Next Generation Smart Metering

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Multi Utility Metering group
ESMIG
Task Force "Next Generation Smart Metering"
Task Force "5G"

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About ESMIG

ESMIG is the European industry association that provides solutions and expertise on smart energy measurement and management at a European level. ESMIG's members are the leading companies in the European smart metering market: meter manufacturers, IT companies, data communication and protection solution providers, system integrators, etc.

The activities of ESMIG are organised through various working groups that cover strategic, regulatory, and technical subjects. These groups are reviewing statements and papers issued by European organisations and produce proposals about how to approach the important issues that influence the implementation of smart energy solutions in Europe.

ESMIG's technical working groups focus on functional and technical requirements for all solutions provided by its members. Energy management and measurements are covered in multi utility scope: electricity, gas, water, and heat. Technological developments are moving fast and the trend in infrastructures is modularity in order to be able to cope with these developments that are different for different components of the Automated Metering Infrastructure. This implies more interfaces and increased complexity of standards that must be able to support the developments in technology still to come.
Together with the Task Force "5G" of ESMIG's Data Communication and Protection working group, the Task Force "Next Generation Smart Metering" of the Multi Utility Metering working group has been studying the future architecture and requirements for the AMI. That work has resulted in this report containing a description of the next generation architecture, functional Use Cases and communication requirements.

We would like to thank all ESMIG members that contributed to the work to create this report.

Willem Strabbing
Technical Director
ESMIG

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1 INTRODUCTION AND READER GUIDANCE

Introduction

The implementation of smart metering is crucial to the development of the European energy efficiency programs and consumer involvement. The drive for lower-carbon emissions, combined with greatly improved efficiency on the demand side, will empower consumers better than before. New tools and functionalities provide more and better information and enable demand side flexibility, so local energy consumption and generation can be better managed.

In order to give solution providers, integrators and energy market parties a better insight in the features that next generation technology can bring, but also in the technical requirements that would enable the next generation functionalities, the ESMIG working group Multi Utility Metering initiated a Task Force to develop this report. The Task Force started with defining a Next Generation architecture for the smart meter and its direct (In-home) environment. Based on that architecture an inventory of Next Generation Use Cases has been developed to give insight in the functionalities that can be supported by the architecture. Finally for every Use Case the communication specifics have been specified in order to understand the requirements for the underlying communication technology.

The Task Force has collected Use Cases from external sources and discussed with some energy market parties the expectations and requirements for the future AMI. This report will not be the end of ESMIG's work on Next Generation technology. The report will be used as input for further discussions with market parties and also follow-up work of ESMIG's working groups.

Reader guidance

This report is composed of three chapters and two Annexes:

- **Chapter III** describes the Next Generation architecture. The elements in this architecture are described as functional modules. End users can decide how to implement these modules, eg. in separate hardware devices or combined, modules could be "firmware" modules in combined case. When separate, the standard interfaces listed become more important to create an interoperable environment. The implementation and operation of the different modules can be in the hands of different market players. So will, in most European countries, the Grid Operators install and operate the smart meter. The Consumer Energy Management module will, when managing individual domestic appliances, in most cases be operated by commercial 3rd parties.
- **Chapter IV** lists the Next Generation Use Cases that can be realised by the architectural models described in chapter I. It is important to note that these Use Cases will not automatically be supported in the next generation smart meters.

Some Use Cases require technical adaptations that might not be offered by base products. Some Use Cases will be functional extensions of base products that can be acquired.

