The Meter-ON project: how to support the deployment of Advanced Metering Infrastructures in Europe?

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ABSTRACT

The aim of this paper is to introduce the first results of the Meter-ON project aimed at collecting and sharing lessons learned from several European Smart Metering experiences.

Meter-ON Consortium is led by the European Distribution System Operators for Smart-Grids, including 31 leading DSOs and associations throughout the European Union. The Consortium comprises university-linked foundations (EnergyLab), technological institutions (RSE and CEIT Alanova) and communication experts (ZABALA).

INTRODUCTION: THE METER-ON PROJECT

The Meter-ON project is a coordination and support action financed by the Seventh European Framework Program (FP7) which aims to steer the implementation of smart metering solutions in Europe by effectively collecting the most successful experiences in the field and highlighting the conditions that enabled their development. On the basis of the lessons learned, the goal of Meter-ON is to provide to any stakeholder an open information platform with clear recommendations on how to tackle the technical barriers and the regulatory obstacles endangering the uptake of smart metering solutions in Europe. Meter-ON will address completed, on-going and planned smart-metering projects and is consisting of a three-step approach performing the following activities (as shown in Figure 1):

i) collection of information related to smart metering projects;
ii) analysis of each project according to the identified set of information domains (see below);
iii) drawing conclusions and recommandations on the way forward based on the lessons learned from the most successful smart metering experiences.

During the Topic-Based Analysis, each project goes through the following analysis:

- **Technological analysis** of the grid characteristics of the company running the smart metering project, of the overarching smart metering architecture, of the smart meter devices installed, of the cyber security and privacy policies applied by each smart metering solution presented.
- **Quantitative analysis,** comprising cost and benefit originating from the project and information on the supply chain development process related to each project.
- **Qualitative analysis** on the regulatory and legal framework in place in each country where the project is running and on user acceptance and customer involvement assessment, to evaluate consumers perceptions and attitudes towards smart meters.
- **Advanced topics**, comprising information on the impact of electricity smart meters on distribution network operations, information on smart metering solutions as supportive of electric vehicle infrastructure, demand response programs and the existence/plans of smart metering solution for other energy carriers (heat, gas and water), when applicable identifying also multi-utility approaches.

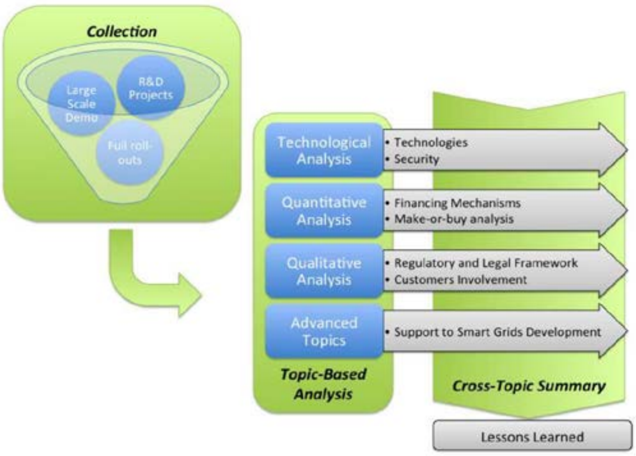

Figure 1 Meter-ON Approach

Finally, all the results of the Topic-Based Analyses goes through a Cross-Topic Summary in order to find out

recurring patterns among projects and draw conclusions on the correlation between these patterns and the successfulness of the projects. The whole Cross-Topic Summary activity will result in a set of lessons learned and recommendations to foster the deployment of smart metering solutions in Europe.
Currently, the project is going through the Topic-Based Analyses (Phase II) and the next session will briefly introduce the collected information as well as the first results of the technological, advanced topics and qualitative analyses, while for the quantitative analysis the proposed approaches will be depicted. Finally, the very first conclusions and next steps will be described.

OVERVIEW OF COLLECTED INFORMATION

In the first collection phase of the project, 15 project information questionnaires have been gathered. Projects collected take place in 10 European countries and according to the information available in total it is foreseen that by 2020 about 100 million meters will be installed. The project information sample comprises 1 project in the R&D phase, 5 projects in the pilot phase, 1 project in the demonstration phase and 8 projects in the roll-out phase (on-going or completed).

1. TECHNOLOGICAL ANALYSIS

Overview of deployed technologies

For the sake of clarity let us consider a simplified smart metering architecture comprising 3 elements:

- Smart meters
- Concentrator, acting as a proxy between the back-office and the set of smart-meters
- Back-office system, managing all smart metering data for commercial and technical purposes as well as scheduling all the maintenance and configuration activities of the smart meters

The analysis of the technology used for the transmission of data between meter and concentrator has highlighted that 10 projects use PLC, 3 projects uses GPRS, while a project use both technologies depending on the location of the meter. A project is still considering which technology to use.

