from self-centred needs or motivations such as conformity, image, popularity or financial success.

The smart *Citizen* belongs to a community or group of smart consumers or customers, interacting to optimize the "smartness" of the entire power system in a city or region. The motivations and needs of the smart citizen are we-centred, such as affiliation or community action as a driver for change. The smart citizen prefers initiatives that are driven and carried through by local actors and that bring collective benefits to the local community.

**Nine remaining challenges**

A literature review of existing research on smart energy behaviour has provided insight into elements missing in literature, leading to the identification of nine key challenges for understanding end user engagement in smart grid projects [5]. Although extensive research has been conducted in all of these areas, there are still knowledge gaps on how to apply the findings to achieve a transformation toward smarter energy behaviour among the public.

Integrating the fundamental question of how to foster smart energy behaviour through active end user engagement in smart grids with these challenges, nine corresponding questions have been formulated as guidance and starting points for further research within each of these fields. The key challenges are presented in Table 1 and details can be found in [4] and [5].

**Table 1.** Key challenges identified within existing research as well as suggested research questions to overcome those challenges.

| | ***Key challenge*** | ***Research question and knowledge gap*** |
|---|---|---|
| 1 | **Understanding the target group** | *Which instruments or approaches contribute to achieving better understanding of the needs and desires of target groups?* Potential enablers, barriers and success factors for end user engagement have been documented in literature. Still, it is unclear how they relate to different target groups. This needs to be clarified to provide suitable and attractive offers to different target groups, and thereby encourage engagement and smart energy behaviour. |
| 2 | **Products and services** | *What innovative products and services contribute to fostering smart energy behaviour?* End users in Western Europe experience few flaws and are used to consuming electricity whenever they want. Demand side management (DSM) programs may therefore be perceived as demanding. Innovative products and services providing added value to end users must be developed to counteract this. |

| | | |
|---|---|---|
| 3 | **Incentives and pricing schemes** | *Which (monetary or non-monetary) incentives and pricing schemes contribute to fostering smart energy behaviour?* Empirical evidence and understanding of the effects of various (monetary or non-monetary) incentives and pricing schemes, as well as combined approaches, are still weak. |
| 4 | **End user feedback** | *What feedback information and which feedback channels contribute to fostering smart energy behaviour?* Empirical evidence and understanding of effective feedback information and feedback channels, as well as combined approaches, still lack. |
| 5 | **Project communication** | *Which communication channels, information and marketing techniques contribute to recruitment and engagement of end users in smart grid projects?* Documented use and empirical evidence on the effects of using marketing techniques in smart grid projects, and thereby effects on smart energy behaviour, are lacking. |
| 6 | **Cooperation between stakeholders** | *Does involvement of non-energy stakeholders contribute to end user engagement and smart energy behaviour?* Existing projects may include non-energy stakeholders, but it is still unclear to what extent their involvement influence end user engagement and smart energy behaviour. |
| 7 | **Smart energy communities** | *Which instruments or approaches contribute to the development and support of smart energy communities?* Few bottom-up projects, where end users are initiators and project owners, have been reported in literature. Combining research on smart grids and smart cities may provide indications on how end user empowerment can be facilitated. |
| 8 | **New market structures** | *Which features of the interaction between end users and energy market structures or business models contribute to end user engagement and smart energy behaviour?* This includes how to ensure that legislation and regulation can support rather than hamper smart grid development. New market structures can also introduce new end user roles on the energy market. The increased requirement of personal information further addresses integrity and trust issues. |
| 9 | **Scalability and replicability** | *Which issues hamper and/or facilitate upscaling or replication of smart grid projects?* There is significant reported experience on pilot smart grid projects, but little on large scale roll-outs. Pilot projects often target specific end users such as early adopters, while large scale roll-outs deal with a much more diverse audience, which likely needs to be approached differently regarding information, communication, and technology. |

## Research methodology

The research methodology applied in this paper focusses on a staged research process, including in-depth collection of experiences from existing smart grid pilot projects and a multi-level analysis. This results in identification of key success factors and barriers, which are presented in this paper. The staged research process, in turn, will provide input to the next step in the S3C project, aiming at creating guidelines and tools for smart grid practitioners. An overview of the research methodology is given in Figure 1.

