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D 2.2.Challenge brief and description of uncovered functionalities

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Reviewers	S. Bedin

Abstract

This document, following the assessment of needs which have been discovered and determined with WiBGi methodology and the collaboration of the buyers group as presented in D2.1, reports on the challenges and the uncovered functionalities that the new water smart metering system will have to provide in order to match the targets implied by the needs assessed.
In order to focus the uncovered functionalities a detailed analysis of technologies has been conducted, internal processes and ICT infrastructure compared against the Baseline implementations as currently found in Water Distributor environment and against the State of the Art that the manufacturers / solution providers are proposing to the Market as the most advanced implementations.
This detailed analysis is started summarizing the EU M/441[1] requirements as implemented in the meantime for Electricity and Gas systems and trying to find all the common points with the Water System able to suggest the most likely evolution of water system regulation in the framework of M/441 mandate.

The analysis carried out that, amongst the functional requirements, the following ones resulted uncovered within the known solutions on the market:

[1] EU M/441 - STANDARDISATION MANDATE TO CEN, CENELEC AND ETSI IN THE FIELD OF MEASURING INSTRUMENTS FOR THE DEVELOPMENT OF AN OPEN ARCHITECTURE FOR UTILITY METERS INVOLVING COMMUNICATION PROTOCOLS ENABLING INTEROPERABILITY (12/3/2009)

- Open Standard Protocol and data model enabling interoperability.
- Centralised Network Control and Management (backup and synching) with bidirectional communication.
- Network sided leakage alerting and identification.
- Water pressure and reverse water flow measurement / detection (self-diagnostic and alerting).
- Availability of local (to the smart meter) display for end customer or field technician and local communication for field technician.

Revision History

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V3.5.8	4/2/2018	S. Bedin	QA Final Revision
V3.5.9	24/04/2018	P. Bottiglione	Reception of review comments

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Introduction

Lead by a group of seven water utility companies, the aim of the SMART.MET project is to drive the development of new technologies to deal with drinking water smart metering data collection and management through a joint Pre-Commercial Procurement (PCP).

As stated in the project description (http://cordis.europa.eu/project/rcn/207206_en.html), smart water metering will be one of the key elements leading to more efficient water management in this new century. By enabling automatic reading and billing, real-time assessment of the water balance or direct detection of meter defaults, smart meters can help decreasing operating costs, timely identifying performance issues, improving customer service and better prioritizing infrastructure investments.

However, while these benefits may be very clear to water utilities, this is not the case of all stakeholders. Thus, the general public audience is often not familiar with the core issues and technicalities of smart metering and management of a utility. In addition, some of the challenges this project seeks to address (lock-in situations, lack of standards, etc.) are unknown or widely underestimated to some of the main stakeholders (public authorities, water meter vendors, etc.) because of their very peculiarities.

This lack of information needs to be addressed to raise awareness up and to **involve the external stakeholders (especially smart metering equipment producers and even common citizens)**. It is an essential requirement for the project to be sponsored and favored as an opportunity by the industry and fairly accepted by the citizens involved with their own house installations as a advantageous innovation.

The aim of this deliverable will therefore be to provide detailed identified needs to design properly the procurement model.

To better reach the goal it was carried out a broad and rigorous analysis to identify the following statements:

- **BASELINE**: the most advanced collection of systems and processes **currently in use** by the buyers;
- **STATE OF THE ART:** the most advanced solutions made of systems and processes the market is already offering or it is about to offer;
- **PROJECT SOLUTION:** the wished result of our project activity which want to be innovative or even disruptive if related respectively to the State of the Art or to the Baseline.

Thus, this deliverable will establish a list of technologies answering to the identified needs.

The figure below represents in the methodological steps addressed by this deliverable.

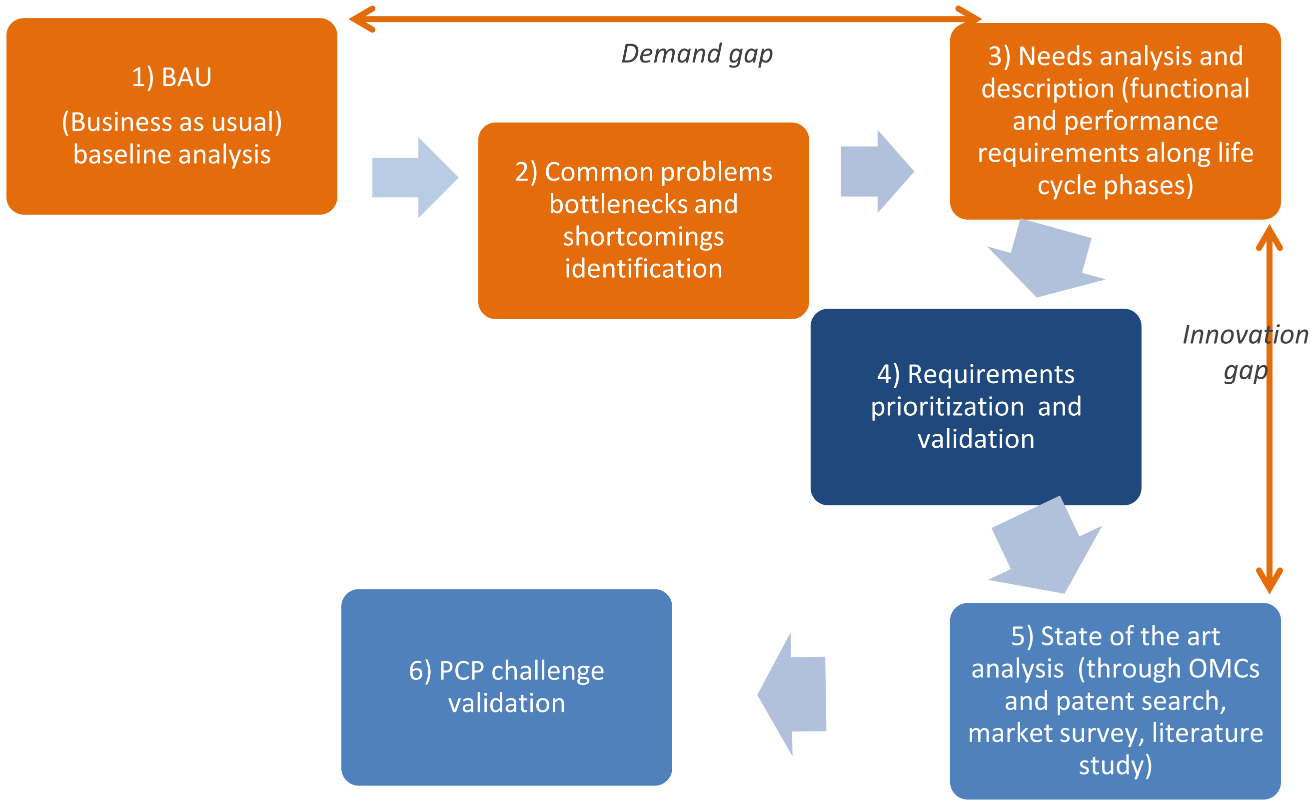

Figure 1 - Methodology and steps covered in the document (in orange)

List of Annexes

Glossary and Abbreviations

IWS: Integrated Water System

DWD: Drinkable Water Distribution

HES : Head End System or Control Room System

WSS: Water Sewage System

WP: Water Purification

SM: Smart Meter

EM: Electricity Meter

GM: Gas Meter

WM: Water meter

CBA: Cost Benefit Analysis

NRW: No-Revenue-Water

SoA: State of the Art

1. Smart Metering in Europe. Electricity and Gas Smart metering

First of all let's recall the definition of Smart Electricity (or Gas) meter :

This is an electronic device that basically records the consumption of electricity (or gas) and communicates that information for monitoring and billing activities to a central Meter Data Management application software.

The "smartness" of such devices is directly related to the ability to implement some flexible tariff structure personalized for the end customer, or some demand side management functionality if not some control actions on the service delivered at the user premises.

This means that a smart meter is also able to accept commands coming from the central application SW.

It should be also able to implement basic or more complicate (Time of Use) tariff plans, simply done by remote re-programming, to be able to execute remote FW upgrade and implement secure communication for privacy, integrity and availability of data exchanged.

This basic definition has nothing in itself that could not be applied to the Water application environment.

In this scenario the communication of data is normally bidirectional with different schemes of access to communication media.

The sending of meter data can happen on a timely scheduled base or after a request coming from the central software, so supporting unsolicited sending of data or well defined request – respond schemes between one or more clients and a population of servers (= the smart meters).

The physical media currently supported can be : Power Line Technologies (PLT), RF Meshed radio or GPRS and again (excluding PLT) all these communication solutions can be applied to Water application environment.

Smart meters also come with in-home displays interfaces, which give users real-time feedback about their energy (and/or gas and/or water) usage, what is the current cost of service consumption and definitively they are able to increase the awareness of consumers about their energy / resource consumption fingerprint.

Clearly this new approach to metering, revolutionized the residential metering application as seen before by the Utilities, opening new opportunities to innovate products and processes with a great benefit for the utility market and for industry.

Mandate M/441

The EU Directives concerning common rules for the internal market for electricity and gas (2009/72/EC and 2009/73/EC) and the EU Directive on energy efficiency (2012/27/EU) required EU Member States to ensure the implementation of 'intelligent/smart metering systems' that shall assist the active participation of consumers in the energy market.

Regarding electricity, the first smart metering systems started following some positive assessment of the long-term costs and benefits analysis (CBA), and after that it was decided that at least 80% of the households should have been equipped with smart metering systems by 2020.

The front runner in electricity field were Italy and Sweden, while other EU countries tried to better assess functionalities and investments, because of the not shareable customized approach had in these two very first deployment (e.g in the communication protocol adopted or in the data modeling adopted).

Some of the countries found a positive CBA and therefore were positively oriented to start a smart metering deployment (e.g. UK and NL), some other (e.g. Germany) found a not positive CBA for a complete residential market implementation, so is still (2017) inspecting and selecting the best way to approach smart metering for residential market.

In order to address the challenges of such new implementation and in order to widen the market and optimize R&D efforts the European Commission and EFTA mandated CEN, CENELEC and ETSI (Mandate M/441) in 2009 to develop an open architecture for residential utility meters involving at least interoperable data communication and implementing at least a set of minimum functionalities valid all over Europe (smart metering use cases).

The objective of European Commission Mandate M/441 was the creation of European standards to enable the interoperability of utility meters to improve customers' awareness of their actual consumption.

In response to Mandate M/441, the European Standardization Organizations (ESOs), CEN, CENELEC and ETSI decided to combine their expertise and resources by establishing the Smart Meters Coordination Group (SM-CG). The first phase of the Mandate M/441 requested the ESOs to produce a European standard for communications. In this context, the SM-CG produced a Technical Report, CEN-CLC-ETSI TR 50572:2011 'Functional reference architecture for communications in smart metering systems', which identified the functional entities and interfaces (see following figure) that the communications standards, to be used in smart metering systems, should address. It was intended to support the development of software and hardware architecture and related standards.

As you can notice in the right upper part of Figure 1 for all the Utility meters (Electricity /Gas/Water/Heath..) the same communication interfaces are defined and therefore all these applications have to share the same architectural approach.

Given this global picture, the analysis of needs for Smart Water meters had taken into account this as a starting point.

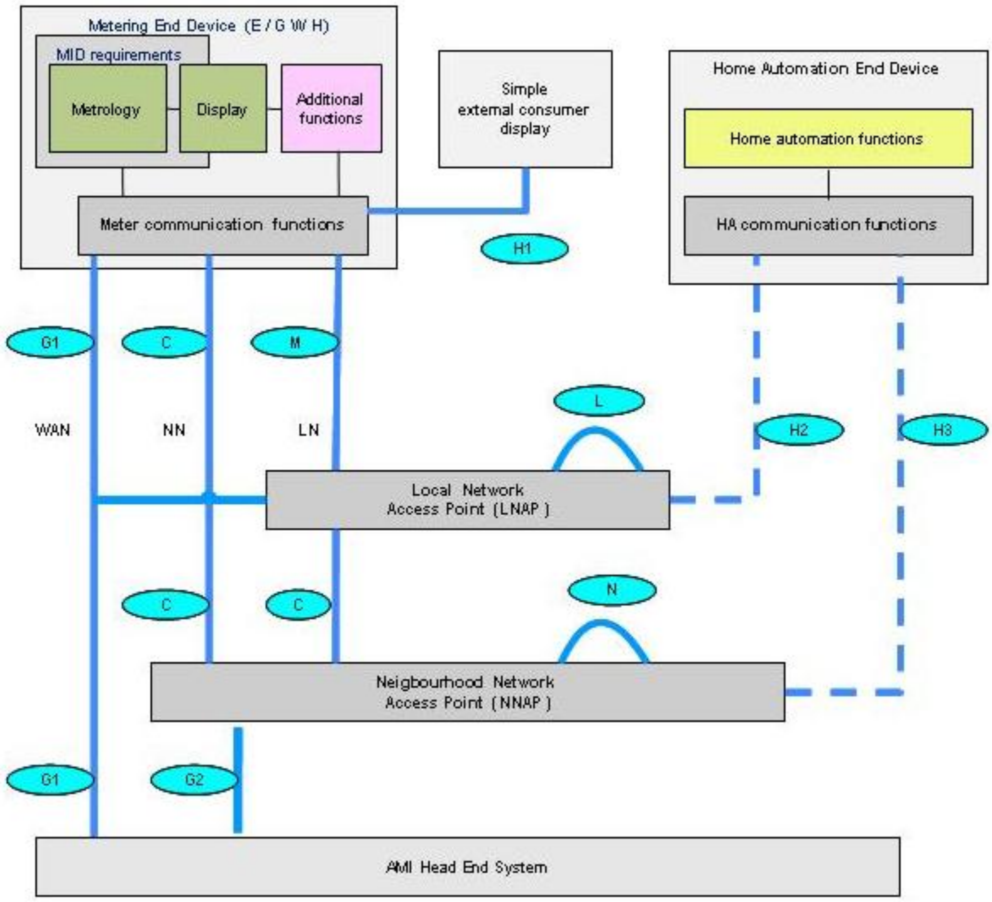

Figure 2 - Functional reference architecture for communications in smart metering systems

The second phase of Mandate M/441 focused on the development of European Standards containing harmonized solutions for additional functionalities within interoperable frameworks. From then and on a national basis the details of this standardization work was fully exploited (see IT, NL, UK, Germany) widening the scope from the original smart electricity meters to smart gas meters.

