GUIDELINE: SMART METER MONITORING AND CONTROLLING FUNCTIONALITIES

Abstract

The objective of this guideline is to highlight the available functionalities available in smart meters and to provide advice on how and when to use them depending on different target groups and technical constraints. The guideline is primarily intended for smart grid service providers and for utilities. It requires basic smart grid and smart meter knowledge from the reader.

What is it?

The introduction of smart meters has enabled a variety of novelties, which cannot be offered and used effectively by all types of users in all circumstances. The offered functionalities are services or applications that benefits to the end user or service provider and needs the smart meter's software (SW) and hardware (HW) for its operation. The selection of smart functionalities depends beside the smart meter capability also on project goals, end user structure, stakeholder interests and economic benefits. This document outlines some information about organizational and technical issues that need to be considered when implementing specific functionalities in a smart grid (project). It describes the purpose of a particular functionality in relation to the hardware (smart meter) characteristic, stakeholder interest (such as raising awareness, reducing energy consumption and peak power, or actively manage production and consumption with demand response), and relation to the target audience and end user segmentation.

The earliest smart meters provide what is called automated meter readings (AMR). They were based on simple one way communication, enabled regular (monthly) automated readings involving the customer on one side and billing/accounting departments on the other. The evolution then first added the system services like daily hourly reads on demand, emergency notifications, etc. (AMR+) used by electricity transport and distribution companies to maintain grid safety and stability. The modern smart meters are based on an advanced real time two way communication technology called advanced meter infrastructure (AMI). It has brought advanced smart grid and end user oriented functionalities, such as demand side management (DSM), unregulated market trading, real time information, upgrading by remote programing, home area network (HAN) support etc., as presented in Figure 1 (ERGEG, 2011).

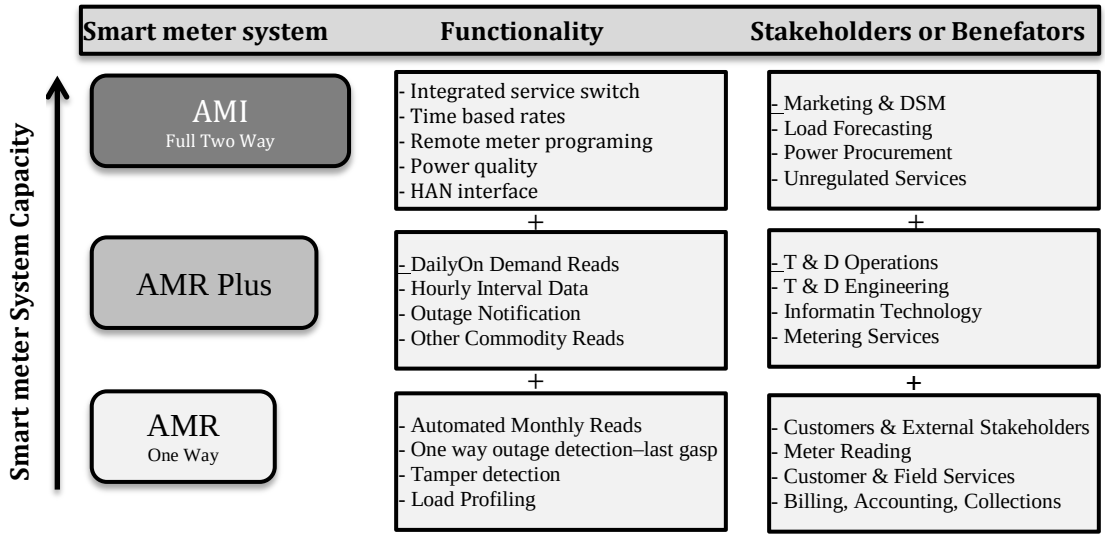

Figure 1: Smart meter technology evolution (EEI, AEIC, 2011)

The document is based on the recommendations provided by ERGEG[1], which has announced a list of recommendations (ERGEG, 2011) that the future smart metering stakeholders (suppliers, service providers, etc.) should consider .

When to use?

The information described in this guideline can be primarily adopted in the first stages of the project and/or product development, i.e. in the planning phase or in the early stages of implementation.

It is important to offer and use smart meter functionalities according to the needs and type of the target group, the interests/needs of other stakeholders involved, taking into account the technical constraints (data transfer capacity, smart meter type) and economical point of view.