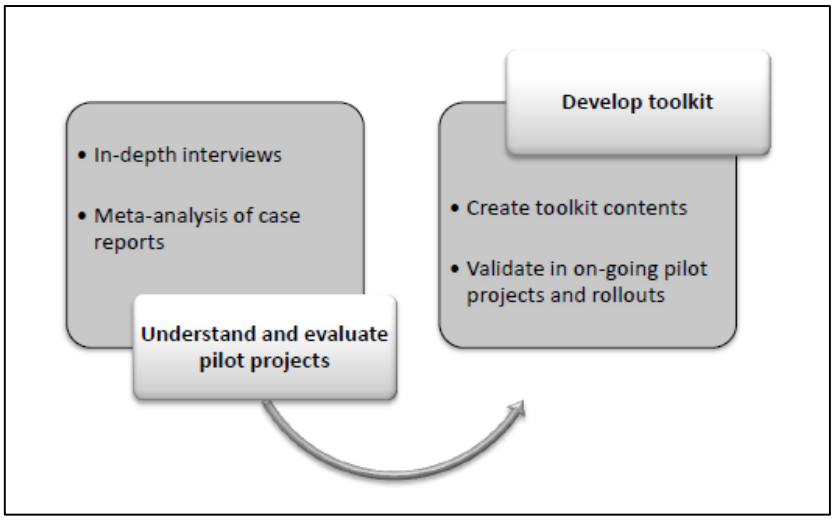


**Figure 1.** Research methodology of the S3C project.

### Data acquisition

In total, 32 on-going and completed European[3] smart grid pilot projects have been investigated to provide insight to what engagement strategies works under which conditions. These pilot projects have implemented a large variety of engagement strategies on different levels, including economic, technological and informational actions aiming to activate end users in different contexts. Some examples of such engagement strategies are new tariff structures, visualization of electricity consumption, information campaigns, etc.

The studied pilot projects were selected according to their estimated potential for learning alongside the following main selection criteria:

- Are all data available and sufficient, without any major restraints?
- Does the project have the potential to involve end users with a central role?
- Does the project involve some practical (field) applications?

The 32 pilot projects show great variations in project setting and size, as pilots are not designed to be comparable but rather to achieve the goals and needs of the project practitioner within a certain budget. The development and implementation of pilots are context specific. Thus, the availability of harmonized, quantitative data varied to a large extent between the studied pilots, implying that they could not be compared in an assessment. In order to enable a structured analysis, a qualitative approach was introduced aiming to answer the nine research questions corresponding to the identified challenges in Table 1.

Experiences from each of the pilots have been collected and described in individual case reports

3 Projects from Sweden, Belgium, the Netherlands, Germany, Italy, Slovenia, Denmark, Austria, the UK, France, Finland, Latvia, Portugal, Spain and Switzerland have been studied. The complete list of projects is found in [5].

based on information from in-depth interviews with project management representatives, with additional information from project reports and documentation. The interviews followed a protocol structured to capture information related to the nine key challenges, see [6]. The detailed case reports contain information about how each pilot deals with end user engagement, with in-depth descriptions of promising practices, success factors, pitfalls and results. Wherever possible, quantitative data was incorporated to support the qualitative information.

### Multi-level analysis

Data has been assessed through a meta-analysis incorporating a cross-case investigation of case reports and identification of cause-impact relations in order to identify best practices, success factors and pitfalls for fostering smart energy behaviour and engaging the three types of end users (consumer, customer and citizen). The step-wise process is described briefly in Table 2, and further information can be found in [4].

**Table 2.** A step-by-step description of the staged analysis process.

| | *Step* | *Description* |
|---|---|---|
| **1** | **Exploratory qualitative data analysis** | An explorative analysis of the qualitative data in the 32 individual case reports was performed to identify common topics and to ensure uniformity of the acquired data. |
| **2** | **Exploratory quantitative analysis** | The analysis of the available quantitative data aimed to identify potential cause-impact relations and success factors that could be further investigated in the qualitative analysis. |
| **3** | **In-depth thematic analysis of cause-impact relations** | A thematic qualitative data analysis was conducted based on the Toulmin Model of Argumentation[4] to clarify the reasoning behind the success factors, pitfalls and best practices found in the 32 case reports. The result of this step was the identification of cause-impact relations and the formulation of answers to the research questions from Table 1. |
| **4** | **Cross-cutting analysis** | Based on the previous steps of the analysis, an overarching assessment provided insight to cross-cutting cause-impact relations. The Toulmin Model of Argumentation was once again used to reveal interdependences and contradictions between the answers to the research questions. |
| **5** | **Synthesis** | The outcomes of the multi-level analysis (step 1-4) were integrated into a synthesis of results and conclusions. |

## Results

Results from the analyses of the selected pilot projects include key success factors and barriers, which are presented in Table 3 and 4 below. The key success factors comprise seven areas and actions characterizing successful implementation of smart grid projects for engaging end users.