With regard to the communication protocol, it emerged that the most used communication protocol are DLMS/COSEM, METERS AND MORE, PRIME, G3-PLC protocol and TCP-IP, while only one project uses a proprietary protocol.

The analysis has shown that generally the projects aim at ensuring cyber-security adopting counter-measures at the level of the communication protocol. In some projects that mechanism has been improved, for example by the insertion of further user's access rights, by the use of a better authentication mechanism or by permitting the transmission of meter's data only after a specific request by the concentrator.
In 5 project there is no data encryption for the communication between meters and concentrators, and between concentrators and the back-office system.
In 4 projects there is no security-events logging.

With regard to the billing profiles, the analysis has highlighted that all projects allow to program different programmable tariffs inside a day, a week, and a year.

2. ADVANCED TOPICS

Distribution network operations, EV, demand response and other services leveraging on smart metering infrastructure

Nowadays, the operation of distribution network can leverage on different smart tools (i.e., exploiting Information and Communication Technologies) and smart metering can be a key tool to manage and operate power grids. Smart meters can also contribute to network planning, network maintenance, their information could be used to analyze energy losses, and to monitor quality of supply parameters.
All DSOs involved in the study agree on the positive impact of smart metering on their Distribution Management Systems (DMSs). The possibility to receive real time information of the MV and LV power grids guarantees a higher monitoring and observability of the network, which leads to an easier and more flexible grid management in the Network Operation Centers. The analysis of the collected data may offer valuable information for SCADA management, providing offline data necessary for the SCADA operation (e.g. evaluate the feasibility of a given grid connections or perform loads flow analysis on LV grid). In addition to meters, sensors must be in place (feeder meter) to help the system to act in real time when needed, and planned solutions can be carried out remotely thanks to the automation and real-time control of the MV network. Certain defined alarms are delivered real time to DMS, and DMS can query the status of defined meters. Communication systems also enable the DSO to be more reactive in case of MV outages.
Based on real data stored in the meters, a set of load curves can be calculated representing different clusters of customers (residential, industrial, etc.). As a result, load curves of each MV/LV transformer can be calculated based on the number and typology of customers connected downstream.

Smart metering and electric vehicle infrastructures

Smart meters can enable the deployment of EV charging infrastructures, with enough intelligence to manage the charges and minimize the impact of EV penetration in the power grid, maintaining the conditions of QoS and continuity of the supply. They enable also the possibility of the EV to be a support of the power system, giving remaining energy to the grid in case of need, systemically (Vehicle to Grid, V2G), or locally (Vehicle to Home, V2H). Among the 15 DSOs, 6 DSOs declared that they will pursue Smart charging, 2 will pursue Vehicle to Home and 1 Vehicle to Grid capabilities.

Smart metering and Distributed Generation

In order to facilitate the integration of distributed generators, smart meters implement the ability of measuring information about generation patterns. Almost all projects are provided with smart meters measuring Active Energy in a bi-directional way and reactive energy in 4 quadrants.

For some DSOs, the bidirectional reading capability of a single smart meter is not enough for a pro-sumer connection because the relevant national authority requires 2 meters, the first to determine the electricity generation which qualifies for feed-in rates, the second to determine usage (net-metering) and grid-delivery compensation. In case of pure producers, a bidirectional meter is installed at customer premise. Normally, the DSO is responsible of the metering (installation, commissioning, maintenance ...), but, in one case the producer/prosumer has the role to acquire the meter and the GSM modem, and the DSO is in charge for their certification.

Smart Metering and Demand Response

Demand response services are key aspects to optimize the efficiency of power systems. With the ability to manage consumer demand, peaks can be reduced, and periods with little demand can be filled with alternative consumptions, like EV charging or programmed consumptions, so the demand curve can be flattened and the whole electricity system can be used more efficiently.

The different features implemented by European DSOs smart metering systems are internal remotely programmable breakers and demand control algorithms on board, display on board, HAN serial interface (which enables local communication with customers devices/appliances), residual power threshold to use during active demand periods, critical and non-critical periods of demand management, mobile peak tariffs, remote reduction of the power threshold, real time communication between the meter and the connected applications, remote reduction of the available power until disconnection, load control relay. Regarding the participation of consumers, there is a diversity of opinions coming from European DSOs. A consolidated position is to establish a direct link between the utility and the customers, and give them the information of their consumptions. In other countries, due to the regulatory framework the requirements are stricter: daily delivery of hourly-grained meter readings to consumers, delivered through an internet application using an in-home display service. The most common interfaces provided by European DSOs are web interface, dedicated in-home displays, personal computers, and smart phones.

Regarding demand response projects, 5 out of 15 DSOs are developing pilot projects where demand response features are deployed.

Other services

Regarding other advanced metering solutions, there is a common tendency of all DSOs enquired to develop neither heat nor water metering solutions by now. Nevertheless, there is some interest in developing a solution for gas metering.