- The functionalities offered to the audience should reflect the **needs and type of the end users target group**. For example, a large portion of residential end users is usually interested only in some basic smart grid functionalities, while some advanced functionalities (if offered) will probably remain unused. From the behavior point of view the project S3C (http://www.s3c-project.eu/) proposed a segmentation of end users on “Smart Consumer”, “Smart Customer” and “Smart Citizen”. The Smart Consumer wants to reduce energy consumption and costs and change his lifestyle routines. The Smart Customer wants to become a Prosumer, thereby consuming energy as well as providing energy services and consumption flexibility. The Smart Citizen wants to

[1] European Regulators’ Group for Electricity and Gas.

become part of a 'smart energy community' and help ensure quality of supply and environment preservation.

- Another important issue, which should be taken into account at planning and integrating the functionalities, are **interests of the stakeholders** related to the end user behavior. The basic goals like end user motivation for demand reduction, use of RES and/or consumption shifting determine what functionalities should and/or could be offered to the end user.
- Monitoring functionalities may meet also some technical constraints at integration. There must be a proper **type of smart meter** to support the functionalities foreseen by the project. The first smart meters were pronounced "smart" because they enabled remote reading of the consumed energy. Some advanced functionalities require technically more complicated elements such as two-way communication, remote management, interface with the home automation, informing through web-portal gateway, etc., which are not always available or feasible to integrate.
- From the **economical point of view** the introduction of new smart grid functionalities should be based on "win-win" combination for the parties involved. End users receive incentives in various forms (see our set of guidelines on this consisting of the guidelines Choosing and combining monetary and non-monetary incentives, Choosing from different types of monetary incentives and Choosing from different types of non-monetary incentives), while stakeholders get their benefit from network maintenance and investments cost reduction (network operators), energy supply optimization (suppliers) or better market position (service providers).

What do you need to do?

In general, the smart meter functionalities should be user friendly, understandable, uniform or standardized and provide a broad though effective spectrum of technical functionalities in order to better engage the end users, inform them of their consumption, help increase awareness of energy consumption and furthermore, engage them to actively participate in the electricity (and gas, water, heat) supply market.

The functionalities that may be used by the smart grid technology should be related to project goals, target audience and required infrastructure.

Basic functionalities

The basic functionalities require the basic feature of the smart meter – remote access to measurements. The basic functionalities usually fulfil the requirements of the passive "smart consumers". This type of functionalities are services offered to the end users when introducing the smart meters.

- Online access to the consumption and cost data.
- Bills based on actual consumption.

- Simple change of supplier or service provider is supported. The installed smart meters need to follow the rules and communication protocol prescribed by the regulator, which is responsible for the supplier change legislation.

The basic functionalities are intended for commercial standardized installations like mass smart meter rollout. According to the
ERGEG recommendations (ERGEG, 2011) the “basic functionalities” should be free services offered to the end users when introducing the smart meters.

Advanced monitoring functionalities

Advanced monitoring functionalities are probably best tailored for projects with rather ambitious goals, such as setting a hi-tech energy environment and targets mostly the “smart customers” and “smart citizens”, because they require more active involvement of the end user. The functionalities that need to be considered are:

- *Alarm functionalities:* alerts regarding unexpected interruptions of energy delivery and exceptional (high) consumption. This functionality may also indirectly contribute to the energy preserving goals by introducing the load operation details to the end user and enhancing its energy knowledge. . These functionalities do not require advanced smart meter technology and may be supported by one-way communication. The service provider needs to implement the communication channel to send the alerts to the end user.

- *Diagnostic monitoring functionalities* like monitoring of the status of the system and monitoring of the diagnostics of electrical components (detection of the inconsistent metering results). The functionalities are supported by the one way communication system, but need a communication interface with the end user’s home automation system. These functionalities are more suitable for larger end users like smart buildings and SMEs. The functionality enables more active end-user to get a closer look into the system and appliance operation, enabling him also to optimize its performance.

- *Dedicated functionalities* for the producers: smart customers dealing with the production and selling the energy on the market are interested in functionalities such as:
  - Metering of production and consumption in one spot. This functionality enables internal consumption of the locally produced energy and full refund of incentives for RES production.
  - Monitoring of the end user production device disruptions.

- *Interface to home automation system* is considered beneficial to all archetypes of smart energy system users, including the most basic consumers, since visualization of energy consumption, as well as other

functionalities enables better control over energy use and in this way helps reaching their goals of reducing energy consumption. Services enabling control over smart energy processes have been found beneficial in achieving reductions of energy and peak power consumption.