4 The Toulmin model is based on the work of the philosopher Stephen Toulmin. The model provides a method for revealing strengths and weaknesses in arguments by breaking them down into six parts; data, claims, backings, warrants, rebuttals and qualifiers. More information on the Toulmin model can be found in [7].

The identified key barriers can be divided into four areas that need to be carefully addressed in order to avoid end users being indifferent to the project or program. Additionally, a set of opportunities to enhance active end user engagement were identified, which can be found in [4].

**Table 3.** Key success factors identified in the cross-case analysis.

| *Success factor* | *Description* |
|---|---|
| **Addressing end users as human beings (instead of as points of electricity demand)** | Successful projects are often tailored to the everyday life and daily routines of the end users. Needs, demands and expectations of end users are investigated before providing smart grid infrastructure, products and services to ensure added value for the end users. This applies to economic incentives, design of feedback and feedback channels as well as communication and choice of communication channels. |
| **Obtaining a thorough understanding of target groups** | Common methods for learning about end users have shown to provide an incomplete picture, since end users tend to describe themselves in accordance with expectations and social norms instead of reality. Alternative innovative methods can be applied to establish a closer interaction with end users, for example qualitative contextual inquiries, culture probes, home visits and co-creation. The choice of method depends on the context. |
| **Emphasizing sense of place: underscoring the local character of a smart energy project** | When applicable, a regional connection in the project is usually advantageous; picking up regional topics or stories, involving local stakeholders and persons etc. Since familiar faces are more likely to be perceived as trustworthy, locally appreciated characters can be used as the project's face to the public. Additionally, local stakeholders usually have better insight into the specific context. |
| **Drawing upon community dynamics** | Closely related to the regional and local context is the importance of community dynamics. Establishing a feeling of affinity and belonging to a group can be a powerful way to motivate and engage end users, who might be triggered by the will to contribute to the community good. The community approach also allows end users to learn from other people similar to themselves. However, establishing community dynamics (if not already present) can be quite a challenge that requires long-term intensive support. |
| **Testing before roll-out** | End users in many smart grid pilots consist of "friendly users", as participation is often voluntary. Progressive end users are usually more inclined to take part in new field tests, and the sample group will therefore not represent the general public. Likewise, the results regarding energy behaviour can rarely be considered representative. However, troubleshooting and creative workshops with those positive biased end users still provide highly valuable input to the development of the project, and thus also to a future roll-out to the public. |
| **Creating personal relations and build trust over time** | Apart from addressing end users as human beings, the individual needs and expectations of the end users should be attended to; preferably via personal contacts. Establishing personal relations, listening to end users and helping them according to their individual situation are crucial elements of building trust, which has proven to be a key success factor. End users have shown to value personal attention highly and often prefer this to written information. However, individual personal contact is resource intensive and therefore it is important to find a balance according to budget and goals. |
| **Motivate end users with fun and good news** | People are in general driven by positive incentives and good news on one's own performance. Negative feedback, on the other hand, may cause guilty conscience and reduce motivation. Fun and gaming elements, celebration of project milestones or gifts may enhance end user engagement. |

