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PERSPECTIVE

The Smart Grid Challenge is Social Rather than Technological

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Abstract: ***Background*:** Smart grids have expanded over the last decade, with large-scale smart meter deployments in several regions of the world.

***Objective*:** The goal of this perspective is to discuss the social challenges faced by smart grids. While numerous scholarly works have thoroughly examined smart grids from a technical perspective, a noticeable shift has occurred in recent years towards conducting research about the interaction between technology and customers that shows some issues to future deployments.

***Methods*:** This study is a review of recent literature on smart grids focused on studies related to the social acceptance of these networks, which has been published in the last five years.

***Results*:** The review of studies shows that discussion about smart grids has been traditionally focused on technology, paying no attention to social issues.

***Conclusion*:** It is essential to understand the motivations behind public perceptions of smart grids in order to enhance and extend awareness campaigns in the short and medium term, as without social support, the expectations placed on smart grids may be severely limited.

Keywords: Smart grids, smart metering, energy savings, technology, smart device, power.

1. INTRODUCTION

The Smart Grids (SG) concept emerges as a response to the problems derived from the growing electricity demand, focusing on rational consumption and efficient management of the entire grid. Large-scale deployments of smart meters have taken place in most countries of the European Union [1], North America and Asia, reaching average penetrations of 69.1% for residential, 65.6% for commercial, and 63.1% for industrial customers in North America, according to the U.S. Energy Information Administration [2]. Smart meter deployments are set to increase in coming years, rising from 665 million devices installed globally in 2017 to more than 1.2 billion by the end of 2024, doubling cumulative global spending on advanced metering infrastructure (AMI) over the same period to 145.8 billion by 2024 [3]. Latin America, Oceania, and Africa will remain comparatively small markets over the next years, although the Latin American market is expected to recover as the economic context improves [4, 5].

Beyond the number of smart meters installed and the financial investment, the main question is how these devices impact grid management and benefit the companies and customers. In general terms, the following issues can be mentioned:

- Reduction of the duration and frequency of power outages: Many companies claim to have reduced the average duration of power outages to customers [6] and/or to have avoided outages to customers in cases of distribution network failures [7].
- Savings on crew mobility: Smart devices, with communication and autonomous operation capabilities, enable the implementation of Fault Location, Isolation and Service Restoration (FLISR) schemes, which avoid the need for crews to travel to repair faults on the grid, reducing outage duration and repair cost while increasing customer satisfaction [8].
- Demand savings: Smart metering enables the implementation of demand-side management (DSM) programs and policies, which achieve significant demand savings [9]. Such policies are often accompanied by variable electricity tariff schemes and are complemented by customer awareness programs [10].
- New ways of managing and trading energy: Smart grids drive customers to participate in the management of the grid, behaving like prosumers [11]. The low voltage distribution grid digitalisation allows for

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the development of novel ways of trading energy through cooperative approaches, real-time applications and gamification strategies. Some pilot projects have shown that significant economic savings can be achieved for residential customers through the use of digital management platforms [12].

2. THE SOCIAL DIMENSION OF SMART GRIDS

The research on SG has been mostly focused on its costs and benefits but has neglected the analysis of the social costs. Recent research has also started to consider social costs as an obstacle to smart grid deployment [13]. Most definitions of SG do not include social aspects in the technical descriptions, despite the fact that a smart grid has broad social impacts [14].

Unlike in the past, the energy issue is on the current political and social agenda. According to a survey carried out in Spain [15], concerns include rising energy prices (94.7%), lack of energy (92.4%), worsening climate change (91.5%), and pollution caused by fossil energy sources (90.6%). In the same way, the priorities from a social point of view are securing energy supply (66.9%) and having energy at reasonable costs for customers (63.3%). A quarter of people surveyed would be willing to switch to a renewables-based energy supplier, even if it would mean an increase in their current bill. This percentage is lower than would be expected based on the concerns expressed by survey participants.

One of the most important features of SG is that customers are able to know their consumption in real-time and can adopt decisions based on the energy price. A survey conducted in Portugal during the first half of 2020 showed a social willingness to reduce consumption based on tariffs [16]. According to this survey, 95% would accept the control of at least one electrical appliance by an external entity and almost 93% would be ready to plan their energy consumption in case of applying hourly energy rates.

A study conducted in New York (2017-2019) suggested that social acceptance of SG remains stable or even decreases over time. Customer expectations were compared before and after the installation, and a decrease in the original expectations of the participants was found. This is worrying because any smart grid initiative requires customers to be actively involved in energy use and management [17]. A more recent study conducted in Brazil (2020-2021) showed the important role of social influencers in the adoption of smart meters. The study recommends promoting the ludic aspect of smart meters rather than their impact on energy consumption through the development of apps with user-friendly interfaces, the intervention of digital influencers to popularise smart meters, and the emphasis on the positive impact on the environment [18].

According to the results of a study conducted in France (2018-2019), the deployment of SG is facing increasing resistance, not only from customers but also from local governments [19]. Contrary to what happens in most cases, where the local governments are the drivers of the new technology deployments, this study shows that there might even be resistance from those who should be driving them. The study highlights that the forced adoption of technology should be changed by involving intermediary actors in all phases of deployment and adopting differentiated communication strategies, as well as reducing the trade-off between costs and benefits for customers.