UK and NL decided for a full integrated architecture in which electrical and gas smart meters are both standardized according to M/441 mandate, but in their architectures the electricity meter is an home gateway for which the other meters (e.g. gas) despite being smart as the other, operates as a sub meter that has a mediated connection to the central Advanced Metering application software by means of the electricity meter itself.

As already said the EU Commission required each member state to equip at least 80% of all end users with smart meters by 2020. But before any deployment of smart metering application a Cost-Benefit-Analysis (CBA) should have been conducted showing that in the smart metering scenario some money can actually be saved by the users.

All main member states conducted these preliminary (electricity and/or Gas) CBAs and the results obtained were clustered into three categories:

Positive CBA : (which means B/C > 1) and large-scale roll-out planned/started

Neutral : CBA not clear, some countries plan roll-outs, some don't

Negative CBA: (which means B/C < 1) and no roll-out planned

In total, and considering the electricity scenario, it is expected around 200 million smart meters will be installed in Europe by 2020.

This huge roll-out scenario requires that some important issue needs to be addressed first of all privacy, security, reliability of communication but also who are the most likely actors involved in this huge data transfer scenario.

At the EU level it has been understood that the eligible parts in the data transfer scenario should be :

Energy vendors market: Smart meter data can be used to simplify switching processes, to apply time-of-use tariffs and for billing processes as well. Furthermore, smart meter data can help to increase the efficiency of market party communication: the data exchange between vendors/retailers and DSOs for billing and balancing processes.

Distribution network operators: Smart meter data can help to operate the distribution networks. The distribution grid operators can use the data to develop more accurate projections to operate and optimize the networks, contract flexibility in the service delivered etc.

Energy Service provider market: Smart meters could allow a much more detailed tracking of energy consumption and production. Developers can use this data to provide new services to the consumers. For example, the data could be used to provide energy efficiency applications or to develop a better usage reducing the system loss (or the water dispersion in a water smart metering system) or implement dedicated payment services for new appliances (e.g. electric cars home recharging) or prepayment schemes

Having found these three eligible parties, it was also understood that the very big data management system enabled and sourced by the smart meters, should have been correctly managed for the success of the deployment.

As a consequence an important trend appeared with smart metering system introduction, is the convenience in the centralization of all the data produced by the smart meters (data hubs), in order to facilitate the access and the data exchange to all the market players removing also any market entry barrier for new service providers that would try to compete with the incumbent businesses.

State of the Art after M/441

Although the European Union in its Third Electricity Package committed member states to an (electrical) smart meter roll out target of 80% by 2020, current installation plans of Electricity Smart Meters in Europe is proceeding in fits and starts, beset by several doubts regarding the most future-proof solution, fitness-for-purpose concerns, the right approach to use big data.

This uncertainty could be amplified by the fact that the success of the roll-out across the EU is dependent on criteria largely decided on a local basis, including regulatory arrangements, and by concerns about the extent to which the smart metering systems will be technically and commercially interoperable, in relation to a minimum set of functionalities derived from basic Use Cases, as well as be able to guarantee data privacy and security.

The results were:

Italy, which started in 2001 expects to reach 99% penetration by 2020 but mixing 1st and 2nd generation of E.M. and reaching an 80% for Smart Gas meters by 2020,

UK and IRE started their deployment (of Smart Electricity and Gas) in 2014 with the target to reach 100% by 2020

Netherland also started the deployment of a Smart Electricity and Gas system with the target to reach 100% by 2020

But some countries (Germany, Slovakia and Latvia) have opted for a selective rollout, in Germany's case amounting to only 23% by 2020.

Some interesting graphics showing the results of the analysis or of the current status of implementation all over Europe, are available on the internet resource :

http://ses.jrc.ec.europa.eu/smart-metering-deployment-european-union

Status of deployment of Smart Metering systems for some EU country

UK

In the UK, there has been a very significant start with the installation of about 8 million Smart meters (E + G) already in 2014. with the target of 100% penetration by 2020

In UK it was decided that smart meters would be the responsibility of supply companies, not of the distributors. This is a fundamental difference with other major European countries. The traditional view, shared among countries different from UK, being that the Meters (but really for any service) had always been assigned to distributors for the good reason that they are an essential part of the network operation and billing.

UK assumption will be checked only after 2020.

The architecture of UK Smart metering system is depicted in the fig. #4 below. It is evident that we are in a frame of integrated smart services .

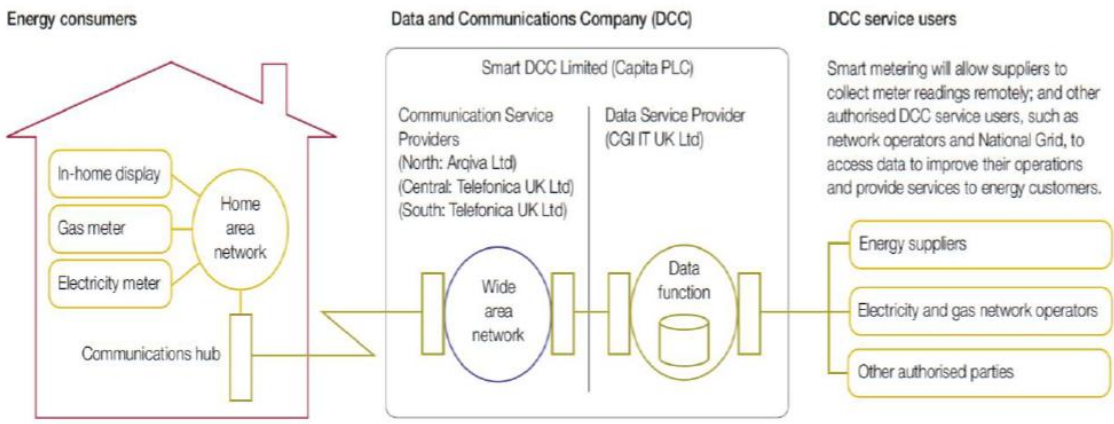

Figure 3 - Smart Meter system Architecture in UK (Source: British National Auditi Office)

Germany

About Germany, there is no expectation to achieve significant penetration of Smart metering before 2027.

In the German approach there is a statutory obligation to install intelligent metering systems for customers with an annual consumption of more than 6000 kWh. Operators of plants funded under the Renewable Energies Act (EEG) with an installed capacity of more than 7 kW are also likely to be under an obligation to install such systems starting at the end of 2017.

After the completion of the rollout in 2027, it is expected that around 20% of all electricity customers in Germany should have smart meters installed. The other 80% will be equipped with a so-called modern metering device, which is an electronic meter without a communication module.

No information about their approach to smart water metering systems.

Netherlands

The Netherlands Government mandated in the 2014 a smart electricity and gas metering deployment following a cost-benefit analysis of €770 million of positive benefits. This equated to approximately €50 per metering point and an energy savings between 3% and 6%, close to the average for European countries.

Energy network companies Alliander, Enexis, Stedin and Enduris, committed to deploy 15 Million of smart gas and electricity meters by 2020.

In the following fig. #5 a schematic representation of the functional architecture of the smart metering system in Netherlands that natively integrates electricity, gas and other public services such as water .

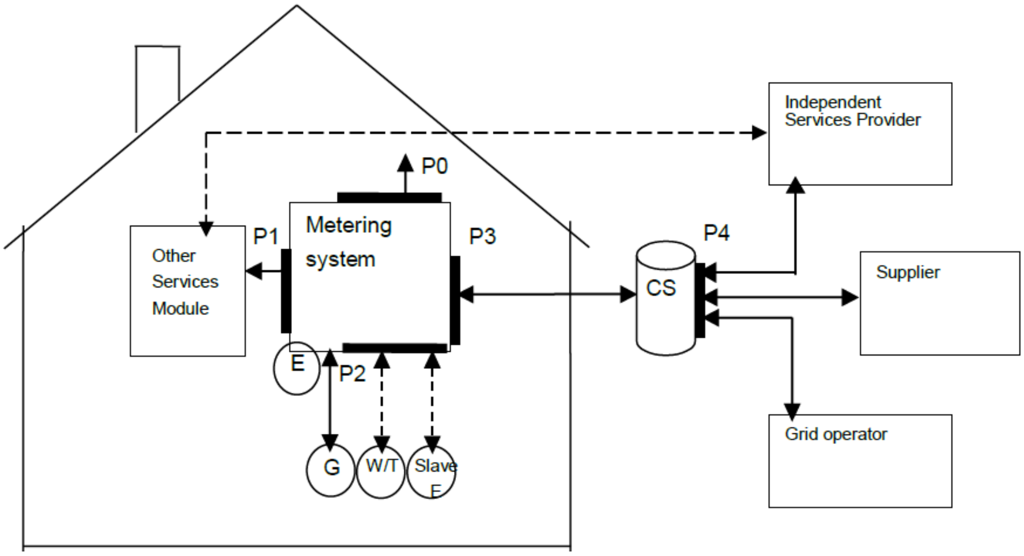

Figure 4 – Functional Architecture of the Smart Metering solution in the Netherlands

Italy

Despite Italy had been the front runner in 2001 in implementing a smart electricity metering system, several of the functionalities and enabling factors focused in other countries due to smart metering implementations, were not available in this Italian first deployment of 28 Million of Electricity Smart meters.

Therefore the possibility to manage in an integrated way electricity and gas was not exploited. The fundamental reason for this is that in Italy multi service distributors are mostly an exception, so from the early 2012 we have assisted to Italian Authority AEEGSI acts and regulations pushing on the smart gas system implementation in order to define an smart metering system composed of interchangeable components opened to other public services.

2. Evolution of Water System towards a Smart Scenario

After all the work and all the analysis done so far about smart metering systems all over Europe it remains another big service to be framed in this picture. It is the smart water metering.

The basic difference of water compared to electricity and gas is its fundamental link to human life and mankind survival. So any economic evaluation about money invested in smart water metering shall be weighted in front of such basic consideration. That said, in order to move from an idealistic point of view to something more pragmatic, we adopt a common sense principle that has inspired some sector regulation authorities when it was time to fund investments necessary for electricity and gas and the related tariff counterpart. The principle is: total costs must remain unchanged.

In this sense even though it is reasonable to expect an increase of the costs about each of the components constituting the basic architecture (mostly Capex), it is expected that all the advantages gained at operating level (mainly Opex) with more efficient and effective processes in the new smart scenario, will not increase the Total Cost of Ownership (TCO). In this sense we will consider both Capex and Opex originated from the introduction of Smart Metering and the related new processes and the needed organization. We expect to obtain:

$$TCO_{\text{Smart Metering}} = Capex_{\text{Smart Metering}} + Opex_{\text{Smart Metering}} <= TCO_{\text{Traditional Metering}}$$

where: $TCO_{\text{Traditional Metering}} = Capex_{\text{Traditional Metering}} + Opex_{\text{Traditional Metering}}$

There are a couple of interesting experiences that can be borrowed from smart metering past implementations (Electricity + Gas).

Data exchange and flexible tariffs. Still important, because of EU and national directives, it is the data exchange for a correct billing to the customers based on a precise and updated consumption, but for what concerns flexible tariff, due to local regulations, water distribution is currently operated as a public monopoly so it doesn't apply as it could in an open and fully liberalized market.

Distribution network operation and optimization: Water Smart meter can be the real breakthrough from the point of view of consumption monitoring, discovery and reduction of water losses, distributed water quality monitoring and demand side control actions.

With reference to the this second point, discovery and reduction of water losses is not only a matter of leakages to be located and possibly completely identified and reduced, there is also another key point that is until now really not clearly understood but quantified about 20% of revenues and it is known as No-Revenue-Water (NRW).

This is the amount of water that is not billed because it disappears from the distribution network either because of the leakages due to pipe or junction faults or due to unauthorized tapping (for example in agriculture), but also due to the inaccuracy of the old meters installed on field, typically measuring with big inaccuracies or even not measuring at all the small water flows under a certain minimum threshold.

It is a general belief that with new smart meter technologies and communication features it would be possible to face also this big issue.

Finally the existence of a bidirectional communication between central system and smart meters could enable some very specific and dedicated demand side control actions : e.g. water flow limitation or even shut off in case of some emergency occurrence on the water network. Currently, apart from North America which is already leading the deployment of residential two-way communication water meters as part of advanced metering infrastructure systems, a few countries in Europe are already moving in this same direction. For example France is a fast-expanding market with smart water meter penetration approaching the 50 per cent of the market, and in Europe we find also UK, Ireland, Spain and Germany moving fast .

But despite all this, the generality of water utilities in Europe doesn't seem to have completely realized the importance of a smart water metering systems. The major part of them has standalone traditional water meters in field, some other is doing limited pilots with SoA technologies that are trying to exploit the potentiality of an AMI system applied to water. Currently there is no real involvement of customers, neither for the leak detection nor for some basic demand side control of water delivery or even simply for customer advising/awareness.