**Table 4.** Key barriers identified in the cross-case analysis.

| *Barrier* | *Description* |
|---|---|
| **Non-viable business cases for end users** | Many smart grid projects so far have presented business cases for pricing schemes that are not very viable, neither for the household, nor for the distribution system operators (DSOs). The price spread is usually too small to offer an attractive (financial) incentive for participants to create long-term transitions and behavioural change. Further investigations are required to assess whether the load shifting potential can be increased by stronger incentives. |
| **On-going technical problems and unreliable technology** | Technical problems that cause delays in the installation and/or execution phases are common. This in turn often results in loss of engagement or even drop-out, and perhaps also a damaged reputation and relation that might be hard to repair. Thus, expectation management (see below) as well as phased roll-out with testing and troubleshooting among friendly users are central in the development of smart grid products or services. |
| **Inadequate expectation management** | Expectation management regarding project outcome and process is highly important to keep end users committed and engaged. For example, malfunctioning devices, a failure in meeting expectations on aesthetics and long periods between recruitment and instalment may damage initial engagement and commitment. |
| **Engaging end users without sharing decision power** | The presence of end user influence in the design phases of new products and services, such as project communication, service concepts, procedures etc. is often limited, although it can be of great help for improvement. Providing end users with shared decision power may be perceived as a too big trade-off by the management, but may to a certain extent be necessary to achieve real end user engagement. |

## Discussion

The results presented in this paper are based on collection and analysis of experiences from 32 smart grid pilot projects which all involve end-user interaction and engagement. The search of relevant pilots revealed that the presence of smart grid projects with a clear focus on end user engagement are still infrequent, especially transparent pilots with defined results that are willing and able to share their outcomes, successes and failures. One should keep in mind that the final set of projects constitutes an empirical material that is too small to draw statistical conclusions from. Still, the qualitative research reported in this paper has allowed us to identify similarities and trends that can provide new directions for further research on end user engagement. As such, they indicate a way for attaining smarter energy behaviour of end users in the future.

The results reveal that knowledge on how to successfully engage end users to become smarter actors in the energy system remains partly unmapped. Likewise, there are still significant knowledge gaps on attitudes and behaviour of end users in smart grids, and how engagement strategies in pilot projects affect the daily life of its participants. The reason for this might be that many smart grid projects still have an economic or technical focus. These tendencies are seen in the empirical material; although the analysed pilot projects were selected with the premises of having the potential for learning about end user engagement, the drivers applied to obtain behavioural change were mainly related to economy and technology.

Capturing and analysing context-specific aspects of end user engagement has proven to be

challenging as there is a magnitude of variables affecting the outcomes of a specific pilot project. Culture, policy, trends, history, social aspects etc. are complex elements to capture in a multi-variable analysis but may nevertheless alter the success of end user engagement to a great extent. This means that the specific context and settings must be taken into careful consideration when applying a certain engagement strategy.

## Conclusions

The analysis and results show that, when striving for end user engagement to increase the success of smart grid products and services, there are several actions that can be taken by project owners and executors. These actions include responsiveness towards the end users, building relationships with and between end users, communication and involvement of end users in the process. On the other hand, there are a number of pitfalls that have shown to be devastating to end user engagement, and which should – and can – be avoided.

Based on the identified success factors, the main conclusions are that the end user is not a black box, and that context sensitivity is crucial to succeed in end user engagement. Additionally, successful smart grid projects tend to use multiple incentives and engagement strategies combined with several other factors, such as clear communication, the right type of feedback etc.

## Future work and expected project outcome

The analyses presented in this paper constitute a part of the S3C project. The results will be applied when creating a toolkit for smart grid project or program implementers. The purpose of the toolkit is to guarantee easy access to the knowledge gained from previous pilot projects and existing research. The toolkit contains guidelines[5] and tools[6] to support developers of smart grid products and services in understanding their end users and the social and technical issues involved. By following the guidelines and using the tools, practitioners can receive valuable input and ideas for the approach they want to take with their product or service, alongside hands-on tips from design and implementation of previous pilot projects. Such information can prevent common mistakes from being repeated.

Some of the toolkit content will cover broad topics, while others are more specific. A few examples of guidelines and tools are an overview of monetary and non-monetary incentives, a description and checklist of storytelling, a strategy-finder for tariffs and incentives, etc.

The guidelines and tools will be validated in certain smart grid pilot projects during 2014-2015. The final toolkit will be available online by the end of 2015.[7]

5 A guideline contains descriptive information to explain a particular topic and to address issues or questions that should be taken into account. It includes a general description of the topic, when to use it, what is needed for implementation, do's and don'ts, best practice examples, etc.
6 A tool is more practical and specific than a guideline. It contains ready-to-use material that brings added value to the project, like a step-by-step process description or instrument, and is specifically aimed at support during implementation.
7 A preliminary version of the online toolkit is available at www.smartgrid-engagement-toolkit.eu

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