- **Chapter V** lists the communication requirements for the different Use Case listed in chapter II. These requirements are technology agnostic and can serve as a basis for the evaluation of various communication technologies used in the AMI.
- **Chapter VI** finally gives suggestions for the use of this report and describes the work that ESMIG working groups are taking on as a follow-up of the work done that resulted in this report.
- **Annex I** lists the Use Cases in more detail.
- **Annex II** lists the communication requirements in more detail

2 TASK FORCE MEMBERS AND VERSION HISTORY

2.1 Task Force members

Task Force “Next Generation Smart Metering”

Nuno Teixeira (chair)	Sagemcom
Henri Teboulle	Sagemcom
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Tomas Dostal	Iskraemeco
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Gerben Kuipers	Kamstrup
Jussi Numminen	Wirepass
Simon Dunkley	Itron
Neil Bosworth	Thales
Fabien Seheux	Thales

2.2 Version history

Version	Date	Changes
0.1	September 2022	- First draft by Willem Strabbing - ESMIG
0.2	September 2022	- Update of chapter III (New generation architecture) by Nuno Teixeira - SAGEMCOM
0.3	October 2022	- Chapter IV by Nuno Teixeira - Edits by Willem Strabbing
0.4	November 2022	- Edits by Jürg Haas Edits by Michael Jary
1.0	December 2022	- Update Final version

2.3 References

[1] – CEN/CENELEC/ETSI Smart Metering Coordination Group - TR 50572 – Functional reference architecture for communications in smart metering systems – December 2011

[2] – CEN/CENELEC/ETSI Smart Metering Coordination Group - SM-CG_Sec0060_DC – Smart Metering Use Cases – November 2012

[3] – CEN/CENELEC/ETSI Smart Energy Grid Coordination Group – Overview of the main concepts of flexibility management – November 2014

[4] – Interconnect project deliverable D1.2 Mapping between Use Cases and large scale pilot

[5] - VDE-AR-E 2829-6-1 - Technical information exchange at the interface to the property and the elements of the customer's facilities located there – Part 6-1: Use Cases – Draft - June 2021

[6] - 214/53/EU - Radio Equipment Directive – 16-4-2014

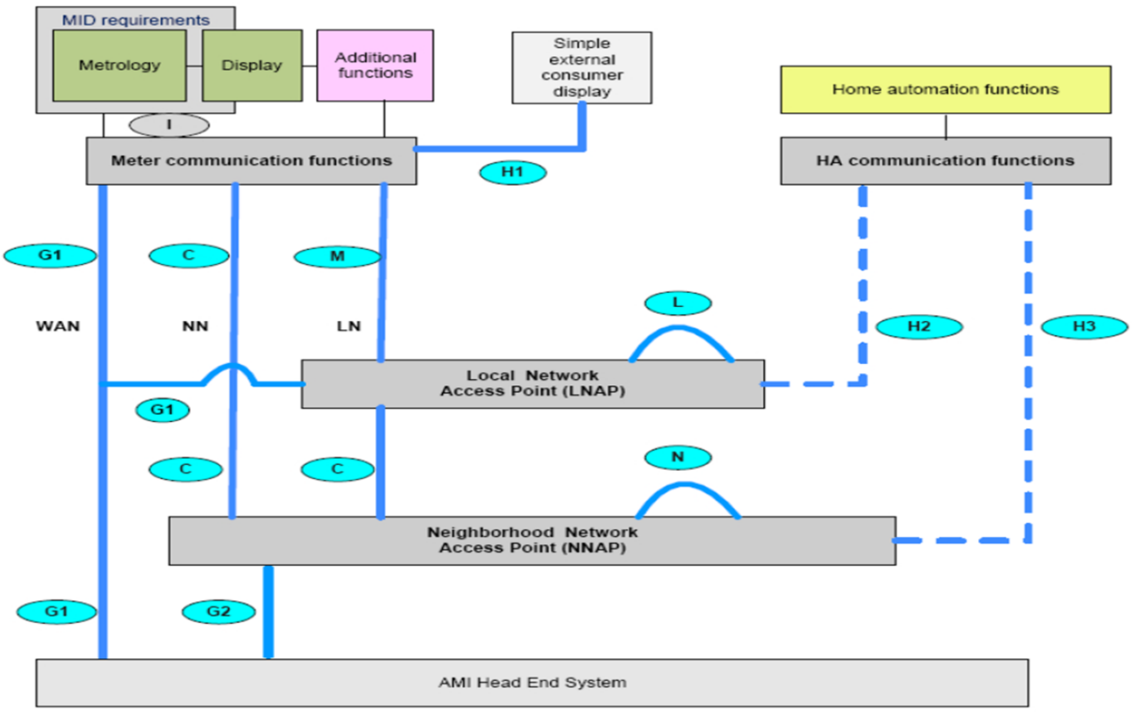
[7] - Commission Delegated Regulation (EU) 2022/30 – 29-10-2021