The new smart water system potentialities are related to the possibility to introduce some App devoted to the end- customers awareness and energy efficiency. Such Apps make possible to present to end customer some key indicators in graphic form showing: recent usage with a comparison against expected average usage; usage trends; detailed charting of historical usage; leak alert function; and recommendations to a careful water utilization, with the ability to set up a customized profile to receive personalized tips and access to a savings calculator. Clearly these Apps require to be fed by the original data sourced by the smart meters and transported by a communication network. Given this concept for granted, it shall be applied also to water smart meters the security concepts of privacy, integrity and availability of data exchanged which are essential requirement of the M/441 mandate.

2.1 Integration with other smart scenarios (Electricity and/or Gas)

A common experience valid all over Europe is that when the public service to be distributed is vertically integrated and operated autonomously, the distributor responsible for that service will not see the convenience to share the costs (e.g tlc infrastructure costs) with some other public service. This is even more true for the water distribution market when it is organized as public monopoly.

This applies unless the local regulation Authority does issue a legal obligation for that.

This problem is emerged as above stated, also during the analysis of needs as declared by the water distributors belonging to the consortium for the Water distribution service (see document D2.1).

2.2 Scarcity of Water resource and more effective management using smart meters

At EU level it has been clearly stated that all member states shall implement smart metering systems and processes in order to increase the feeling that water in all its usages is not only a public and universal service, without the need to give it a real economic value, but also a scarce and valuable resource with a big impact on the wellness and health of citizens. It has been stated (e.g by Italian AEEGSI authority) also that a powerful leverage to increase awareness is the pricing policy:

"Pricing is a powerful awareness-raising tool for consumers and combines environmental with economic benefits, while stimulating innovation. Smart metering is a pre-condition for any incentive pricing policy".

Last underlined statement is a matter of fair approach to any price policy that includes incentive schemes.

Therefore the conclusion is to experiment and deploy Water Smart Metering Systems

"The installation of smart meters should therefore be encouraged as it is functional for the elaboration of tariff structures based on the volumes consumed and when this consumption occurred. In addition it allows to know more in detail about the different specific uses in the integrated water system."

The billing policy consequence of the previous assumptions, should be also managed with different periodicity related to the quantity of water effectively consumed in 1 year. Clearly, this strategy will have the desired effects, only in presence of an accurate and up to date availability of the measurement data. Additionally the continuous information of the end user is part of a better water resources management policy. The use of an home display, or better an equivalent mobile app, should be encouraged in order for the end user to be able to control all what is related to his own consumer habits.

Finally, following EU directives, the end customer is recognized to be the measurement data owner, and this can be fulfilled only if the requirements of **data privacy, integrity and reliability** are properly implemented in the Smart Metering System.

The outcome of these recommendations and directives is that any leverage reducing efforts and widening the potential market is welcome. Beside this **the adoption of Open standards and the definition of Interoperable / Interchangeable devices** will be the logical foundation of smart water applications.

In conclusion and referring again to the M/441 mandate and all the associated standardization work, it is clear that a new smart metering application dedicated to water management and consumption is needed.

It deserves to be furtherly analyzed and investigated in the next paragraphs.

2.3 Automation of Water Distribution network

The trend that is appearing in Water Sector, due to directives and regulations published in the last 2-3 years, is related to the so called Integrated Water System (IWS).

Water management is operated taking into account the 3 specific dimension of : Drinkable Water Distribution (DWD), Water Sewage System (WSS) and Water Purification (WP).

In order to better manage the IWS, the basic need is to know the exact contribution of each part to the Water Cycle and the fundamental focus is on DWD .

For example Italian regulation (AEEGSI DCO 42/16), much like we did in D2.1, identified the following phases as essential in the management of the IWS :

1- Installation & Replacement

2- Use & Management

3- Maintenance & Disposal

and the functionalities to be addressed and to be evolved towards the IWS new scenario are process management and customer management.

The meter data management, always present along the IWS, requires in particular a great focus on measurement accuracy, stability, flexibility on meter side, while scalability, seamless integration and easy administration on systems side (Control Room Layer).

Clearly if one tries to integrate in such a IWS scenario, the needs of having available all the measurements, at any level gathered, at the central control system and to overlap these to the needs of some demand side management and control action in order to optimize the process, he is defining a novel water metering system, where the system smartness will be obtained by the way in which all the data and functionalities are managed and by the degree of automation and customer awareness obtained in the system .

In what follows some short example of what is achievable in such novel scenario enabled by new regulations and technologies is depicted.

2.4 Leak detection and management (resource management)

In this novel integrated approach there should be available accurate measurements of water flows at any level of the distribution system e.g. at conduit, buildings and dwelling levels.

If this set of measurement would be also time tagged with the proper accuracy (e.g. let's say about a couple of seconds) and transferred by a capillary communication system from periphery to the central application Sw, then it would be possible to monitor, locate and know the amount of drinkable water loss in the distribution system.

Considering the importance of knowing the losses for the correct management of such a valuable resource, it should be clear the interest to move on and experiment.

In such approach elements of research and innovation to be pursued could be water measurement technology, bidirectional communications, distributed vs centralized algorithms, methods and technologies for integrated distributed flow control.

2.5 New tariff scheme implementation (demand management)

This new requirement is justified at regulation level in the frame of IWS because of the statement :

Pricing is a powerful awareness-raising tool for consumers and combines environmental with economic benefits, while stimulating innovation. Smart Water metering is a pre-condition for any incentive pricing policy and flexible tariffs".

So it is encouraged as a preferential leverage in order to make a better use of a scarce resource like water. This way a water flow control become a necessary condition for managing the demand side.

When the functionality is coupled with a bidirectional communication system transporting all the measurement data from meters to central acquisition system, it is mandatory the implementation of the 3 pillars of secure communications that is to say : **Privacy, Integrity and Availability** of the transported data. This aspect will be dealt with also within other requirements.

2.6 Better awareness of end-customers (advanced display)

Last important dimension of the definition of Smart Water metering is the awareness of the end customer.

This will imply some new fact to take care of:

1- **Property and authenticity of data**. The meter is the definitive source of metrological relevant data and the customer with his behavior defines how these data are structured. The smart meter Hw/Sw architecture can easily guarantee the authenticity of the metrological data all the path long, from periphery to center.

2- **Data availability to customers** for easy accessibility and content fruition, asks for a display with graphic capability. The customer should be able to interact directly and locally with the Smart meter (to display the most recent and updated consumption data) or to access remotely to data already gathered by the central acquisition system.

These data can be further processed in order to extract other synthetic and more useful customer oriented view of the resource consumption. For example: the recent usage with a comparison against expected average usage; the usage trends; charting of historical usage; leak alert function, etc..

3. Specific needs definitions, along the entire value chain, as defined in WP D2.1

Smart.Met project, as a first target, allowed to all the partners in the consortium, especially buyers, to validate a common, shared background regarding smart metering innovation and pre-commercial procurement.

3.1 Methodology adopted for the stakeholders involvement

As described with much more depth in D2.1, a combination of the "WIBGI Brainstorming" and "Nominal Group Technique (NGT) " methodologies have been chosen in order to collect all the information about the needs of the SMART.MET procurers, reunited in the SMART.MET Buyers Group. A detailed definition of these requirements can be found in D2.1

Such a combination of methodologies prevented the drawbacks of a "classic" Focus Group where almost all the work of the moderator is in driving and developing the session in the right "path", trying to get away from the issues of less importance, generated within the group discussion.

With the proposed approach participants were allowed to add value because from the very first moment they had to discuss their points of view (after viewing consultant's team presentation and being aware of the proposed examples).

Several buyers group NGT meetings have been managed to prioritize and collectively select common innovation needs and validate them against their relevance.

These meetings aimed to:

- Explicit the technology baseline: bottlenecks and inefficiency to be solved.
- Clarify the outcomes to be achieved, the drivers of the investment and KPIs.
- Clarify the specific processes and areas of service affected by a cost-quality problem impacted by the adoption of a Smart Metering Solution.
- Describe the functional requirements, the desired solution expected to be delivered.
- Don't focus on how the solution to satisfy the need should be designed and built.
- Describe functions along the solution life-cycle phases (production, delivery, installation, use, management, maintenance and disposal) in order to encourage suppliers to propose solutions with the highest long-term performance while lowering total life-cycle costs.
- Contextualize the desired solution into the real working environments and (national) regulatory frameworks

- Support the market in proposing alternative solutions, though equivalent from the point of view of performance, avoiding to pre-define any technical solution or design.

- Avoid to describe the need in general and short sentences but encouraging the actors to specify each need: upfront, clearly and unambiguously.

- Clarify trade-off and possible technical contradictions (eventually imposed by different regulatory systems).

3.2 List of the needs emerged after stakeholder discussion

Afore described needs analysis brought to a list of current drawbacks, described in chapter 4 of WP D2.1 that should be addressed by the needed innovation (see also following Table 1):

- proprietary technology lock-in
- installed meters without MID certification
- lack of Interoperability
- Short Battery lifetime of electronic part supply (less than 16 years)
- global costs of technology solutions
- no data standardization for communication
- costs of installation
- costs of operations
- wet environment damaging the electronics devices
- weak radio signal coverage (concrete shafts, walls, etc.) or jamming interference.

At the same time, the joint identification of the desired benefits of a Smart Water meter system has conducted to the following list:

- Better detection of water loss to facilitate immediate action
- Better management of networks and water balance: decreasing operating costs
- More efficient management of the billing process
- More efficient water use, thanks to increased awareness of water users' behavior
- More sustainable meters: longer battery lifetime, more easily recyclable
- Prevention of lock-in situations.

As explained in chapter 5 of D2.1 the above desired benefits are expected to be achieved through the following overall need description.

The need is to develop (a) solution(s) able to transfer data and information bi-directionally between meters and a Control Room system. In order to avoid the problems of the difference of "languages" or of technical specifications for the communication among the different Reference Architecture Layers, the development could be focused on the adoption, and, when needed, the definition of a common open communication and application standard, to assure interoperability and interchangeability among components from different vendors.

Once identified and assessed by the procurers, through an analysis of the problem to be solved and the definition of clear outcomes, this need has been decomposed in a list of 35 functional requirements, necessary also for the following next steps: validation of the need through the state-of-the-art analysis, prior patents/IPR search and open market consultation.

3.3 Smart system architecture and analysis of expected functionalities

As shown in Figure 4, the smart system architecture, as emerged from the analysis currently active in most European countries can be organized around 3 logical layers.

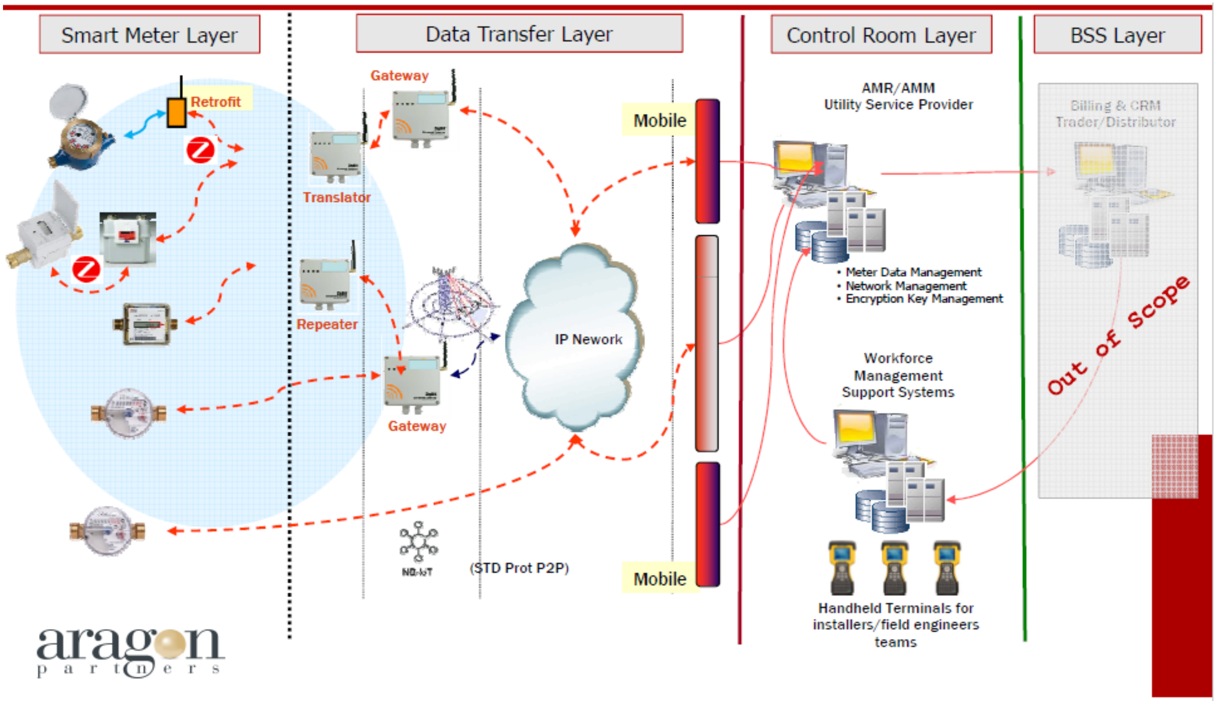

Figure 5 - SmartMet Logical Reference Architecture

The components represented in Figure 5 and the logical structure of the architecture is fully equivalent to the one described in CEN-CLC-ETSI TR 50572:2011 (see Figure 2). Namely we have:

I. Smart Meter layer

This is the portion of logical architecture that contains Smart Meters of all types and technologies. It is ought to mention: new generation Building Smart Meters or old traditional Building Meters retrofitted and enabled to offer some Smart Metering functionalities. New generation household Smart Meters or old traditional household Meters retrofitted and enabled to offer a limited set of Smart Metering functionalities. There are no constraints about the measurement technology, be it mechanical or electronic.