- *Communication channel* for the reception of the grid operator/supplier messages. The functionality, which requires connection to automation system, enables the transfer of the energy related messages from the service provider to the end user. The messages contain information about dynamic price tariff, power limit, energy consumption performance indicators and other data with the purpose to influence the end-user consumption behavior.

- *Demand response* is a functionality that is appropriate when the project's target audience is "smart customers" and the project is intended to engage the full potential of smart grid capabilities. The demand response may be performed via setting the consumption power limit or control of the electrical appliance operation flexibility. It is advisable that the functionality is offered with remote operations like remote power limit setting, remote configuration and remote emergency load disconnection.

Grid safety, stability & maintenance

Network related functionalities, which are mainly responsibility of the grid operator, also involve end user directly however they don't have a large influence on its engagement using the smart grids. They require more advanced smart meter technology supporting the two-way communication and power control output. The following services may be considered:

- *Remote power capacity reduction*/increase should be available. The reduction of power to the minimum instead of the disconnection in case of the non-payment is more user-friendly and enables the end user to keep the basic and important living appliances, such as refrigerators, running.

- *Remote (de)activation of the power supply* should be possible. The functionality is applicable to the smart customer, which is involved in the electricity production. It is an issue of grid operator's interest to control the distribution grid's (un)pleasant production. Introduction of the functionality needs to handle the question regarding the incentives of the unproduced energy of RES during the deactivation.

- *Remote upgrade of the smart meter software* (without data reading interruption) should be enabled.

What do you need to do?

The following table summarize the smart meter monitoring and controlling functionalities according to the characteristics in the section “When to use?” – AMR, AMR+ and AMI.

Table 1 Smart meter functionalities summary table

Functionality	Meter type	End user type	Service provider	Economic effects	
				End user	Service provider
On-line data access	AMR	Consumer	distributor, supplier	Savings	Market liberalization
Bills on actual consumption	AMR	Consumer	Supplier	Bill simplification	Market liberalization
Supplier change	AMR	Consumer	Supplier	Service liberalization	Market liberalization
Alarms	AMR+	Customer	Supplier	Maintenance	Profit
Home Diagnostics	AMR+	Customer	Supplier	Maintenance	Profit
Production monitoring	AMR+	Customer / Citizen	distributor, supplier	Maintenance	Market liberalization
Interface to home automation system	AMI	Customer	supplier	Savings	Market liberalization
Communication channel to HAN	AMI	Customer / Citizen	distributor, supplier	Incentives	Profit
Demand response	AMI	Customer / Citizen	supplier	Incentives	Profit/Maintenance
Remote operations	AMR+	Not applicable	distributor	Not applicable	Maintenance

The table may be used as a decision matrix to advice service provider at installation of smart meter type and about usage of smart meter functionalities under different circumstances.

The following three steps are suggested to introduce the proper set of monitoring and controlling functionalities:

1. At the introduction of the monitoring and control functionalities first the target audience should be analyzed and end user segmentation provided to offer the proper functionalities. More information on end user segmentation can be found in the guideline Learning about target groups.
2. The characteristic of the infrastructure (existing or new) should support the proposed set of functionalities. Beside the meter types this issue also covers the communication paths and service provider capabilities.
3. The final decision maker about the implemented functionalities is usually taken by the service provider. The grid operator usually prefers the functionalities related to the grid stability and maintenance. Suppliers and other service provider compete for end users offering him various home automation functionalities cost savings related to the behavior change.

The resulted functionalities have different economic effects on the parties involved. The functionalities described (with the exception of “remote operation”) provide various benefits for the end users. With online data access he can become active in looking for consumption savings. Bill simplification and supplier change improves the energy supply service quality. Advanced functionalities like alarms home diagnostics and production monitoring enables him easier home maintenance. Demand response and communication channel for ToU offers him to get additional financial benefit through incentives. On the other hand the service providers should offer these services to stay with the competition on the liberalized market. They also make profit from advanced functionalities like maintenance functionalities for end user and changing the end user behavior over ToU tariff or automatic demand response.