[8] - 2004/22/EC – Measurement Instrument Directive – 31-3-2004

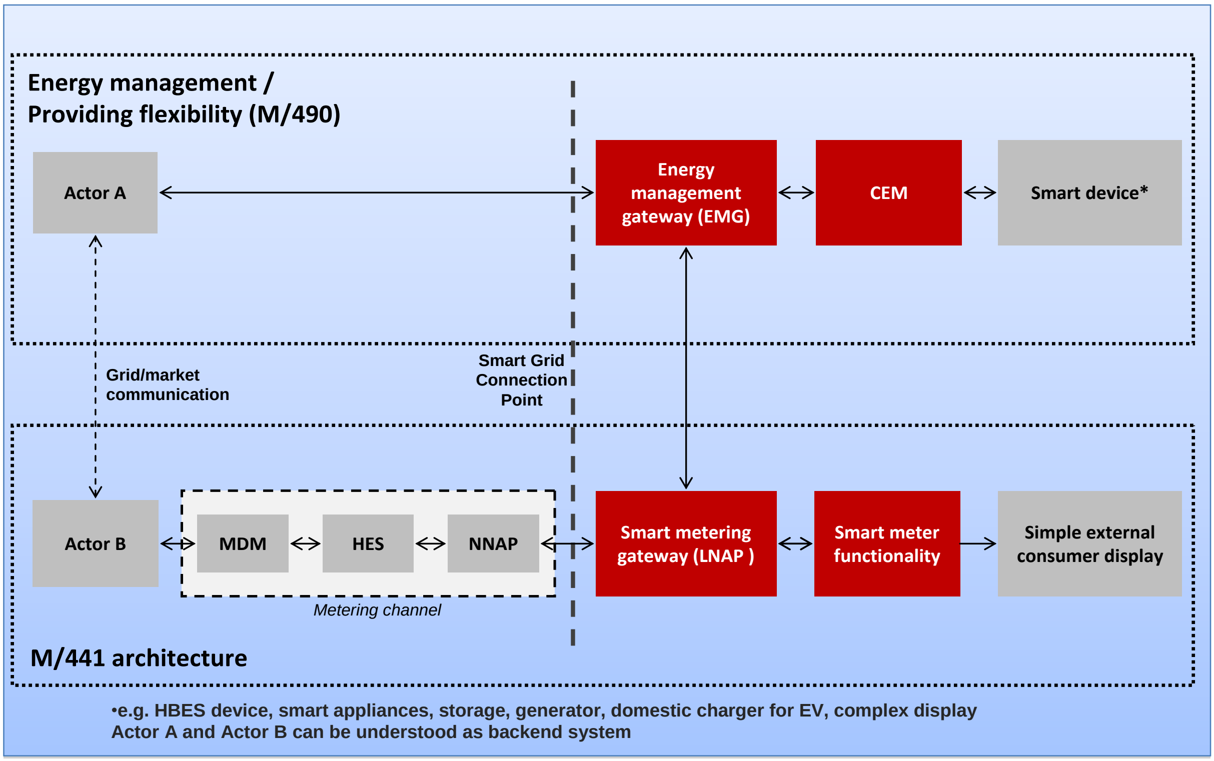
[9] - 2016/679 – General Data Protection regulation – 27-4-2016

3 NEXT GENERATION ARCHITECTURE

The Task Force "Next Generation" has used the architectures developed by the CEN/CENELEC/ETSI coordination groups as a basis for the Next Generation Architecture.
The first reference architecture below shows the AMI architecture as developed by the Smart Metering Coordination Group (reference [1]). It contains the functional elements of the AMI and the interfaces between them. Some elements, such as the Network Access Points are optional. In current practice examples of the Local Network Access point (LNAP) are the Communications Hub in the UK and the Smart Meter Gateway in Germany. The Neighbourhood Network Access Point (NNAP) is also referred to as "Data Concentrator". The H1 (home) interface is mostly implemented as a one-way interface pushing consumption data out of the meter. H2 can be a more sophisticated two-way interface from the LNAP to home automation / energy management functions. H3 is currently not implemented.