II. Data Transfer layer

This portion of the architecture takes care of transferring the information from the periphery (Smart Meters located by end-user houses) to the Control Room. Here we can have several very different approaches and solutions. From a "heavy weight" local wireless network made of protocol translators and repeaters to better support the dialogue with gateways appointed to talk with a small set of Smart Meters and to use the mobile or fixed line operator network to communicate with the Control Room, to the lightest approach leveraging directly on the mobile network of a telecom operator where Smart Meters could connect to directly.

III. Control Room Layer

This layer is also called *Head End* and contains all the IT support systems for the Smart Meter solution to work. Network Management, Meter Data Management and Encryption key Management systems are all part of it. Sometimes, also an integration of Work Force Management system could find its place in the Control Room layer along with Reporting systems enabling monitoring and control procedures to be carried out. This layer is, obviously, tightly integrated to the billing system and the customer care support systems that are decidedly out of the scope of this document.

3.4 Analysis of expected functionalities

In next paragraphs, and keeping in mind system and meter architectures, the issues and the functionalities emerged and reported in WP D2.1 are here repeated and deeply analyzed.

3.4.1 Areas of service vs issues and needs

Table 1 which follows, correlates and analyses Areas of Service versus related issues and needs in case of adoption of a Smart Metering Solution. These elements have been considered at a process level.

Areas of services / processes	**Short Description Issues / needs**
1. Material Management	
1.1 Meter and specific Smart meter material management for Returns under warranty	Enable WFM operators to check the "under warranty" status of the Smart Meters they are handling. Remote malfunction detection. Find out device problems better and faster
1.2 Meter and specific Smart meter material management for Returns due to other reasons but malfunction	Automated " factory defect detection " from remote
1.3 Receipt of incoming materials in stock	Related factory configured smart meters incoming in synch at the warehouse, Secure Encryption keys transfer and storage
Areas of services / processes	**Short Description Issues / needs**
2. Purchase Order Issuing Process	
2.1 Product approval process and revision. Periodic technical specification approval	Keeping up with new technical specs and approval requirements.
3. Meter valve closure	
3.1 for defaulting User	Constraints to Applicability for ethical reasons
3.2 for reverse flow	Automatic with valve directly managed to the Smart Meter
4. Meter valve (re-)opening	Enabled by remote but operated on site by the user himself, constrained to avoid unnecessary water dispersion

4.1 Meter reopening for welded arrears	If the complete closing would be not applicable for ethical reasons, more than reopening should be better to speak of unlocking of the valve
5. Periodic regular Meter readings	At least, one per day from remote for billing and awareness of end customers. One per minute for Distribution Network Monitoring.
6. Supporting radio communication network	
6.1 Plan	A radio planning must be executed to simulate and check the potential radio coverage, optimized to reach as much as possible of the Smart Meter park Installed
6.2 Install	The installation process homogeneous regardless the make and model of the Smart Meter
6.3 Operate	Necessary to take into account the public RF spectrum regulations and the availability of the same bands all over EU .
7. Emergency technical intervention	Alerted by the Smart Meter but operated on site by field technicians already aware of the specific problem encoded in the type of alarm sent
8. Massive replacement planning	The process should be homogeneous regardless the make and model of the Smart Meter and kept as simple as possible in order not to require special skills other than the ones needed for the installation of traditional meters.
9. New meter installation and activation	The process should be homogeneous regardless the maker of the Smart Meter and kept as simple as possible in order not to require special skills other than the ones needed for the installation of traditional meters. No retrofitting after installation. Minimize specific technical knowledge device related. No lock-in situation due to dedicated hand held terminals

10. Operations control	The operations must be controlled remotely by a Control Room Application Software capable to monitor and operate both Network devices and Smart Meters
10.1 Software platform	The software platform must comply to all interoperability/interchangeability requirements for the whole solution
10.2 Alarm Reporting System	To control battery failure, or abnormal battery consumption, or any other malfunction related to metrology by remote

Table 1 - Areas of Service versus related issues and needs

3.4.2 Functional requirements per phase and related KPI's

Always keeping in mind the architectural framework and the contents of previous Table 1, in the following **Errore. L'origine riferimento non è stata trovata.**, **Errore. L'origine riferimento non è stata trovata.**, **Errore. L'origine riferimento non è stata trovata.** and **Errore. L'origine riferimento non è stata trovata.**, the list of emerged functionalities, per each phase, and associated KPIs we dedicated meetings to with the buyers group, are reported.

Column labeled F/NH (Fundamental function / Nice to Have function) gives the qualitative judgment derived from the technical Buyers Group meeting discussion and based on the prioritisation laid down D2.1. With respect to the table reported in D2.1 2 two requirements have been added during D2.2 exercises:

- U26 The Smart Meter must be MID certification compliant also with reference to meter accuracy.
- U27 The Smart Meter must have a Measurement Rate / Reading Log rate of, at least, every 15 minutes.

KPI definitions and their measures, along with the basic functionalities, have to be managed very carefully.

Indeed, with the support of technical people, the Buyers Group is the responsible of the application of KPIs factors and functionality checking in order to have a clear picture of the rating of each product/system supplier. A misunderstood KPI can bring to make a wrong decision.

The main purpose of the rating/scoring is to give an operative tool aimed to purchase the best technically rated offered solution at the lowest price. It is not easy at all for people that are not experienced professionals specialized in those technologies to be able to provide any opinion on this matter without an indication.

This tool will be further developed and tuned in WP3 (D2.5) but some of its foundations are hereby provided in the following table.

Phase	Functionalities	F/NH	Performance / KPIs
Installation & Replacement (Phase I)	**I_1** The solution component must be interoperable complying with a industry market standard defined or yet to be defined	**F**	**1** Operational tests must be carried out to check the compatibility of different devices from center to periphery and backwards and of different AMM/AMR software components in executing the same commands.
	I_2 The Smart Meter must fit the pipe section, thread, step and other technical characteristics currently in use, room occupation etc. for an easy installation and procurement compliance	**F**	**2** KPI: every procurer must specify pipe technical specs and room occupation for the Smart Meter to comply with. Indicator expressed as max acceptable

Phase	Functionalities	F/NH	Performance / KPIs
			mechanical quotes . Judgement is binary : C /NC
	I_3 The meter and the related solution should be as simple as to require no special competences but the usual hydraulic skills to install	**F**	**3** KPI: same installation time of traditional meters. Indicator expressed as : Lower, Equal, Greater of a standard installation time. Mathematical function perhaps needed to interpolate intermediate levels of judgement. Technical weight shall increase with the lowering of installation time.
	I_4 It has to be ensured the automatic centralised backup and synching of configuration parameters from the old meter to the new one at replacement time.	**F**	**4** KPI: the replacement operation, including the initialization of the new Smart Meter, cannot take more time than the current replacement installation for traditional meters. (the procurers are asked to specify how long time is required for the current replacement operations). Same additional consideration as the previous KPI
	I_5 The Smart Meter size must allow easy installation with little or no masonry works	**F**	**5** KPI: it must comply to the tiniest niche size amongst the procurers national standard (every procurer is requested to report the nationally regulated niche size to house the Smart Meter). Could be managed with the same KPI of # 2

Table 2 – Phase I – Requirements and related KPI's

Phase	Functionalities	F/NH	Performance / KPIs
Use and management (Phase II)	**U_1** Communication must be bi-directional from center to periphery and backwards, preventing the end-user from a direct connection to the meter bypassing the Distributor's Control Room and BSS layers	**F**	**1** KPI : presence of secure and authentication methods for on site operations and a secure encrypted and authenticated communication method for data transmission. This could split in a collection of several KPIs : **1.1 KPI** : is standard adopted compliant to NIST or EU standard ? Yes/Not **1.2 KPI** : in case the adopted std is compliant, which type of security infrastructure ? Public/Private keys or symmetrical Keys method. Evaluation taken from literature. **1.3 KPI 3**: In case symmetrical keys which Encrypt/ Authentication algorithm and key lengths adopted. Algorithm evaluation taken from literature Key length judged in terms of length (256 better than 128 bits) and easiness of evolution towards higher lengths. **1.4 KPI** : How many installation already done per each proposed method and how many positive feedbacks from the distributors. Qualitative judgment

	U_2 On site measurement Verification capability. The Smart Meter should offer a functionality and an automated or semi-automated process to detect a potential measurement error (negative or positive) and possibly to trigger an alert (in case of automated process). This requirement goes along with requirement U_{11b} for non revenue water detection.	**NH**	**2** KPI: is the evaluation of the time needed in both scenarios but also the complexity. The automated process should take no more than 10 minutes, while the semi-automated process should take no more than 30 minutes. In alternative to these cut off values, it should be better to have a range of values weighted in such a way the weight becomes worst at the increasing of the time declared and at the increasing of complexity. This last one measured considering how many steps to have access to it selecting from different menus and how many steps for the execution.
	U_3 The Smart Meter, Data Transfer and Control Room Layer should be based on an open, solid, tested, efficient and resilient interconnection standard	**F**	**3** KPI : in case of an architecture with gateways for interconnecting the NAN (Neighbor Area Network) and the WAN (Wide Area Network) networks, the communication standards can be different on the two sides, one from Smart Meters to Gateways (NAN), another one from Gateways to Control Room (WAN)
	U_4 A schedulable On-Demand communication feature is necessary. This is particularly useful for a complex work flow involving a strong interaction between center - periphery and backwards or a complex data exchange communication. For instance a Leakage Detection Analysis Process and a remote Firmware Update) in order to have the benefit of a real-time interactive communication for a short period while saving battery consumption when the communication is no longer needed.	**F**	**4** KPI: The Scheduling of the On-demand communication is foreseen and can be booked with some adequate notice (for example 1 day before) This feature should be present in the application protocol chosen, if not it should be the subject of a companion standard.

	U_5 The Smart Meter should not be fed by end user's energy supply, but it should be autonomously powered.	**F**	**5** KPI : The autonomous power supply must comply with some defined Smart Meter lifetime duration. Performance measurement should be based on a usage profile against which the manufacturer shall declare the power supply life time.
	U_6 The system must have a self-diagnostic alerting function in case of: 1) lack of water pressure, 2) measurement errors, 3) water reverse flow and automatic valve closure, 4) tampering and fraud alert, 5) low battery alert, etc.)	F	**6** KPI : provide a list of at least 5 of the most fundamental alert messaging . It should be based on a table that each manufacturer should fill and using a specific rule it should produce a score. Such score should be used as a technical weight and it shall increase at the increasing of functionalities implemented. Weight = 1 will correspond to the set of minimum requirements
	U_7 The technical life time, when we speak of Smart Meters, must be as long as the asset's useful life from accounting point of view.	**F**	**7** KPI: The technical life time of SM should span from a minimum (e.g. 12 years) up to a maximum (e.g. 16 years) this range is established by specific country regulations. The longest meter life time of 16 years as required by some of the partner countries and/or by accounting regulations. KPI judgement is binary: Yes/Not but graded the best while reaching 16 years
	U_8 The Smart Meter should be dust and water resistant . IP minimum level required.	**F**	**8** KPI: required resistance to 8 hours exposition to dust, and resistance to submersion of at least 1.5 m depth for 30 minutes This means IP68 requirement

	U_9 Meter valve management functionalities (flow limitation, manual on site reopening remotely enabled, automatic closure reaction time for emergency).	**NH**	**9** KPI: the Smart meter must be designed to operate in its lifetime at least one automatic emergency valve closure without impacting on battery charge (no impact meaning no measurable reduction of battery life). Better if the evaluation criteria is organized as written in point 5. It should be based on a usage profile (e.g. one closure in 2 years doing the normal activities, or once in 3 years doing the normal activities and so on until only once in lifetime). Then the manufacturer shall declare per each case the % of battery life used, as long as it will not give measurable effect =0%) . The better KPI will be when the meter will accept one operation per YY years, with the lowest % impact (ideally 0%) in the shortest YY period
	U_{10} The Smart Meter must sport a front display capable to show in sequence the most relevant register contents suitable for both end-users purposes and field technicians. The display should be made of low energy consumption components and implement an energy saving management system, turning off after a short time.	**F**	**10** KPI: The buyers should list the functions and data that must be available using the display. The functionality and the accessibility must comply with practical constraints. The evaluation could be based on a list of minimum requirements and the technical weight be increased at the increase of extra useful data (based on practical considerations) to be easily accessed and displayed
	U_{11} Remotely Operated Leakage Detection – a) Semi-Automated leakage detection at Distributor Meshed Network side, b) Fully Automated leakage detection at Household side with a potential functional extention in terms of measurement inaccuracy detection (see requirement U_2)	**F**	**11** KPI could be the following pair of values: a) operation efficiency increase of 500% from old leakage detection process to new semi-automated process, b) less than 3% errors in automated leakage detection The first KPI is very demanding and is clearly under distributor responsibility (i.e. money to be invested). The second KPI is again under the responsibility of the distributor, that should buy more accurate Smart Meter in order to have more reliable results from the leakage discovery algorithm

	U_{12} The Smart Meter must be provided with anti-fraud and anti-tampering systems to detect and prevent both measurement fraud and device tampering. These functionalities will sense the attempt to infringe the meter integrity or meter measure capability and will issue an alert message towards the AMR/AMM system in the Control Room.	**F**	**12** KPI: the system should implement at least one kind of global alert to the Control Room. It is better to have the capability to return two different alerts concerning anti tampering alert and anti-fraud alert. The evaluation should be based on a list of minimum requirements and the technical weight increased at the increase of how many extra cause of tamper or frauds (based on practical considerations) are satisfied by the Smart Meter.
	U_{13} All the solution components, from Smart Meters Layer, through Data Transfer Layer to Control Room Layer, must be compliant to the open protocol application and communication standard in order to ensure interoperability / interchangeability among components from different vendors.	**F**	**13** KPI: level of compliance to interoperability or interchangeability in the communication and application protocol shared among the devices (Smart Meters, and, if applicable, Gateways, Repeaters, Translators, etc.) and the application systems MDM, NM. The KPI level should be lower for a simple interoperability requirement, higher in case of a more advanced interchangeability requirement. A solution is defined to be interoperable when substituting anyone of the devices in the system with a similar one coming from a different manufacturer, the functionalities of the system in the AMR/AMM system shall not to be degraded, updated or changed. Data exchanges, parameters, primitives are always alive and supported at the system in the Control Room. On the other hand the solution is said to be interchangeable when substituting anyone of the devices in the system with a similar one coming from a different manufacturer, the functionalities, data, parameters and primitives of the two devices are exposed exactly the same and in addition also the installation and configuration procedures are the same. Evaluation criteria based on the level and adherence to an EU standard . See Table 6 to follow.

