Energy Strategy Reviews 20 (2018) 133–149

Contents lists available at ScienceDirect

Energy Strategy Reviews

journal homepage: www.ees.elsevier.com/esr

Smart energy solutions in the EU: State of play and measuring progress

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ARTICLE INFO

Article history:
Received 16 August 2017
Received in revised form
12 February 2018
Accepted 13 February 2018

Keywords:
Smart meters
Demand side management
European union

ABSTRACT

The European energy system is undergoing, and will continue to in the future, a transition towards a more sustainable energy system. An important part of this will be the deployment of smart energy solutions in the household sector, including smart meters, controls, appliances, and their integration in home networks. This study is in support of the Commission's work related to smart energy solutions in the framework of the SET plan, in particular in understanding methods to develop indicators that can be used to measure progress under the Declaration of Intent for the Action 3.1 on Initiative for Smart solutions for energy consumers. First, 'smart energy solutions' are defined and the type of technologies that this includes are detailed. Once the scope has been established, existing indicators that are able to monitor the levels of deployment of such technologies will be reviewed. This includes indicators being proposed or used by international and Member State level energy agencies and other organisations. It is not intended that this study will comprehensively assess the actual deployment of smart energy solutions across all EU Member States. Instead, selected countries who are more advanced in the deployment of such technologies are considered in more detail. These include France, Switzerland, Ireland, UK, and Sweden. Finally, we review estimates of the potential of demand response in Europe to achieve goals related to energy efficiency, cost savings, and renewable energy penetration.

1. Introduction

The EU's broad energy policy objectives - as defined in the *2030 Climate and Energy strategy* - are security of supply, environment, and competitiveness. In the electricity sector, this will require decarbonisation of electricity generation and reducing primary energy consumption. The increased use of smart energy solutions (SES) is one measure that can contribute to achieving those goals. "The widespread use of smart [energy] solutions should not be a goal itself, but rather be seen as a tool amongst many" [1] to achieve the overall objectives. SES are expected to support the ongoing shift on the supply side towards more renewable generation, both on the central grid system and also in distributed systems. SES could also provide consumers with ways to reduce costs in multiple ways: by shifting demand; through improved information and automation to optimize energy use; and through a move towards being prosumers.

From the policy maker's perspective, there needs to be a distinction between the technical feasibility - technical components installed, smart energy solutions technically possible - and the actual contribution of smart energy solutions to the wider electricity supply system - cost of installing and running smart energy solutions against savings achieved.

Accomplishing this will require a regulatory framework that promotes demand response and energy efficiency services, where the availability of real-time information and secure handling of data is guaranteed to consumers. It will also require an improved understanding of how consumers understand and view smart solutions.

In this paper, indicators relevant to smart energy solutions are

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https://doi.org/10.1016/j.esr.2018.02.005
2211-467X/

identified and explained. In order to do so, smart energy solutions are first defined. Selected case studies are then presented to highlight successful measures related to the deployment of smart energy solutions. An overview of the current status of smart metering in the EU is provided. This is followed by a discussion of the demand response potential in the EU and how the estimation of this potential can be improved. Finally, a set of conclusions are provided.

2. Definitions and scope

Information and communication technologies (ICT) are increasingly applied in almost all technological areas. This trend towards 'smartness' [2] is usually driven by the goal to gain more control over technical processes, decisions and communication [3]. In accordance with [4], this paper does not employ the term 'smart' normatively as a desirable state, but it is rather understood as a description of a technical system with increased utilisation of ICT [5]. Laitner [6] describes smart energy solutions as follows: any energy solution that is described as "smart" […] has semiconductor sensors to measure temperature or other variables; communications chip to receive and transmit data; memory chips to store the information; and microcontrollers, microprocessors, and power management chips to adjust energy loads". In this paper we focus on electricity loads that are either stored, generated or consumed. Smart energy solutions are generally applicable to all energy carriers. However due to the importance of the electricity supply system for the decarbonisation of the European energy system, we focus on electricity. We then classify the technical components of SES as storage, generation and consumption (Fig. 1).