The second diagram below covers a wider functionality: Demand Side management / Flexibility. This reference architecture has been developed by the CEN/CENELEC/ETSI Smart Energy Grid Coordination Group (reference [3]). Actor B in this diagram is the party responsible for operating the AMI, while actor A offers energy management/flexibility services to consumers. One example of such an implementation is the P1 consumer port as defined in DSMR (Dutch Smart Meter Requirements).



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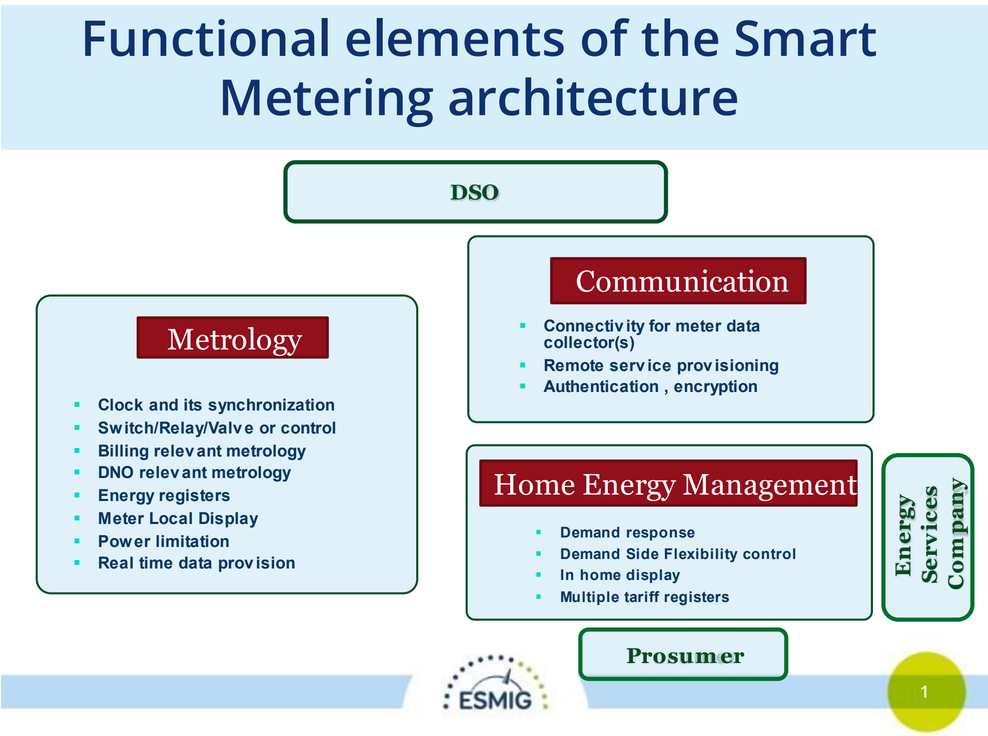
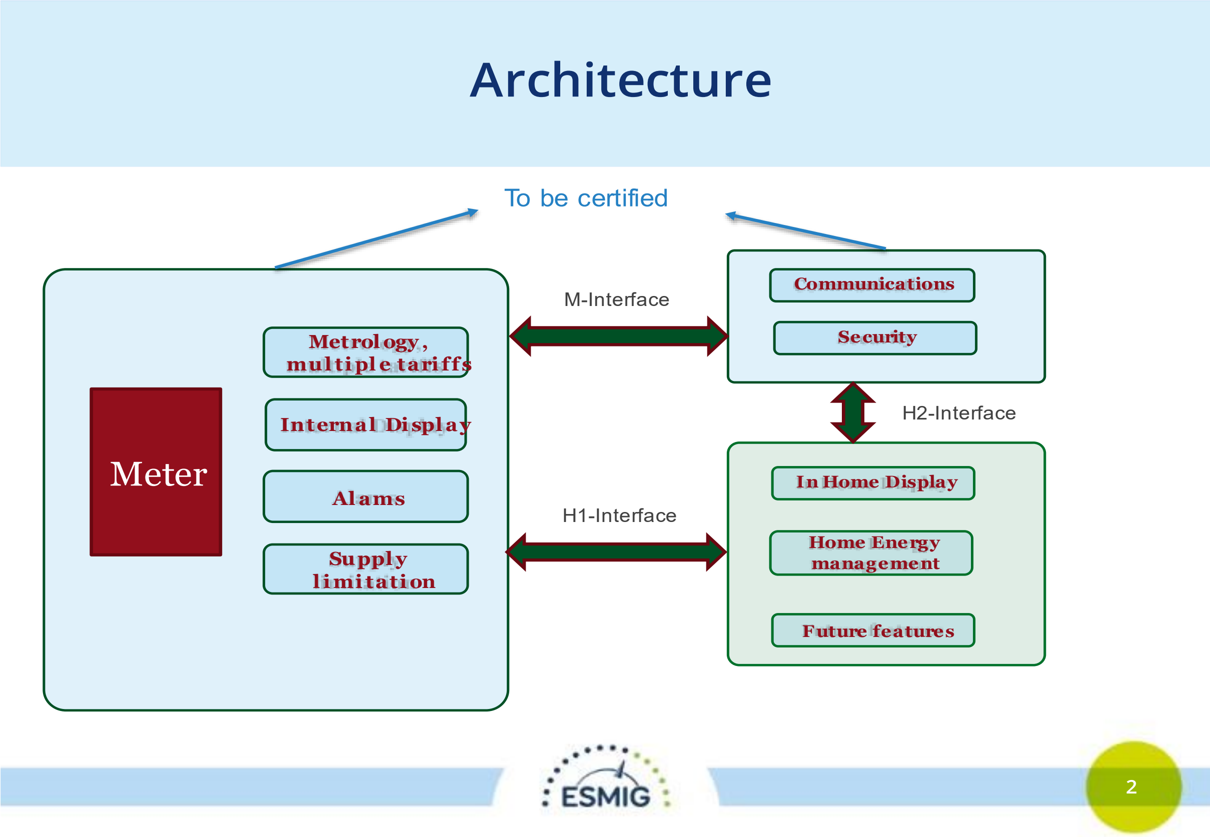
The Task Force created a new modular architecture as a more simplified version of the above, but also based on current practises and the expectation for the near future. See the two diagrams below.