In this regard, 3 out of 15 DSOs are actively working on a gas metering solution, but just one of them is exploiting the electricity metering infrastructure already in place. Another DSO uses combined electricity and gas meters for some consumers. In this case, the gas meter is connected to the electricity meter via radiofrequency as data concentrator.

3. QUALITATIVE ANALYSIS

Regulatory, legal framework and user acceptance issues

In the European Union an appropriate regulatory and legal framework for the massive uptake of smart metering technologies is far from being homogeneously in place. Compliance with Directive 2009/72/EC (2003/54/EC) concerning common rules for the internal market in electricity can be observed to be at different stages of implementation. Then, the involvement of the customer is noted to be a complex point linked to the regulation in place in each Member State, where customers are expected to be engaged in these changes, but as some evidence show the information needs to be shared in a more accessible and understandable manner for them to do not see smart meters as a danger and to experience real benefits from their usage.

According to the existing literature two main issues hinder the acceptance and involvement of customers vis-à-vis smart metering solutions:

- Security and privacy related issues;
- Cost related issues.

The granularity of data collected from smart meters might suggest to consumers that their habits and lifestyles are under control, and worse that unauthorised accesses could happen if proper measures are not taken. Along with this issue, trivially, consumers might fear they are charged the costs related to the infrastructure without receiving back the corresponding benefits.

As a general rule it is observed that effective information campaign promoting consumer awareness and knowledge should be performed by the company running the smart metering project, not only to mitigate their resistance to the technology but to promote at an early stage the interaction with the meter, to support those advanced smart metering uses, such as demand response programs, where the involvement of the customer is crucial.

Information collected by Meter-ON shows that in some cases companies running the smart metering projects adopted a clear strategy targeting the engagement of the end-users, but in other cases it is clear how the focus was more on the technological side and how the customer was not involved at the early stage of implementation. The initiatives to engage the consumers in the smart metering implementation range from basic informative letters on the matter with updates throughout the process, to round-table meetings with the stakeholders and to large-scale surveys and Customer Service platforms to attract customers in providing their opinions and to enhance their interaction with the smart meter. In the next phases Meter-ON will try to identify the most successful strategies to involve consumers in the smart metering field.

4. QUANTITATIVE ANALYSIS

There is quite a number of on-going smart-metering projects in the European Union with highly different technical, economic and social features. The promoters of smart meters claim the several benefits enabled by this technology, and the first phase of the Meter-ON project already identified the "technical" benefits originating from these solutions. In the next phases of the Meter-ON project the consortium will collect and evaluate economic information related to costs, benefits and will try to identify the more appropriate smart metering supply network configuration which is a major concern for companies (being DSOs or Energy Suppliers) in charge for the implementation of smart metering infrastructures. Our research question in the project will thus be: is there a set of likely supply network configuration and management ways enabling the tuning of the costs (not always minimization) and the benefits (not always maximization) for a number of stakeholders of the project? To this purpose, smart-metering project information collected by Meter-ON will be in-depth investigated, aiming at identifying their supply network configurations and management ways (starting from Tang, 2006), where five inter-related issues define the kind of "supply management" implemented, namely "supply network design", "supplier relationship", "supplier selection process" (which is in fact instrumental to "supplier relationship", as in Masi et al., 2013), "supplier order allocation", and "supply contract" (which is in fact the result of the combination of "supplier relationship" and "supplier order allocation"). From the above, three elements will constitute the construct of the variable "supply network configurations and management ways": the network design, the kind of relationships in place, and the distribution of the orders among the suppliers. Once the supply network configurations and management ways will be identified, their implications in terms of costs and benefits will be investigated, to produce a non-normative critical appraisal of the supply network configurations and management ways themselves, to provide a benchmark for the current projects and the future ones.

CONCLUSIONS and Next Steps

This paper introduced the Meter-ON project and the very first results highlighting how at the European level most of the utilities are focusing on the Smart Metering technologies that will certainly be one of the cornerstone of the future electricity grid enabling a lot of smart applications like load shaping, integration of the distributed generation from renewable sources as well as recharging of electric vehicles. Meter-ON project has already shown how different technological solutions has been adopted in 15 projects that are going to involve about 100 million customers in the next few years. The different technological solutions involves different communication protocols within the metering infrastructures as well as different available devices/systems aimed at directly communicating with the final customer and supporting active demand applications; furthermore some of the smart metering projects are encompassing electric vehicle charging applications and multi-metering applications (e.g., a single metering infrastructure for both electricity and gas).

Meter-ON will continue deepening the analyses to draw lessons learned and to highlight recurring patterns in order to depict a set of recommendations for the deployment of smart metering solutions in Europe. Furthermore, in the next phases Meter-ON will enquire projects where other players are in charge of some metering functions (e.g. suppliers, metering service providers) and compare the different scenarios.

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