Do’s and don’ts

The following section outlines some specific recommendations on choosing the right smart meter functionalities:

- **Don’t charge for basic features**. Data for consumption and costs on a monthly basis should be free of charge.
- **Include privacy and data protection.** Implementation and utilizing the smart meter should follow the data ownership best practice what is described in the guideline Privacy and data protection.
- **Take care about data security. Beside privacy and data protection the** implementation and offering smart grid functionalities needs to take into account also the data security issues. A systematic approach of smart grid security measures smart grids is well described in the Enisa document (ENISA, 2014) which structures the assets (HW and SW elements in the network), threat types (failures, data losses, attacks, etc.) and list a catalogue of the corresponding security measures (physical, information, network security, etc.).
- **Optimize smart meter performance.** Smart meter data collection should be in line with the meter reading frequency and available storage capacity. To prevent the potential transmission of large amounts of data it is possible to use the ToU (time of use) registers. It is recommended to use at least three registers: peak, middle level, and off-peak, during a period of 24 hours.
- **Use the open option of the home area network (HAN) interface.** One of the main advantages of offering the services through the smart meter infrastructure is one communication path and one security model to the customer. However there are also disadvantages like complicated and expensive changes along the path of devices for all new functionality, which in addition may require approval from the side of the regulator. The recommended alternative may be the use the open option of HAN interface, which connects directly to the data center of the service provider. Open option of interface disables the DSO/TSO from the privileged position. Standardized

gateway enables energy management solutions like home automations, different schemes on demand response, data delivery, information for price signals and consumption adaptation. Some further information on this issue may one find in the S3C guideline How to make energy visible through feedback.

Joining energy monitoring and home automation (Stockholm Royal Seaport, SE)

Advanced monitoring functionalities were used in the Stockholm Royal Seaport Smart and sustainable city project. The home energy management system on one side included measuring consumption for different rooms and appliances, with motion- and temperature sensors in all rooms, dimmers, regulators on all radiators and "away"-buttons decreasing the consumption when the family is not at home. On the other side it has a connection to the service provider setting an advanced system of ToU tariffs. With the online monitoring of the particular consumer the residents were able to change their behavior efficiently according to the provider price signals.

More information on: http://stockholmroyalseaport.com/en/

Bringing the online monitoring information to the home (Promoting energy efficiency in households, LT)

The Latvenergo – largest Latvian distributor and energy supplier has purchased and installed 500 smart meters in households. Beside data readout system used by service provider for grid planning and maintenance, two options were offered to the end user for monitoring his consumption: a) web access to web access based on the service provider infrastructure, and b) separate in-house metering and monitoring equipment with open option of the HAN interface. The purpose of monitoring was to make the end user aware of their consumption and motivate them to use less energy.

More information on:
http://www.latvenergo.lv/portal/page/portal/TOPLEVELSITE/printpage?p_pageid=1477181&p_siteid=80&p_language=us

Further reading

- EEI, AEIC, 2011. Smart Meters and Smart Meter Systems: A Metering Industry Perspective, March 2011.
- ERGEG, 2011. Final Guidelines of Good Practice on Regulatory Aspects of Smart Metering for Electricity and Gas, Ref: E10-RMF-29-05, 8 February 2011.
- ENISA, 2014. *Proposal for a list of security measures for smart grids*. (https://ec.europa.eu/energy/sites/ener/files/documents/20140409_enisa_0.pdf)

This guideline was developed in the S3C project, and is freely available from www.smartgrid-engagement-toolkit.eu.

S3C paves the way for successful long-term end user engagement, by acknowledging that the "one" smart consumer does not exist and uniform solutions are not applicable when human nature is involved. Beyond acting as a passive consumer of energy, end users can take on different positions with respective responsibilities and opportunities. In order to promote cooperation between end users and the energy utility of the future, S3C addresses the end user on three roles. The *smart consumer* is mostly interested in lowering his/her energy bill, having stable or predictable energy bills over time and keeping comfort levels of energy services on an equal level. The *smart customer* takes up a more active role in future smart grid functioning, e.g. by becoming a producer of energy or a provider of energy services. The *smart citizen* values the development of smart grids as an opportunity to realise "we-centred" needs or motivations, e.g. affiliation, self-acceptance or community.

S3C performed an extensive literature review and in-depth case study research in Smart Grid trials, resulting in the identification of best practices, success factors and pitfalls for end user engagement in smart energy ventures. The analysis of collected data and experiences led to the development of a new, optimised set of tools and guidelines to be used for the successful engagement of either Smart Consumers, Smart Customers or Smart Citizens. The S3C guidelines and tools aim to provide support to utilities in the design of an engagement strategy for both household consumers and SMEs. The collection of guidelines and tools describe the various aspects that should be taken into account when engaging with consumers, customers and citizens. More information about S3C, as well as all project deliverables, can be found at www.s3c-project.eu.