As you can see bot the H1 and the H2 interface can be used to communicate with Home Energy Management functionality that can be limited to an external display but also extended to full functional flexibility management of household consumption, storage and generation.

The M-Interface connects multiple (multi utility) meters to the communication device or gateway.

As explained in the Introduction, the modules are functional and can be implemented in separate hardware devices or combined. For example, in some European countries the communication device is integrated in the smart electricity meter.

ESMIG members see a trend to implement the communication device / gateway in a separate hardware device, since the communication technology develops much faster than the metrological functionality in the meter and therefore the need for replacement can be quicker than for the meter itself. The meter should however cover the functionalities expected to be needed in the lifetime of the meter. One example is the power limitation function that will be needed more frequently for the management of distribution network congestion. Another is the provision of near-real-time data to the consumer or party designated by the consumer for processing this data.

The consumer services and associated required flexibility is evolving and is to be taken into consideration by offering dedicated appliances and thus a smart device that will be able to provide the best level of services and evolution capabilities.

Metrology:

This module integrates the main pure metering functionalities required for billing, power, and energy monitoring as well as real time data provisioning. In fact, the evolution of the metrology and European standards related to metrological functions requires sometimes several years and the provisioning of data allowing to improve the services and network management, quality, or devices associated to it are requiring upgrade capabilities as well as services being able to make use of real time data.

This module is required to be certified according to Measurement Instrument Directive (ref [8]) as well as Reliability. Some EU countries require national certification for billing relevant functionality beyond MID.