In addition to the lack of interest or social resistance to change, a study conducted in Sweden shows that there is also a problem of marginalisation that prevents certain individuals or social groups from fully integrating into a smart grid [20]. This marginalisation can manifest itself through customers' lack of knowledge and skills in using smart grid services and products, the financial inability to purchase devices and services, the exclusionary and limited design of products and infrastructure, and the lack of access to both energy and communications infrastructure.

A particular case of SG social perception can be found in civil organisations and social movements against smart meters and the digitalisation of electricity grids. Although this is a relatively small phenomenon, it stands out for its resistance to technology. Such groups are mostly found in the United States, where they have some media and web presence, warning about the risks to neighbours' health, customers' privacy and the economic cost of metering devices [21]. The scientific basis for their claims is not clear, and they are mostly based on the use of fear as a tool, supporting the use of older metering technologies, such as electromechanical meters, as a safer option.

Finally, there are concerns about the possible negative impact of SG on the labour field. The SG deployment could eliminate jobs assigned to meter reading and complaint handling. While it is true that experiences in different parts of the world reveal a notable reduction in fieldwork, this should not necessarily imply dramatic reductions in the staff. Smart grid implementation could potentially lead to the creation of new, more skilled job opportunities and facilitate training and improvements in working conditions. Nevertheless, it is evident that this is an aspect that influences decision-making and could potentially slow down the adoption of these new technologies.

3. THE PRESENT CHALLENGE: EVOLUTION OR IMPASSE?

The assimilation of SG by society as a whole is a complex issue that presents many different facets and deserves special attention. The potential savings may be attractive to customers, but not everyone assesses it in the same way (see Table **1** for a relation among previous concepts). The implementation of DSM strategies to control the activation times of certain appliances based on hourly tariff costs could be a potential inconvenience for customers. An example of this could be a peak consumption reduction that affects home heating or cooling during a heat wave. In such cases, customers may not be satisfied with the achieved savings, as it does not compensate for the loss of comfort. Other customers prioritize the reliability and quality of the electrical service over the tariff, while some also weigh the underlying environmental concerns.

However, all these studies are still limited, as they are confined to specific regions and populations. It is necessary to conduct more extensive studies to verify trends in other

Table 1. Relationship between individual customers, the society as a whole, and the electric companies with regard to some of the main issues mentioned in Section 2.

-	Individual Customer	Society	Electric Companies	Refs.
Information about consumption in real-time	X	X	X	[16]
Adopting decisions based on the energy price.	X	-	-	[16]
Decrement of interest in technology associated to Smart Grids	X	X	-	[17]
Ludic aspects	X	-	-	[18]
Forced technology adoption	X	X	X	[19]
Marginalisation	X	X	-	[20]
Social movements against smart meters	-	X	-	[21]
Impact of Smart Grids on the labour field	-	-	X	---

regions or countries. These studies should not only focus on the scientific and technological advances of SG but also the benefits they offer in terms of efficiency and sustainability. It is essential to understand the motivations behind public perceptions of SG in order to enhance and extend awareness campaigns in the short and medium term because, without social support, the expectations placed on SG may be severely limited.

Although the social factor can be evaluated as an uncertainty and, therefore, can be considered as something separate from smart grid technology, the reality is much more complex. The discussion about SG has been traditionally focused on technology, paying no attention to social issues. According to some authors [14], one of the reasons that explain the slow SG deployment in some communities and regions is the dissociation between the social and the technical, where those who are supposed to implement these visions are not included in either the definition or the imagined futures.

CONCLUSION

Smart grids are essential for, among other things, meeting the growing energy demand without relying on fossil fuel-based generation sources. However, their introduction into everyday life brings about a change in the relationship between people and electricity. Unlike in the past, where customers only behaved as loads, in SG, the customers participate in the management of the grid by managing their own consumption and/or becoming prosumers. This triggers unknown reactions in the social environment, ranging from acceptance and expectation to disinterest or complete rejection of the introduction of smart meters and similar devices.

The transition from conventional grids to SG is technologically and economically unavoidable. It is, therefore, important that this transition be driven rather than slowed down, as its social and economic impact will be very positive in the medium and long term. Most of the problems are concentrated in the short term, which represents a great challenge for the people or bodies in charge of implementing them. In this sense, it is important to emphasize that SGs are not limited to smart meters and actuators with communication systems but also require public awareness campaigns, technology replacement programs, *etc*.

Finally, future research on the social challenges associated with SG should be conducted in two different ways. On the one hand, to repeat the studies already carried out in the aforementioned works and those not mentioned here due to lack of space to characterise the evolution of social perception over time. On the other hand, to extend these studies to developing countries, for example in Latin America, where the introduction of SG is slower and is based on the learning process of more developed countries. In the latter case, it is very likely that different perceptions will be observed with respect to the European and North American cases.

LIST OF ABBREVIATIONS

SG	=	Smart Grids
AMI	=	advanced metering infrastructure
FLISR	=	Fault Location, Isolation and Service Restoration
DSM	=	demand-Side Management

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise

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