	U_{14} The communication must remain stable and reliable regardless of meter locations (basements, dedicated meter rooms, technical rooms, etc.)	**F**	**14** KPI could be the ratio of Unreachable Commissioned Smart Meter number / Whole Smart Meter Commissioned Park, ratio >= 96% during operating system life time.
	U_{15} Reverse Flow Detection and Management - in case of reverse flow the Smart Meter is able to sense it and to autonomously close the valve to prevent network pollution sending a special alert message to the Control Room.	**NH**	**15** KPI could be : valve closure reaction time, the less the better (e.g. 10 seconds). Again better not to give a sharp amount of time, but a table with technical weights that become lower with the increasing of reaction time. Weight = 1 at the agreed basic request of reaction time (e.g. 10 sec). Weight > 1 for reaction time less than 10 sec.
	U_{16} The meter, with reference to the combination table shown in table #3, can be of the following type: Main Meter, sub-meter, new gen and retrofitted old gen. Every typology must be compliant with the solution.	**NH**	**16** KPI : see the combination table #4 below. KPI worse in case of some lacking combination
	U_{17} The Meters should respect regulation about toxic agents and chemicals of materials.	**F**	**17** KPI: it must comply to the strictest set of rules deriving from the assessment of the procurers national standard (every procurer is requested to report the nationally regulated tolerances to toxic agents and chemicals of materials as to Smart Meter) Evaluation criteria : Y/N

	U_{18} The Smart Meter should be sediment and abrasion resistant	**F**	**18** KPI: Smart Meter replacement due to sediment or abrasion of exposed parts less than 3% of the installed park (value to be confirmed by procurers) on the whole lifetime period But defined in this way it gives no possibility to the distributor to exercise its rights against a poor quality product. It should be defined as % per year (e.e. 1.5% / year) In this way it would be enough to wait for 1 year to have the possibility to act against a poor quality product.
	U_{19} The meter could have a battery self-recharging system. In that case battery should be a rechargeable one.	**NH**	**19** KPI : in case of a mechanical self-recharging system, it should not let the pressure decrease more than a Delta_P from the nominal pressure of water distribution (e.g. less than 0.75 Bar) . The electrical characteristics of the recharging system are to be defined according to the electricity consumption behavior defined by the vendor.
	U_{20} The solution minimizes the request of equipped sites (e.g. gateways, repeaters, translators, etc.) and is economically convenient.	**F**	**20** KPI: In order of preference 1) Smart Meter Direct network connection to the Control Room, 2) connection through gateway of high concentration rate (more than 2000 smart meters per gateway). Both with the constraints of not affecting battery lifetime nor other required functionalities. The point 2) introduced only to select among several system proposals that for all the other requirements are more or less comparable. It seems better if procurers define a table with several system entries with the purpose to judge and select in terms of system delay, system complexity, system cost vs minimum functionalities satisfied. The highest the weight the less the delay and the complexity and the costs . Interpolation function needed to obtain final weight, to be proposed and discussed.

	U_{21} The Smart Meter joints/threads should be resistant to the same tightening torque of joints/threads of the the current traditional meter pipes.	**F**	**21** KPI: Procurers must provide the value for the current max tolerance for tightening torque (N.m) of joints /threads during traditional meter installation. Evaluation criteria is binary : Y/N
	U_{22} The communication should be wireless from the meter side to AMR/AMM system on the Control Room side through the Data Transfer Layer.	**F**	**22** KPI: Yes for wireless without affecting battery lifetime nor other required functionalities. In order of preference for each portion of the Data Transfer Layer connection (from Smart Meter to GWY, from GWY to Control Room) 1) bandwidth available, 2) Energy consumption for the same content transmitted over the period. A ranking will be arranged based on the combination of these two indicators. Interpolation function needed to obtain final technical weight, to be proposed.
	U_{23} Network Management System (NM) has to be provided as part of the solution for monitoring, reporting and administration of network devices, as well as Meter Data Management System (MDM) must be provided for the governance of meter reading and command operations execution. The two of them must be apart but tightly integrated.	**F**	**23** KPI: 1) open standard application interface to ensure modularity and 2) full functional integration between the two system (NM and MDM) in order to make up a seamless solution. The interface should be in any case open and even better if complying to a renowned international standard for AMM/AMR communications. The KPI value could be: 0.5 in case only condition 1) is satisfied, 1.0 in case both conditions are satisfied . But definitively 0.0 in case of proprietary not std solutions
	U_{24} Capability to measure flows in both directions - this is necessary to check measurement accuracy and for reverse flow detection	**F**	**24** KPI: minimum measureable flow (l/min) coupled to MPE - Maximum Permitted Error of let's say 5% for residential customers . Procurers are asked to provide a desired value for this indicator. Traditional or SoA water meters are approved for MID class 2 (=2% MPE from 25 L/h up to 1600 L/h in case of DN15, 5% below 25L/h)

	U_{25} NM and MDM Control Room Layer Systems must be scalable in case of PoD and related Smart Meter number increase.	**NH**	**25** KPI: performance deterioration not greater than 10% if compared to the original configuration. It would be better to deliver a table whose outcome is the deterioration of nominal performances at the increase of device population. Each performance deterioration weighted the most at the decreasing of deterioration for some fixed range of values of meter populations.
	U_{26} The Smart Meter must be MID certification compliant also with reference to measurement accuracy**.**	**F**	**26** KPI (Yes/No)
	U_{27} The Smart Meter must have a Measurement Rate /Reading Log rate of, at least, every 15 minutes.	**F**	**27** KPI: this will describe the resolution in terms of amount of samples of usage daily curve by means of the reading frequency rate, the higher the better. (E.g: quarter hourly = 96 samples; every 5 minutes = 288 samples; etc.)

Table 3 – Phase II – Requirements and related KPI's

Phase	Functionalities	F/NH	Performance / KPIs
Maintenance (Phase III)	M_1 The meter should have a measurement technology to minimize frost damages, be it mechanical or electronic	NH	**1** KPI: Smart Meter replacement due to water freezing of exposed parts, less than 3% of the installed park (value to be confirmed by procurers) on the whole lifecycle period. Again should be better to have a parameter yearly based, otherwise would it be never possible for the purchaser to act against a poor quality meter .
	M_2 The hydraulic section, regardless of the measurement technology of the meter has to be apart from the electronic communication section in order not to infringe metrological certification in case of maintenance activity with the need of removal of the electronic section or for replacement in case of communication technology update or upgrade.	NH	**2** KPI: less than 5 minutes for electronic part removal and replacement operations. Better to have a table to be filled with several maintenance time for evaluation . The resulting weight would be better at the decrease of the maintenance timing
	M_3. The system must have consumables and asset lifecycle aligned in order to minimize the costs related to consumables (batteries) replacement in terms of materials and operations	F	**3** KPI: Should be based on the formula (average energy drained per day) times (the expected number of days of lifecycle) < (the available energy in the batteries) plus (the energy that may be harvested by means of a possible battery self-recharging system) (if applicable). The evaluation criteria should be based on a typical usage profile and the manufacturer shall supply the result of calculation. By the way this calculation shall be described completely by the manufacturer and possibly to be repeated autonomously by the distributor.
	M_4 Capability to execute an On the Air Smart Meter Remote Firmware Update	F	**4** KPI: Smart Meter unsuccessful remote firmware update < 3% of the installed park (value to be confirmed by procurers) on the whole lifecycle period. It is clear that in case FW upgrade is mandatory, it remains the above described KPI as the only parameter for evaluation of system performance.

Table 4 – Phase III – Requirements and related KPI's

Phase	Functionalities	F/NH	Performance / KPIs
Disposal (Phase IV)	**D_1** Capability to separate electronic waste from hydraulic components	**NH**	1 KPI: recycling ratio not worse than integrated Smart Meters models. In any case both technologies must be fully compliant to ROHS/WEEE directives.

Table 5 – Phase IV – Requirements and Related KPI's

Interoperable Std (N/ Y (which))	Interchangeability Companion (Y/N)	Technical weight
N	N	The lowest
Y / e.g. DLMS/COSEM	N	Low
Y / e.g. DLMS/COSEM	Y (integration of DLMS/COSEM)	The highest

Table 6 - Decision Grid for KPI #U13

	Main-Meters	Sub-Meters
New Gen Smart Meters	X	X
Old Gen Retrofitted Smart Meters	X	X

Table 7 - Combination table for KPI #U16

3.5 List of emerged Smart Met Functionalities - Analysis of functional coverage and comparison against Baseline implementations and SoA

In the following
Table 8 the SmartMet functionalities emerged during brainstorming and discussion sessions within the Buyers Group (see D2.1) and solutions are analyzed with the help of technicians, several basic remarks are reported and each one of the functionalities is compared with current **Baseline** or **State of the Art Solutions**[2] available today on the market.
As seen in D2.1, the solution lifecycle is made up of 4 different phases and the functional requirement have been classified accordingly:

1) **Installation Phase** highlighted with -> requirements **$I_1..I_5$**
2) **Use and management Phase** highlighted with -> requirements **$U_1..U_{28}$**
3) **Maintenance Phase** highlighted with -> requirements **$M_1..M_4$**
4) **Disposal Phase** highlighted with -> requirement **D_1**

Each requirement has been checked against 7 different solutions that we consider fairly representative of the current Water Smart Metering market:

Baseline solutions that some of the partner procurers were *already using at home*:

- CILE – Liege (BE)- Hydroko solution;
- SDEA – Strasbourg (FR)- Itron solution;

State of the Art solutions (SoA) that some of the partner procurers were *already experimenting at home or considering to test in a short term period.* This last solution set was supposed to be technologically more advanced than the Baseline set.

- Eau de Paris – Paris (FR)- EDP Homerider solution;
- Eau de Paris – Paris (FR)- EDP Suez solution;
- Promedio – Dip. Badajoz (ES) – Acciona Arrow solution;
- Promedio – Dip. Badajoz (ES) – Contazara solution;
- Promedio – Dip. Badajoz (ES) – Elster solution;

The evaluation has been executed following a simple logic to check whether or not the implementation of a requirement was present in each solution. We have been working onto two different solution set:

A) Baseline
B) Baseline + SoA that we called, for the sake of simplicity, "SoA" .

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[2] These two definitions are the same seen in D2.1, par. 3.0, pages 6 and 8 and namely:
-**Baseline** to be intended as the collection of systems and processes currently in use by the buyers
- **State of the Art** – as the most advanced solutions made of systems and processes the market is already offering or it is about to offer.

The algorithm used was, for each requirement #z:

if requirement #z is "yes" in solution #1 OR solution#2 .. OR solution #7 then "yes" else "no"

When the requirement is present in the Baseline or in the SoA then it is highlighted in **light green** under the column *Baseline* or *SoA* respectively otherwise it is highlighted in **light red**.

When the requirement is not present in the Baseline nor in the SoA it is highlighted in **full red** under the column *Breakthrough*. We gather under this label all the functionalities that must be further investigated by OMC, scientific literature study and in-depth patent search to assure that the innovation need can be covered by a PCP.

A light yellow background under the columns Baseline or SoA means that the requirement got no answer and should thus be added to the functionalities object of further investigations.