Communication:

The communication modules will require:

- Security
- Flexibility
- Evolution following standards and market needs.

Apart from the pure metering data, using standards such as DLMS, the new market needs also requires using different data delivery points and, in case of separate module, different communication technologies evolving during metering module lifetime. Security and privacy of data are key points for the coming years and next generation of meters.

Devices that use radio communication technology have to be certified according to the Radio Equipment Directive (ref [6]), that currently is being extended with security requirements (ref [7]).

In general data processing equipment and related processes need to comply with the General data Protection Regulation (ref [9]).

Home Energy Management:

Besides of the metering ecosystem, the end user is to play a role on the energy demand side and take benefit (interest) of the flexibility offered by the Next Generation architecture as a key player/role. Prosumers with their own power generation become increasingly popular and relevant for the grid.

4 NEXT GENERATION USE CASES

Based on the architecture from chapter 3 Next generation architecture, an inventory of Next Generation Use Cases has been defined to give more insight in the functionalities that can be supported by such architecture.
In the table below, the summary of the use cases provides an overview of:

- Aggregated Use Case: Final need expressed by the DSO or the user of the Smart Meter ecosystem
- Original Use Case: brief description of the need or requirement
- Objectives: Benefits brought by the use case

Annex I lists the use cases collected in more detail.
Please note these use cases are a suggestion to be supported in the next generation smart meters but might not be all supported by default without adaptations or without extra costs.

Aggregated Use Case	Original Use Case	Objectives
Supply limitation by DSO	Limitation of actual power consumption	* Grid stabilisation * Prevention of congestion * Obey contractual limits
	Grid stability via power limitation at Grid Connection Point	
	Near to power limit notification	Warn the CEM and consumer about reaching the power limit
Monitoring consumption, generation and power quality data	Monitoring of Grid Connection Point (incl. PV)	
	Exchange of NRTD	Risk mitigation by enabling better control of the distribution network and having more detailed information (real-time data)
	Exchange of load curves	
	Real Time Identification, Location, & Detection of Grid Faults	Reduce grid operating/maintenance costs
Local energy management by consumer	Dynamic tariff & usage management	* Economic optimalisation of energy usage * Reaction on requests from a grid operator to reduce consumption of generation
	Provide dashboard to inform user about status and stimulate to use opportunities	
	Monitoring active power consumption	
	Energy monitoring and management	
	Unified user interface	
	Awareness and notifications	

	Monitoring energy consumption	
	Appliance level real time energy disaggregation & consumption reduction	Reduce energy consumption Higher customer satisfaction
Remote Flexibility Management by DSO or ESP	Maximize flexible energy consumption in premises	
	Time of use tariffs	
	Flexibility provision	
	Manage peak load to avoid increases in the electricity invoice (peak shaving)	
	Peak shaving via direct control of heat pump	
	Flexibility aggregation of commercial buildings	
	Convenient smart EV charging at commercial buildings	
	Appliance level real time behavioural demand side response	Access flexibility behind the meter at scale
	Flexibility management for distribution grid support	
Monitoring communications and security	Monitoring security	* Early detection of cyber-attacks
	Monitoring the Wide Area communication Network	* Prevention of connectivity outages * Troubleshooting of connectivity outages / issues
Other	Update individual functions	* Allows for ease in updating functions within the meter without necessarily updating the meter's entire binary image

5 COMMUNICATION REQUIREMENTS

To ensure viability of the use cases described in the chapter 4 Next Generation Use Cases, which are requiring data to be exchanged with the Head End System or to be processed locally, the communication channel has to provide reliable and efficient means.
These following requirements are technology agnostic and intend to be used as a basis for the evaluation of various existing or future communication technologies.

In the table below, the summary of the communication requirements:

- “Smart metering UC”: Refers to the use case from the previous chapter
- “Required data speed”: suggests the minimum data speed to fulfil the use case needs
- “Required latency": Maximum latency for the message to be transported to the destination
- ”Number of messages”: Type of message (periodic/OnDemand) with suggested periodicity and number of messages required.

