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Smart metering trends, implications and necessities: A policy review

Javier Leiva [a,b,*], Alfonso Palacios [a,c], José A. Aguado [a]

[a] University of Málaga Department of Electrical Engineering, Spain
[b] Endesa, Spain
[c] Málaga City Hall, Spain

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ABSTRACT

Renewable generation, energy storage, electric vehicles and energy management systems are examples of increasingly widespread products and services that the electricity grids must accommodate safely and efficiently. The fulfillment of this objective involves innovation and, more specifically, the modernization of the existing electricity infrastructure into so-called smart grids, which are based on the interaction between suppliers and consumers through control systems and smart metering. However, the development of these systems requires regulations that take into account the technological capabilities and the needs of users both in the present and in the immediate future. This paper starts with a review of the energy policies aimed at the implementation of smart metering infrastructures (SMI) in Spain, Europe, and around the world. It then addresses the trends in the energy sector that will shape the future and the contribution that SMI are likely to make given its current status, its potential, its limitations, and the implications they would have. Lastly, the paper set outs the conclusions reached and makes recommendations for the adaptation of policies.

Contents

1. Introduction

The reality of the liberalization of the electricity market, together with increasing sustainability and energy efficiency requirements, is making it necessary to introduce more versatile and flexible equipment and systems and to standardize the processing of the associated data in order to bill the service more efficiently and to keep users informed. In short, it is necessary to make the electricity metering system smart.

A smart metering infrastructure (SMI) is an electronic system that is capable of measuring energy consumption whilst providing more information than a conventional meter and that can transmit and receive data using a form of electronic communication [1]. Concern about the development of these systems, which are now commonplace, is not new. Several legislative and regulatory

* Corresponding author at: Universidad de Málaga, Departamento de Ingeniería Eléctrica, Edificio de Ingenierías.,Campus Universitario de Teatinos, Calle Doctor Ortíz Ramos, s/n. Office 3.066.D. CP 29071, Málaga, Spain
E-mail addresses: javier.leiva@enel.com (J. Leiva), apalacios@malaga.eu (A. Palacios), jguado@uma.es (J.A. Aguado).

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initiatives have been taken at a national and international level with the aim of modernizing the measurement of consumption and power generation. The data thus gathered, which is essentially simple, is the basic element for the effective transformation of the existing electricity distribution networks into the so-called smart grids, where new products, services and agents are possible, creating a new framework for competitiveness, sustainability and business opportunities.

This paper is based on a detailed study of the implementation of SMI in Spain, which is an interesting example because it is a country to which the European legislation on the matter has been transposed. Based on this regulatory framework for implementation, the authors propose their ideas here for developing SMI beyond the basic requirements that have already been established internationally in any given geographical area. The main aim is to take advantage of the potential capabilities of these systems with a view to addressing the key challenges that are about to affect the electricity sector worldwide: the increasingly widespread presence of renewable generation and energy storage, the mass use of electric vehicles, the widespread use of information about energy use, and software applications that enable people to use energy in the most efficient way possible.

The objectives of this paper are threefold: (1) to thoroughly and objectively analyse the shortcomings and virtues of the rules governing SMI in the main global geographical areas; (2) to introduce the liberalization of the concept of energy supply point as a means to permanently increase the penetration of renewable generation and energy storage; (3) to present the establishment of unambiguous and universal communication standards for the effective integration of end-user energy applications with SMI, especially in the case of recharging infrastructures and demand management systems.

This paper is organized as follows: Section 2 presents the strengths and weaknesses of specific regulation for SMI in Spain and the most important countries in this field, critically analysing key issues such as the minimum functions required and the context in which implementation is taking place. Section 3 addresses the challenges facing the electricity sector and presents the views of the authors and their proposals on how to overcome them with the help of SMI, as well as the limitations and other implications that these innovations could entail. Finally, Section 4 presents the conclusions and the fundamental ideas discussed in the paper.

2. Existing energy policies

The authors' study begins with the regulations of the European Union, an institution with a strong commitment to the implementation of smart grids and SMI. Spain, as a member of the EU, has adapted its legislation with some success and with some failures, but also with room for improvement in the authors' opinion as discussed in Sections 3 and 4. Having said that, this country is a worthy case study and a good model to follow. This is thanks to the combination of its technical architecture, roll-out planning, and the minimum functionalities that have been established, which are more than adequate in the opinion of the authors, even more regarding other SMI implementations both within Spain's geographical area and beyond.

2.1. European regulatory framework

At an EU level, there are several agreements, regulations and directives relating to sustainability in all its forms. These show that current regulation in the electricity sector is clearly oriented towards transparency, competitiveness and equality for all of the actors involved.

The first reference to note is Directive 2009/72 /EC [2], which states that the electricity market must be based on the real possibility of choice for all consumers and the creation of new business opportunities, for all of which SMI are essential elements; in fact, the document explicitly states that European Union member states should encourage the modernization of distribution networks and mentions the introduction of smart grids as a way to promote decentralized generation and energy efficiency [2].

It is therefore clear that SMI are essential tools for gaining access to information regarding energy consumption in an objective and transparent manner. Thus, the Directive states that consumers should be given access to data about their consumption and the associated prices so that they can invite competitors to make offers based on them, without any additional cost being billed to them for these services [2]. Also each member state must ensure, individually, that the roles and responsibilities of any market participant are defined and reviewed by the corresponding national regulatory authority with respect to contractual arrangements, commitment to customers, data exchange and information ownership [2]. This means that each European country determines, within that framework, the particularities of its market; for example, in Spain data collected from electricity meters is the property of the distribution companies, but there is a mandatory requirement to provide it to retail companies for billing purposes and to customers for their information.

Recommendation (2010) 639 [3] establishes the priorities to be followed in respect of energy innovation, including the recommendation to accelerate the deployment of SMI, to promote smart grids and to ensure the large-scale interoperability and integration of renewable energy and electric mobility [3].

Recommendation (2011) 202 [4], meanwhile, mentions the direct relationship between SMI and the new generation of electricity grids, by presenting smart metering as an inherent part of smart grids. Smart grids are discussed in this document as opening up new possibilities for consumers, firstly through the options for control and management of consumption that they introduce, and secondly due to the way they can incentivize the efficient use of energy if they are combined with an appropriate pricing model based on the time period in which energy is consumed [4].

Directive 2012/27/EU [1], which specifically relates to energy efficiency, brings a fresh approach to the electricity distribution sector. With regard to the implementation of individual smart meters, it adds that this must be subject to it being technically possible, financially reasonable, and proportionate to the potential energy savings [1], conditions which have not been taken into consideration in all member states, as many of them (including Spain) have imposed the obligation to implement them without regard to the ultimate technical and economic feasibility.

This directive also states that SMI must comply with the applicable safety standards related to data transmission equipment and systems, as well as with requirements connected with the privacy of end users [1]. Furthermore, they must also provide accurate information about the input and output of electricity in an easily understandable format, which must also be made available to the end user via the internet or by means of the meter's interface [1]. Again, it appears that making the information understandable and useful to the consumer is essential in order to achieve the objectives of the European Union.

Lastly, Recommendation 2012/148/EU [5] is deeply focused on the deployment of smart metering infrastructures, which must reach 80% implementation by 2020, and on the minimum functional requirements that the SMI must have.

These legislative guidelines are largely based on the recommendations of technical and scientific bodies such as the Joint Research Center [6], which has publications that are useful for cost/benefit analysis of the deployment of SMI [7] and the