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
I_1	Interchangeability / Interoperability	When you adopt, in a regulated public utility environment, or also in a competitive economic environment, a new system aimed to introduce new functionalities, the first analysis to be done is whether or not it is an interoperable or interchangeable set of devices working within a Solution. Let's remember some definition : 1) The Smart Meter Coordination Group (SMCG) that has been acting on the M/441 (see footnote at pag.2) mandate defines **interoperability** as the ability of a system to exchange data with other systems of different types. 2) We define **interchangeability** as the ability to exchange one device with another without reducing the original functionality. To achieve interchangeability several extra conditions must be met beyond the conditions for interoperability. Interchangeability requires devices to support the same functional behavior on their communication interfaces or to allow changes in functionality to be supported by the relevant communication protocol. Both of these two properties enable the compliant manufacturers to reach a much wider market to make business. Preventing market fragmentation and getting the benefits on product cost. The water distributor procurement will be able to tap commercial offerings at a much wider level (continental and not anymore national) increasing competition that normally lowers prices. In order for these benefits to be fully exploited the interchangeability shall be built starting from a well-defined international standard, possibly completed with some companion standard extention aimed to better define interchangeability requirements (if not yet available) and preventing the adoption of a local, customized specification.			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
I_2	Mechanical constraints, in particular : compatibility with pipe sections, hydraulic type and materials for connectors, meter size	A basic requirement in the development of a water smart meter is the mechanical compatibility with typical installations already existing. If not required by other reasons (basically installations maintenance or plant modification planned by the distributor itself) a very basic requirement is to remove the existing meter and to install the new one in the same place and with the same connector dimensions, having also the same compatible connectors (materials and size) as the previous meter. No compliance with this constraints, will result in heavy impact on installation time and costs that distributor has to face during installation of new meter system. In addition all the possible purchasable smart meters shall be interchangeable with the current ones in order to match with the existing plants. This requirement because the water distributor, in case should start a massive deployment of the new smart meter system, wants to optimize time and costs adopting any smart meter coming from anyone of the different certified manufacturers --> Interchangeability concept.			
I_3	Easy of installation by not specialized operators	A smart meter cannot be really smart if should imply a very complicate installation activity or demand for a very specialized operator. The basic requirement should be to use the local port interfacing approach and the flexibility of SW, to implement a product that after being configured in Utility warehouse or in the manufacturer factory, is then installed exactly as a traditional meter. Any other modification to the set of parameters, is possible either via remote communication or again locally via HHT implementing authenticated procedure of meter configuration.			
I_4	Centralized management and back up of data of the replaced meter and subsequent restore and synching to the new installed meter	It is a basic requirement for traditional, SoA or Smart WM system. It is common feeling that such a requirement should be implemented and the path to be followed is the progression toward completely automatized processes.			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
I_5	The Smart Meter size must allow easy installation with little or no masonry works .	An easy installation procedure is needed. The new Smart Meter should fit the housing sites of the old generation traditional Smart Meter.			
U_1	Bi directional RF communications	The possibility of remote management will ask for a bidirectional communication channel, where radio frequency dedicated or licensed bands being the preferred ones. The basic request is that due to the fact WMs are battery powered devices, the communication procedures in free but dedicated bands, should be based on the very basic scheme of scheduled data pushes with an ALHOA Listen Before Talk access to the radio channel. In other similar applications (i.e. gas) the scheduled data push uses a mechanism for which Data Concentrator activity is done in a very short interval of time following the meter push (according to European standard EN 13757-4) this in order to reduce battery consumption. In addition this communication is limited to no more than some seconds per day again for the same reason of energy saving. This very efficient communication scheme, even if inefficient in terms of channel occupancy and bandwidth usage, can be proposed also for smart water meters because of the main reason of battery saving.			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
U_2	On site metrological check	On site metrological verification should be considered as a special feature shown by smart meters. This because it is felt that in the smart meter scenario it could be possible to satisfy a potential end user request to check if the measurement accuracy is still compliant to the original MID certification. The traditional approach consists of the need to install in series to the WM to be checked, some reference water meter, so wasting a lot of time in this check activity. With a smart meter and some very simple accessory (e.g. calibrated water flow limiter) it would be possible to have a fast, accurate and reliable on site verification based on a simple procedure I.e. SW driven time based integration of the water flow. This can be implemented to work along with requirement U_{11} for a complete non-revenue water detection solution.			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
U_3	Adoption of Open standards and common / consistent data modeling.	This is another important point to take into account, the adoption of open standards means normally that the phase of device validation and acceptance will be much more easy and fast. For the Water distributor this will mean to have devices much easier to compare on the base of a list of features extracted by the profile of the standard implemented. As a consequence it would be much easier to give a definitive and clear value to what the distributor is purchasing especially for the end devices such as meters or communication gateways. In particular this need is strongly felt in the communication arena because the adoption of a communication standard, sufficiently developed at international standardization bodies, covering all the basic layers such as : physical, data link, network, security, data modeling and application layers will give the possibility to assign easier an economic value to the product/system to be purchased after the classification of the amount of compliance to the full set of standard specifications of the system requirements. In particular this need is strongly felt in the communication arena because the adoption of a communication standard, sufficiently developed at international standardization bodies, covering all the basic layers such as : physical, data link, network, security, data modeling and application layers will give the possibility to assign easier an economic value to the product/system to be purchased after the classification of the amount of compliance to the full set of standard specifications of the system requirements. It can give also the possibility to define the so called " minimum requirements specification" that has the fundamental purpose to define an interchangeable device which has the basic functionalities exactly as any other one and to evaluate which are the extras that the manufacturer makes available to the application. In the frame of reference of DLMS-COSEM standard, openness, standardization and interoperability are native . This standard gives also the possibility to implement the interchangeable devices of an Advanced Metering System.			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
U_4	On demand communications	Normally when a battery powered device is the source or the destination of data it could be found useful to manage on demand communication raised by the DC . In the common understanding on demand communication would require an always on peripheral, in order to get any moment the request of DC . It is clear that this would impact heavily the energy reservoir of the meter and for this reason is not implemented as such. Another more clever way to implement on demand communication (if the communication protocol adopted includes such a feature) is to send a command to plan a dedicated communication for a well-defined elapsed time in a subsequent day (let's say for tomorrow), it could be also repeated every day for a maximum of nn times, at a well-specified time of the day, so that, respecting the constraint of such time frame, the system executes a real time bi-directional on demand communication. It can be very useful for complex activities requiring a strong interaction between center and periphery in order to analyse, make decisions and execute.			
U_5	Power supply : no external supply from ac mains but battery powered	Water is not so dangerous if the power supply is based on an AC mains connection. But it is probably the cause of costs increase and inefficiency. For these reasons the market seems to prefer battery powered water meter. A battery power supply can put some more constraints in the way in which the meter should be engineered for example in terms of IP68 requirement or to have access to the battery zone without infringement of the metrological seals . But also for the correct battery sizing (D cell?) and technology (Lithium?) of the battery adopted and the constraints on the functional requirements (frequency of occurrence of the data transmission over RF, protocol efficiency of the data transfer, amount of FW updates during meter lifecycle) but also of some management action potentially executable by the meter (valve operation).			
U_6	Self Diagnostics and alerting: water pressure, low battery and other relevant messages	This is really a new requirement. Feasible in the context of a smart metering system. It is required in order to monitor and control the operation and maintenance of the water network.			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
U_7	Product life time	It is not only related to the MID requirement of at least 15 years but also to the max accounting lifetime of SmartMet countries members (16 years required)			
U_8	Protection and tightness to Water and dust. IP68	This requirement is related to the survival of the Smart Meter (as the already existing ones) in a water environment . Water seen either from the inside (=tightness) which means there shall be no water leak from the meter body to outside and from outside as IP protection. If one thinks that a potential approach for water meter design could be the complete separation of electronics from metrology body and that this last one could be not necessarily immersed in water, it appears clearly why shall be given requirements on both aspects. It is also possible to anticipate that tightness shall not be changed from the existing, while IP protection is a completely new matter and should be better than IP68.			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
U_9	Water flow control - Shut Off Valve remotely operated	Remote water flow control. In current implementations and also in SoA implementations, the control of water flow is still done manually and often locally. There is a manual shut off valve, installed before the point of water delivery and therefore before the water meter, used to reduce gradually or close completely the water delivery. Differently from other applications (e.g. Gas) the leak of water is not explicitly dangerous for human life, but nevertheless it is needed to control it for environmental basic reasons (scarcity of resource) and also for the reason of avoiding damages to end user dwelling or to other dwellings inside the building where the dispersion is located. Water is a renewable but scarce resource and all the actions to limit its dispersion shall be considered well in advance. It is evident that in case the smart meter system diagnose a leakage out of an end user premises, for any reason not anymore inhabited, the possibility to discover it automatically and execute a remote closing of water delivery could solve efficiently this type of issues. This is a point that should be submitted to patent search because considering WM dimensions and expected cost, compared to energy reservoir of the battery supplying the meter, the definition of the mechanical shape, weight and power needed to operate this valve, it become a very interesting and sensitive point of the smart water meter design. Other important aspects related to this requirement could be in the field of remote management of water supplied to commercial activities and for the purpose of energy reservoir, some reasoning should be spent in order to define the reaction time, the force needed to operate the PoD and the reliability of components. In case of building meter it seems almost impossible that such a valve could be integrated, on the other hand for a dwelling meter this approach seems feasible (see again the need of a patent search)			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
U_{10}	Local Display and Local communications availability	For a smart meter, the possibility of smart interaction with end-users (included short messaging to the customers) requires a local display. This requirement also in case of authenticated access to hidden menus to give maintenance related information to the distributor operators. Which type of display is a matter of final product cost, reliability and lowest energy consumption over the product lifetime. On the other hand In a smart device normally arise the need to configure, download or upload data and parameters and to update SW in a very direct way. So the availability of a local port is mandatory. For security reasons this port shall be protected by username and password and the communication authenticated in order to avoid unauthorized accesses. The physical implementations for such a local port are potentially a lot: optical, NFC, wireless etc.. but more than the implementation what is important is to define the need of it, the procedures available over this port and which level of security is mandatory.			
U_{11a}	Leaks detection. Network side	Water Leaks detection Network side. This is a features not foreseen in the current in field installations. It is a feature whose best allocation should be a dedicated SW algorithm installed in the central Head End System that uses the set of measurements gathered via the communication channel from water meters located along the distribution network. This algorithm will be influenced by the measurement accuracy and clock synchronization of all the meters involved. It is important to understand that this algorithm will collect and process data profiles, but not instantaneous values. The reliability being better if the data collected are integrated over a defined period of time (e.g. from 1min up to 15 min) whose length be much greater than the clock inaccuracies. Gathered data to be analyzed according to the continuity principle of matter flow.			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
U_{11b}	Leaks detection. Household side	Water Leaks detection household side. This is a features currently implemented in SoA water meters and based on the detection of some minimum water flow always present. It could complement the network side detection giving a complete picture of water leaks all over the entire water distribution network. The values found household side shall be compared and processed together with values gathered network side and for this reason data formats transferred via communication protocol shall foresee data range definition and scaling factors in order not to lose precision when combined. This requirement is apart from measurement inaccuracy that must be enforced by MID certification compliance, nevertheless it can be extended to make up a non-revenue water detection function jointly with requirement U_2			
U_{12}	Fraud attempt detection	This is a very common feature in all the similar smart metering application such as electricity or gas . It is to be considered useful also for smart water meters. Could be accepted a common global alert or coupled to this alert, also a status word giving the decoding of which cause for fraud attempts has been detected.			
U_{12}	Anti tampering detection	Same considerations made about the previous point. It could be accepted a common global alert or, coupled to such an alert, also a status word giving the decoding of which cause for tampering attempts has been detected.			
U_{13}	The network devices compliant to the Network Manager communication standard	The network devices, regardless of the technology, must be compliant to the Network Manager communication standard			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
U_{14}	Stable and reliable communication system	This is the final purpose of a system which heavily rely on communication to implement the Smart Advanced Metering application. For sure it is important to have good performances during any currently running data exchanges, but a smart meter once programmed with sophisticate communication strategies (data recovery mechanisms, data collection schedules ..), it should make feasible to operate on the data gathered in different moment in time, using off line algorithms (i.e let's think to water flow balance). These strategies will have success, if and only if all the needed data had been in the meantime transferred according to a SLA timing . Let's remember that among all the several processes running in utility environment the most important have to be completed for a minimum % of end-users (e.g. 97%) during a well-defined interval of time (e.g. 3 days immediately after the date of closing of a billing period)			
U_{15}	Reverse Flow detection	It should be avoided that water could reflow from end user premises to distribution network, but it is also known that some not common event can happen in the plant, in which the reflow condition establishes. Under these circumstances would be a very important feature if the smart water meter should be able to detect or even to measure automatically this reverse flow . In this way it become possible to have a more complete view of the water flows seen inside the network and to give a more accurate evaluation of the water flow balances to be checked at the HES level.			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
U_{16}	Type of meter	Considering the architecture of the terminal part of the water distribution system (normally is a meshed network of pipes), the typology of Water Meters can be defined independently from the measurement technology (either traditional or static) but in terms of their installation location. It will be needed a Water Meter type to be connected on each branch of the water distribution network (e.g. for water flow balance) and this type will be an "industrial" or "building" type, while on the terminal part of the branches (last section of the water distribution network) there will be a residential or "dwelling " type of meter. It can also be anticipated and easy to understand that some functionalities can be specific of one of the above mentioned types of WMs. For example for sake of clarity but not for sake of completeness, they will differ for the nominal flow rate (=Qn), for the dimensions of the "flange" adopted in the mechanical connections and also for the measurement frequency rate.			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
U_{17}	Health and Safety. Toxic agents and chemicals potentially released in the Water Flow	The use of Smart meters in the drinkable water network should imply a great focus on the understanding of materials used . In particular the acceptance by the manufacturers of all the standard that oblige to use only materials and components free of toxic materials or with a strong constraint in the presence of some hazardous or toxic substance. As an example for electronic industry is mandatory the compliance to ROHS II in which the maximum amount accepted of dangerous substances are among others : •Lead (Pb): < 1000 ppm •Mercury (Hg): < 100 ppm •Cadmium (Cd): < 100 ppm •Hexavalent Chromium: (Cr VI) < 1000 ppm •Polybrominated Biphenyls (PBB): < 1000 ppm •Polybrominated Diphenyl Ethers (PBDE): < 1000 ppm •Bis(2-Ethylhexyl) phthalate (DEHP): < 1000 ppm •Benzyl butyl phthalate (BBP): < 1000 ppm •Dibutyl phthalate (DBP): < 1000 ppm •Diisobutyl phthalate (DIBP): < 1000 ppm In addition it is important also to understand how much the smart meter remains "passive" under aging in a water environment. Clearly all the constraint shall remain the same and should be clearly identified and passed from the existing system to the new one.			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
U_{18}	Sediment and abrasion in drinkable water network	This requirement should be a basic requirement related to some fault in the pipes that implies the collection of sediments or sand inside pipes and that is not filtered, so arriving into the WM. For this requirement to be satisfied these sediments or sand particles as long as they are not pushed out from the end customer taps, remain in the meter body and must not affect metrology and do not cause any increasing abrasion in time. Which are the normal approaches of manufacturers in order to contrast this should be investigated. Perhaps some mechanical barrier or some filter. Should be analyzed and reported what Water distributors have already required for their current installations. Such a requirement should be maintained as it is now.			
U_{19}	Power supply : self-rechargeable battery	One possibility to reduce the costs associated to the size of the battery and to extend over 15 years its lifetime, could be to consider that anytime there is a nominal water flow Qn the mass of water flowing has such a linear momentum to make possible the adoption of an internal system to convert such linear momentum in battery charge (a sort of dynamo). The complexity of such approach is in the mechanical coupling between such a "dynamo " with meter body and the electronics governing the new meter.			
U_{20}	Minimum device network architecture	In terms of total cost of ownership, to be minimized, and in terms of global reliability and therefore availability of the system to be maximized, it shall be implemented a system architecture that take into account the best set of devices with the minimum of layers necessary to cope with the communication targets. Typically such targets measured by the Reachability parameter = (Number of meter in contact with HES in a defined time interval) / (total Number of meter under coverage of HES)			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
U_{21}	Water Meter materials	Passing from current installation to SoA to new water smart meter system, should the distributor set some specific requirement for the meter body material ? Or let the market to feel free to propose some new material, still complying with the general framework of the already existing related requirement as per req. 10, 13 and 14. The best approach in order to promote innovation and competition is that of not giving specific constraints but only the regulation framework to be complied to and in addition set the request of interchangeability.			
U_{22}	Wireless communication from meter to control room	Even though we have evidence of implementations where the communications have been delivered also on fixed-line we prefer by far a design setting favoring wireless communications for simplicity of installation and capital and operating cost convenience.			
U_{23}	Meter Data management system (MDM)	It is an essential part of any SoA data collection metering systems. It a SW running in the HES whose main purpose is to collect measurement data from all the meter population in a defined interval of time and reaching the highest possible % of meters. (typically better than 97% in 5 days). Another task is the validation of data, and the execution of all the procedures (if required) of data scaling according to the accuracy needs of the algorithms to be implemented. Finally take care also of the sending of data and commands to any specific meters managed by it. It must be integrated to an Encryption Key Manager that must be also provided.			
U_{23}	Network Management System for remote monitoring and control	It is another essential part of any SoA solution. It a SW running in the HES whose main purpose is to monitor, control and, whenever applicable, optimize the communications between HES and smart meters. This task realized collecting communication related measurements, finding and tuning best communication parameters and sending commands to re-configure the not optimized parameters in each meters that require this. It must be integrated to an Encryption Key Manager that must be also provided			
U_{24}	Bi directional flow measurement	It is strictly related to the previous point and in order to make possible the water flow balance in the distribution network			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
U_{25}	Scalability	Related to the previous considerations another important point on which focus the attention of the distributor is the adoption of scalable solutions. Here scalability is meant to be either related to the possibility to manage an increasing number of devices, in order to extend the solution to an wider population in a seamless way, and also in terms of new features to be introduced at the central SW, over system lifetime, that do not require a completely new SW but only require to release and to install new versions of the same application SW. In terms of population extension, scalability should be meant also in terms of increasing the number of managed devices without showing significant decrease in performances. Scalability on the other hand should not imply the use of specialized SW libraries/drivers in order to integrate new or old devices which are not interchangeable. This approach would specialize a standard solution to some specific not standard implementation and this should be rejected because normally increases the operating costs locking the solution to some not standard device. Moreover it is not possible to exclude that this approach of using specialized SW libraries/drivers, on the long term, could imply significant changes on the HES SW.			
U_{26}	MID approval and Meter class	Currently for the metrology approval, MID is the most widely accepted reference standard so it should remain untouched also for smart water meters. Class 2 (MPE=2%) still remains the correct requirement for residential meters.			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
U_{27}	Measurement rate or reading frequency	In case of either traditional or static technology, but given for granted we are facing smart meter types, so equipped with a micro processing unit, measurement reading frequency shall be defined taking into account both measurement inaccuracy in presence of water flow dynamic changes (Sampling theorem to be always satisfied) and also the amount of memory needed in case of consumption profiles to be stored for post processing needs. Depending from the installation site (network branches, building basement or dwelling) this frequency could be different simply because the dynamic of flow is different. In any case there is a common feeling that sampling could give accurate representation of water flow if the sample period is included in the range 0.1 sec - 5 sec. It is also possible to have continuous flow measurement that after integration returns volumes of water.			
U_{28}	Frequency of data transfer	In the described communication scheme (see U1) the daily occurrences of the scheduled data pushes should be programmable. In this way during system operation it could be found the best compromise between number of daily connections, the amount of data transfer and the amount of battery charge consumption. If the mechanism of data push expected by the communication protocol is sufficiently flexible, it could be programmed several type of pushes each one independent from the others, carrying different payloads with different daily or weekly or monthly occurrences. Typical mechanisms triggering such pushes could be : time event, alarm event, threshold overcoming. This requirement should be seen combined with U_4 to optimize performance and battery consumption.			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
M_1	Mechanical resistance against frost damages	The new smart meter shall be designed in order to resist not only to an extended Temperature range but also sufficiently strong to resist to ice that eventually is generated inside meter body when ambient temperature goes below 0°C. At this point some special reasoning should be given to an Operating Temp Range with the lower temperature less than 0°C. This should be applicable only to the electronic portion of the Smart Water Meter. Which are the metrological implications of this in particular for static technologies like Ultrasonic or Magnetic induction techniques, again should be investigated via a patent search.			
M_2	Water Meter design philosophy. Full functional integration	It is a long debate to try to define the best design philosophy. Traditional water meter with electronic on top or static measurement integrated with communication module? Any of these approaches has pros and cons and the best strategy for purchaser would be to prepare and submit to manufacturers a table in which using simple plus or minus judgments, referred to several significant requirements, it is analyzed and declared the existence of a preferred choice for one of the possible implementations and how much it is .The points to be evaluated could be : retrofitting, communication module substitution, separation of metrology body, easy of maintenance tasks. On the other hand doesn't seem practical a fully integrated design with the possibility to remove or update the internal communication module due to the IP68 requirement			