Annex II lists l the communication requirements in more detail.

Smart metering UC	Required data speed [Kbyte/sec]	Required latency [sec.]	Number of messages	Max. urban area expected density meters / Km2
- Limitation of actual power consumption - Heartbeats	> = 1 Kbit/ s	<= 10 s	* on demand * 1 per minute	2500
Grid stability via power limitation at Grid Connection Point	> = 1 Kbit/ s	<= 10 s	on demand	2500
Near to power limit notification	> = 10 Kbit/ s	<= 1 s	on demand	2500
Monitoring of Grid Connection Point (incl. PV)	> = 10 Kbit/ s	<= 1 s	6 per minute	2500
Exchange of NRTD	> = 10 Kbit/ s	<= 10 s	1 - 6 per minutes	2500
Exchange of load curves	> = 1 Kbit/ s	<= 10 s	on demand	2500
Dynamic tariff & usage management	> = 1 Kbit/ s	<= 10 s	on demand	2500
Provide dashboard to inform user about status and stimulate to use opportunities	> = 1 Kbit/ s	<= 10 s	on demand	2500
Monitoring active power consumption	> = 10 Kbit/ s	<= 1 s	6 per minute	2500
Energy monitoring and management	> = 1 Kbit/ s	<= 10 s	on demand	2500
Unified user interface	N/A	N/A	N/A	2500
Awareness and notifications	> = 10 Kbit/ s	<= 1 s	6 per minute	2500
Monitoring energy consumption	> = 10 Kbit/ s	<= 1 s	6 per minute	2500
Appliance level real time energy consumption reduction with disaggregation. Appliance level real time behaviorial demand side response. Real Time identification, location, & detection of grid faults.	>1350 - 2160 kbit/s OR raw (analogue) voltage and current signals	<< 750ms sec	constant feed internally into processor. Not shared externally	2500
	> 10 kbit/s	<< 750ms sec	1 per second	2500
Maximize flexible energy consumption in premises	> = 1 Kbit/ s	<= 10 s	on demand 1 per minute	2500
Time of use tariffs	> = 1 Kbit/ s	<= 10 s	on demand	2500

Flexibility provision	> = 1 Kbit/ s	<= 10 s	on demand 1 per minute	2500
Manage peak load to avoid increases in the electricity invoice (peak shaving)	> = 1 Kbit/ s	<= 10 s	on demand	2500
Peak shaving via direct control of heat pump	> = 1 Kbit/ s	<= 10 s	on demand	2500
Flexibility aggregation of commercial buildings				2500
Convenient smart EV charging at commercial buildings				2500
Flexibility management for distribution grid support				2500
Monitoring security	> = 10 Kbit/ s	<= 1 s	on demand	2500
Monitoring the Wide Area communication Network	> = 10 Kbit/ s	<= 1 s	daily down to every 15 min	2500
Update individual functions	> = 20 Kbit/ s	<= 10 s	on demand	2500

6 RECOMMENDATIONS AND FOLLOW-UP

The Next Generation Task Force aims to propose this document as an input for further discussions about forthcoming AMI solutions to answer to European energy efficiency programs.

The DSO's and other market parties' evolutions and ideas for an improved energy management might complete and enhance the list of the use cases described in this document so it can be used as a baseline for the Next Generation Smart Meter architecture. It would also support the harmonisation of solutions at the European level to answer to future needs and harmonization of national practices.

This report is intended to be shared with Energy Distribution System Operators Associations, DLMS User Association, other ESMIG Task Forces and other AMI actors and used as a baseline for further discussions with these market parties.

The recommendations, ideas or needs from market parties' discussions may be amended in this "living" document. This document should be updated regularly, also considering the work of the MUM WG and of the associated Task Forces, in particular of the Multi-Utility Gateway Task Force. So, we can consider the following reflection points:

- Multi-Utility Gateway / Edge Gateway definition and architecture updates
- Necessary changes in the MID particularly for an external display

Annex I and II are provided separately as two tabs in an Excel spreadsheet.