All technical components can either be influenced through a user interaction or automatically (active or passive end-users). By providing targeted information (e. g. about the consumption, the current electricity price, the current electricity generation) the behavioural pattern of the end user can be changed in the short- and the long-term. In the case of an automated influence of the system, the end user only defines the degrees of freedom to be used by the technical automation. This would allow, for instance, a dish washer or laundry machine to start within a defined time period or an air conditioning to operate within a range of temperature. As shown in Fig. 1, the informational connection of the smart energy solution is the basis for both kinds of controls.

3. Case studies

In this section, a set of country cases studies provide insights into the present levels of SES deployment, and what its implications for consumers are. Information on smart metering and its installation, the effect of smart meters in national electricity markets, and its impact in the wide electrical system is presented. In addition, other types of SES - that are in the early stage of development - are also described. The countries selected as case studies — Switzerland, France, UK, Ireland, and Sweden - are among the most advanced in Europe in terms of SES deployment.

3.1. Overview of smart metering in Europe

The Intelligent Energy Europe programme published a report on the European smart metering landscape in 2016 [7]. Based on this, Fig. 2 provides an overview of the regulatory situation (horizontal axis) versus the progress in implementation (vertical axis) of smart metering. Several dimensions are considered for the classification of the countries. For the regulatory axis, four dimensions are considered:

1. cost benefit analysis and rollout plan,
2. timeline of rollout,
3. barriers from new regulations (privacy and data protection, measurement and calibrating meters),
4. legal minimum functional requirements.

For the progress of implementation axis, three dimensions are considered:

1. enabling infrastructure,
2. rollout status,
3. services already available for consumers.

By weighting the dimensions, the Member States[1] were clustered into five groups: *Dynamic movers*, *Ambiguous movers*, *Market drivers*, *Waverers,* and *Laggards*. The *dynamic movers* are characterised by a clear path towards a full rollout of smart metering. Either mandatory rollout is already decided, or there are major pilot projects that are paving the way for a subsequent decision. The *market drivers* are countries where there are no legal requirements for a rollout. Some Distribution System Operators (DSOs) or legally responsible metering companies nevertheless go ahead with installing electronic meters either because of internal synergistic effects or because of customer demands. *Ambiguous movers* represent a situation where a legal and/or regulatory framework has been established to some extent and the issue is high on the agenda of relevant stakeholders. However, due to lack of clarity within the framework, only some DSOs have decided to install smart meters. *Waverers* show some interest in smart metering through regulators, utilities or ministries. However, corresponding initiatives have either just started, are still in progress or have not yet resulted in a regulatory push towards smart metering implementation. Finally, *Laggards* are countries where smart metering is not yet being considered. All considered countries are roughly on the diagonal line from *no clear strategy, no legal framework* to the opposite. Hence, implementation progress is linked with a clear legal framework.

3.2. Switzerland

3.2.1. Smart meter roll-out and technical specifications

Since the liberalisation of the electricity market in 2009,[2] the number of DSOs in Switzerland has increased. This is due to, for instance, municipalities creating their own DSO.[3] As of January 2016, there are 653 DSOs. To enhance liberalisation and market rules, the Swiss Federal Office of Energy (SFOE) issued minimal requirements for smart metering [9], which may be used as indicators of progress. The requirements target the following areas.

- Creation of a technical framework to allow profitable business models;
- Allow the consumer to change easily electricity suppliers. Thus, commercial barriers are avoided;
- Legal and investment security for DSOs;
- Facilitate the deployment of SES and other innovative power solutions.

[1] EU27 and Norway.

[2] The liberalisation of the Swiss electricity market started in 2009, and is currently restricted to large electricity consumers, who can freely choose their power suppliers. Free choice for smaller consumers is expected in 2018. http://www.frenergie.ch/fre-bulletin/louverture-du-marche-de-lelectricite-en-suisse/.

[3] Swissgrid: https://www.swissgrid.ch/swissgrid/fr/home/reliability/griddata/distribution.html.