Req. Id	Functional Requirements	Remarks	Baseline	SoA	Breakthrough
M_3	Power supply : battery lifetime	The main constraint to the operational lifetime of the Water meter should be the lifetime of the battery, it is known that for residential meters subject to MID certification an explicit requirements is : at least 15 years is the metrological life of an residential water meter (they become 16 years for SmartMet Partnership). From this considerations it follows that there should be no more than 1 battery change in the meter lifetime, but should be preferred, in order to reduce the TCO, technical solutions able to guarantee no battery change in the lifetime of the meter.			
M_4	Remote (OTA) firmware (FW) update	This is a functionality that in the new framework of SoA or Smart water system will give the possibility to maintain updated all the meters (or even all the end devices, being meters or not) to new SW releases, avoiding field interventions devoted to the replacement of installed meters or based on the local communication interface.			
D_1	Capability to separate electronic waste from hydraulic components	This is really important to minimize the environmental impact at disposal time.			

Table 8 - Analysis of functional coverage of all Smart Met requirements compared against Baseline and SoA

Summarizing the results of the analysis represented in

Table 8 we get the following list of requirements as functionalities uncovered by both Baseline and SoA Solutions considered:

Req. #	Description
I_1	Interchangeability / Interoperability
I_4	Centralized management and back up of data of the replaced meter and subsequent restore and synching to the new installed meter
U_3	Adoption of Open standards and common / consistent data modeling
U_6	Self Diagnostics and alerting: water pressure, low battery and other relevant messages
U_{10}	Local Display and Local communications availability
U_{11}	Leaks detection. Network side

Table 9 – list of uncovered requirements/functionalities

We want now to evaluate these requirements against their relevance in terms of impact on the different lifecycle phases of the solution. This will be done in next paragraph 3.6.

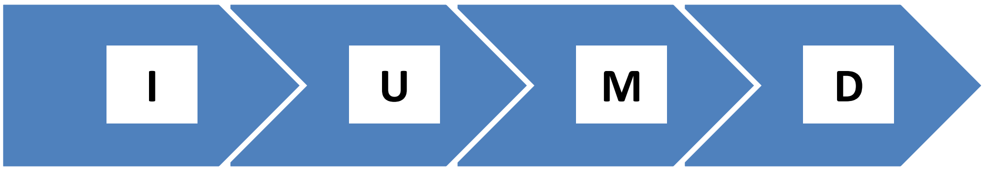
3.6 Impact of emerged SMART.MET functionalities on the Smart Meter Solution lifecycle.

As already seen in the previous paragraphs, the complete lifecycle for Smart Water Metering solution could be composed by the following phases :

- T&P = Tendering and procurement phase
- I = Installation and Replacement phases
- U = Use and manage phase
- M = Maintenance and Replacement phase
- D = Disposal phase

In the linear and straight representation of Smart Meter Solution lifecycle here adopted, will not be shown any potential feedback information or any loop back phase due to the occurrence of some logical condition.

Moreover the adopted WIBGI methodology doesn't take into account the first T&P phase, even if this is a very basic phase, so the solution lifecycle will be represented in graphic form as follows:

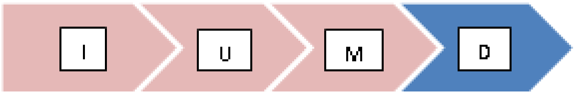
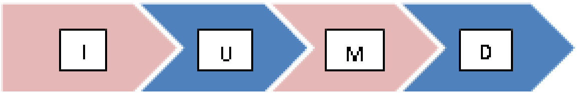
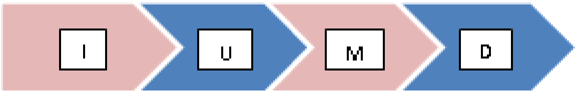
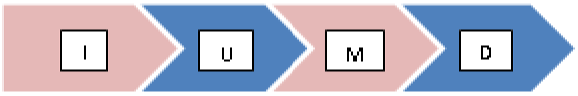
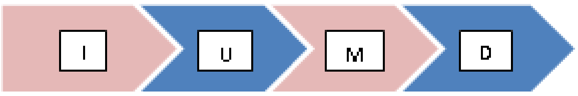
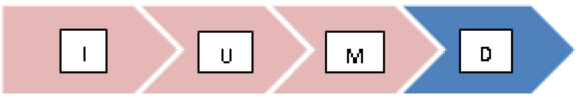


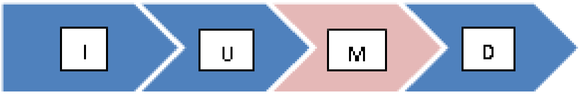
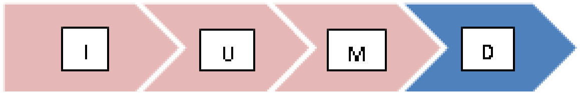
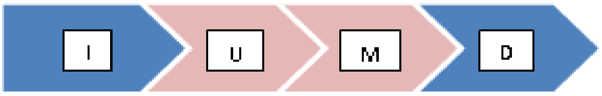
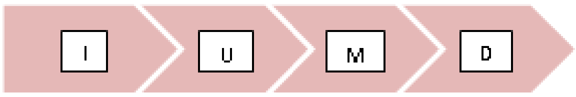
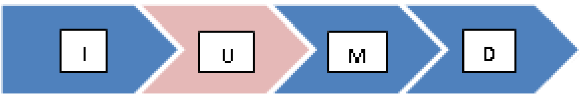
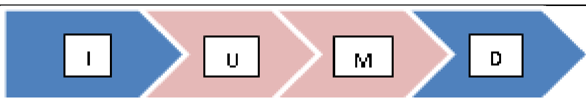
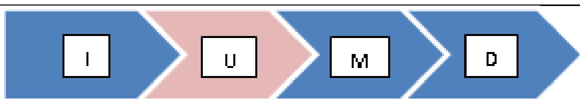
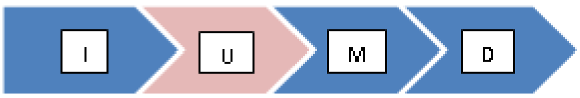
every time one phase is not colored and remain in light blue, this will mean that that specific phase has no relation with the function under analysis, so an unspecified generic solution lifecycle will appear as above i.e. completely in light blue.

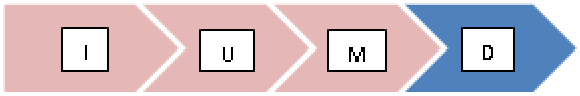
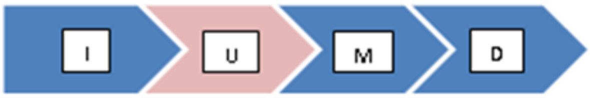
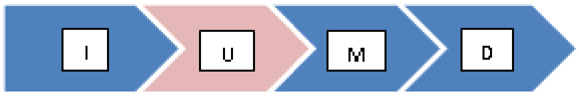
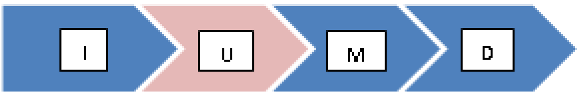
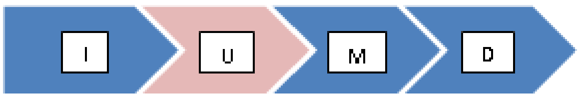
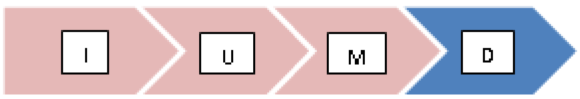
In the following

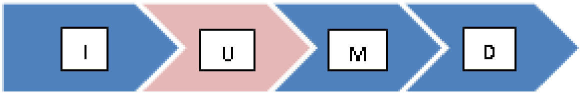
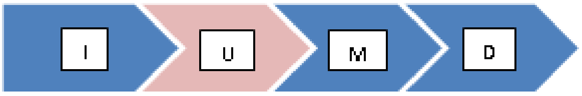
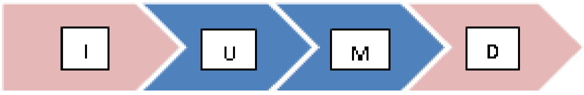
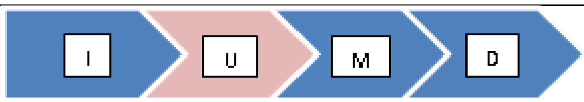
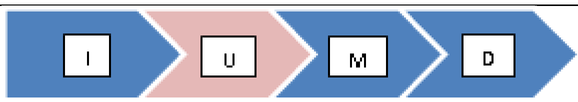
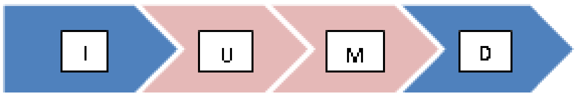
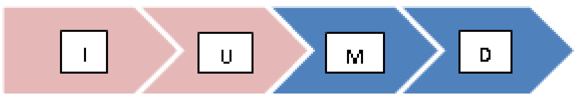
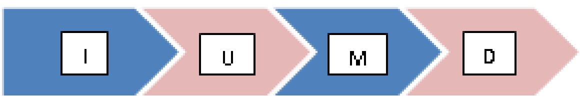
Table 10, a classification assigning all the functions analyzed to the solution lifecycle phases is reported representing the impact of the functionality on the lifecycle itself. This is has the purpose of adding another evaluation criteria to assess the importance of the functionality we are dealing and to confirm or review the requirements list seen in

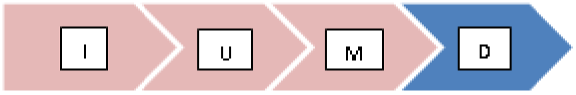
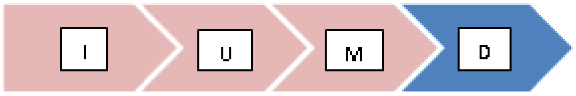
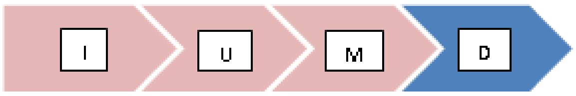
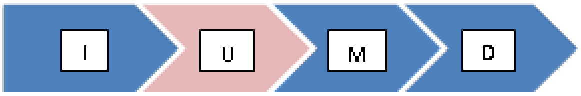
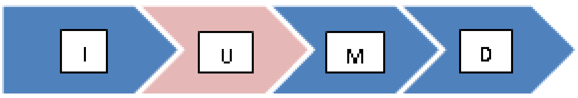
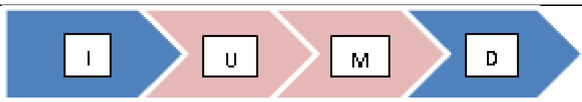
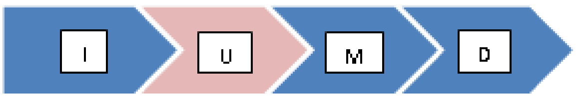
Table 9. For our objectives the most important lifecycle Phase is Usage & Management (U) for its duration and impact on processes.

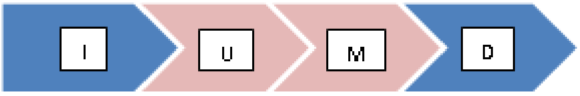
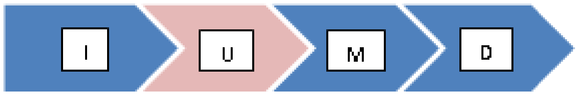
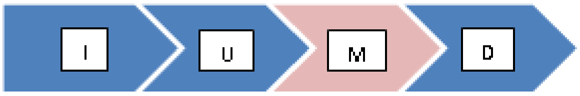
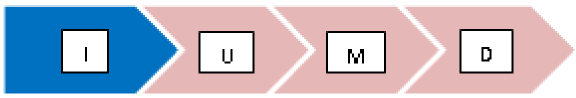
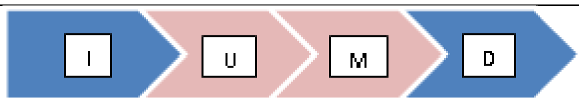
Req.#	Req. Description	Lifecycle Impact	Remarks
I_1	Interchangeability vs Interoperability		Requirement very important. It impacts all over life time made exception of Disposal
I_2	Mechanical Constraints - Hydraulic connection system compatible with the actual existing one (such as connections to screw)		Mechanical constraints shall be managed from the very beginning and impact I&R and M&R
I_3	Ease of installation - The meter and the related solution should be as simple as to require no special competences but the usual hydraulic skills to install		It has an impact on installation and in case of replacement in the maintenance phase.
I_4	It has to be ensured the automatic centralised backup and synching of configuration parameters from the old meter to the new one at installation time.		Same as above.
I_5	The metering system size must allow easy installation with little or no masonry works		Same as above.
U_1	Bi-directional Communication		The impact is from first commissioning operations to maintenance procedures

Req.#	Req. Description	Lifecycle Impact	Remarks
U_2	On site metrological check, verification capability - a process must be defined to measure bias (negative or positive) and to trigger an alert		On site metrological check shall be required and managed during M&R
U_3	Open Standard: The Smart Meter, Data Transfer and Control Room Layer should offer an open, solid, tested, efficient and resilient interconnection standard and data modeling support		Impact all the life time and therefore all the phases exception made for Disposal
U_4	Schedulable On Demand Communication		Useful when in operations or in maintance for special procedures
U_5	Self Powered Devices (battery)		Battery operation requirement impacts all phases also Disposal
U_6	Self Diagnostics and alerting: water pressure, low battery and other relevant messages		Self explanatory
U_7	Product lifetime 16 years		Self explanatory
U_8	Required Water Tightness protection >= IP68		As above
U_9	Flow Control - Meter valve management functionalities (flow limitation, closure, reopening, fast		As above

Req.#	Req. Description	Lifecycle Impact	Remarks
	automatic reaction time for emergency)		
U_{10}	Front display for direct reading of the most important selected registers of the meter by the customer and local communication from a local port for field engineer operations		Field technician can use the display for installation just like end customer when in operation and again field technician in maintenance
U_{11}	Network Sided Leakage Detection		Typical function to be specified and useful during operation
U_{11}	Household Sided Leakage Detection		Typical function to be specified and useful during operation
U_{12}	Fraud Attempt - The system will issue a fraud alert message towards the AMR/AMM system		Self explanatory
U_{12}	Anti Tampering - The system will sense the attempt to infringe the meter integrity and will issue a tampering alert message towards the AMR/AMM system		Self explanatory
U_{13}	The network devices, regardless of the technology, must be compliant to the Network Manager communication standard		The NM must be capable to operate with the Smart Meter from the installation onward.

Req.#	Req. Description	Lifecycle Impact	Remarks
U_{14}	The communication must remain stable and reliable regardless of meter locations (basements, dedicated meter rooms, technical rooms, etc.)		Self-explanatory
U_{15}	Self diagnostics about Reverse flow detection and management		These function impact operational phase
U_{16}	Meter Typology: the solution has to match both household meters and building meters		Typology of meter affects installation and disposal
U_{17}	Toxic agents and chemicals protected devices		Self-explanatory
U_{18}	The meter should be sediment and abrasion resistant		Self-explanatory
U_{19}	Self Rechargeable - The meter could have a battery self recharging system		Impacts Operation and Maintenance
U_{20}	The solution minimizes the request of equipped sites (e.g. gateways, repeaters, translators, etc.) and is economically convenient.		Self-explanatory
U_{21}	Water Meter Materials - A full plastic/composite meter housing is not acceptable. At least the joints/threads		Impacts Usage and Disposal

Req.#	Req. Description	Lifecycle Impact	Remarks
	should be metallic		
U_{22}	The communication should be wireless from the meter side to the control room side		Self-explanatory
U_{23}	Management system (MDM) software functionalities must be defined beside those of Network Management System		Self-explanatory
U_{23}	Network Management System has to be provided as part of the solution for monitoring, reporting and administration of network devices		Self-explanatory
U_{24}	Capability to measure flows in both directions - this is necessary for measurement accuracy and for reverse flow detection		Self-explanatory
U_{25}	Scalability : MDM and NM systems must be scalable		Scalability of solution shall be required at the very beginning and impact OP phase
U_{26}	MID approval, Meter Class		Self-explanatory
U_{27}	Measurement Rate - Reading Recording (at least every 15 minutes)		Measurement rate affect operation (accuracy of data

Req.#	Req. Description	Lifecycle Impact	Remarks
			collected)
U_{28}	Data Frequency Transmission (at least once in a day)		It can have an impact on both Usage and Maintenance for special procedures
M_1	Frost Damages - The meter should have a measuring solution to minimize frost damages, be it mechanical or electronic		Self-explanatory
M_2	Design philosofy - The hydraulic section, regardless of the measuring technology of the meter have to be apart from the electronic communication section in order to infringe metrological certification in case of maintenance activity		Impacts only Maintenance
M_3	Meter Technical Lifecycle 16 years. Battery must have a lifecycle of 16 years regardless of operations behaviour (e.g. from how many times in a day communications occur)		This is a function whose effects are at the Usage and Management, Maintenance and Disposal phase
M_4	Remote Firmware Update		Self-explanatory

Req.#	Req. Description	Lifecycle Impact	Remarks
D_1	Capability to separate electronic waste from hydraulic components		

Table 10 - Mapping of SMART.MET functionalities on solution lifecycle phases

If we assign a weight to the different lifecycle phases as follows:

- I = Installation and Replacement phases -> 20
- U = Use and manage phase (operations) -> 30
- M = Maintenance and Replacement phase -> 10
- D = Disposal phase -> 10

We get with reference to the six requirements identified in

Table 9:

Req. #	Description	Total Weights
I_1	**Interchangeability / Interoperability**	**60**
I_4	**Centralized management and back up of data of the replaced meter and subsequent restore and synching to the new installed meter**	**30**
U_3	**Adoption of Open standards and common / consistent data modeling**	**60**
U_6	**Water pressure sensing**	**30**
U_{10}	**Local Display and Local communications availability**	**60**
U_{11}	**Leaks detection. Network side**	**30**

Table 11 – Weighted Requirements against impacted lifecycle phases

We can observe that no one of the selected requirements goes under the threshold of 30 points. Additionally it becomes apparent the importance of Interoperability ($\mathbf{I_1}$) and the Adoption of Open Standards ($\mathbf{U_3}$).

The conclusion is that it is worthwhile to submit this list for further evaluation during Open Market Consultation sessions and in a patent search.

3.7 Ranking of SmartMet functionalities as evaluated by stakeholders group.

We go now to rate the list of the emerged functionalities ranked and ordered as described in WP D2.1 and considered as tightly associated to the basic need declared by the stakeholder. The result is reported here below in the following

Table 12 .

Req. #	Description	% Occurrences of «fundamental» requirements
U_{22}	U22. The communication should be wireless from the meter side to AMR/AMM system on the Control Room side through the Data Transfer Layer	**83%**
I_1	I1. The solution component must be interoperable complying with a industry market standard defined or yet to be defined	**83%**
U_1	U1. Communication must be bi-directional from center to periphery and backwards, preventing the end-user from a direct connection to the meter bypassing the Distributor's Control Room and BSS layers	**83%**
U_5	U5. The Smart Meter should not be fed by end user's energy supply, but it should be autonomously powered.	**83%**
U_7	U7. The technical lifecycle, when we speak of Smart Meters, must be as long as the asset's useful life from accounting point of view. (1)	**83%**
U_{13}	U13. All the solution components, from Smart Meters Layer, through Data Transfer Layer to Control Room Layer, must be compliant to the open protocol application and communication standard in order to ensure interoperability/interchangeability among components from different vendors.	**83%**
U_3	U3. The Smart Meter, Data Transfer and Control Room Layer should offer an open, solid, tested, efficient and resilient interconnection standard	**83%**
U_4	U4. A schedulable On-Demand bi-directional communication feature is necessary (particularly useful for complex workflow or interactive bidirectional communications as analysis for leakage detection process or remote Firmware Update) in order to have the benefit of a real-time bi-directional communication for a short	**83%**

Req. #	Description	% Occurrences of «fundamental» requirements
	period while saving battery consumption when the communication is no longer needed.	
U_{20}	U20. The solution minimizes the request of equipped sites (e.g. gateways, repeaters, translators, etc.) and is economically convenient (*)	**83%**
I_2	I2. The Smart Meter must fit the pipe section, thread, step and other technical characteristics currently in use, room occupation etc. for an easy installation and procurement compliance	**67%**
I_5	I5. The Smart Meter size must allow easy installation with little or no masonry works	**67%**
U_{17}	U17. The Meters should respect regulation about toxic agents and chemicals of materials.	**67%**
U_{24}	U24. Capability to measure flows in both directions - this is necessary to check measurement accuracy and for reverse flow detection	**67%**
U_{21}	U21. The Smart Meter joints/threads should be resistant to the same tightening torque of joints/threads of the the current traditional meter pipes.	**67%**
U_{23}	U23. Network Management System (NM) has to be provided as part of the solution for monitoring, reporting and administration of network devices, as well as Meter Data Management System (MDM) must be provided for the governance of meter reading and command operations execution. The two of them must be apart but tightly integrated.	**67%**
U_6	U6. The system must have a selfdiagnostic alerting function in case of: 1) lack of water pressure, 2) reading errors, 3) water reverse flow and automatic valve closure, 4) tampering and fraud alert, 5) low battery alert, etc.)	**67%**
U_{10}	U10. The Smart Meter must sport a front display capable to show in sequence the most relevant register contents suitable for both end-users purposes and field technicians.	**67%**
U_8	U8. The Smart Meter should be dust and water resistant	**67%**

Req. #	Description	% Occurrences of «fundamental» requirements
M_3	M3. The system must have consumables and asset lifecycle aligned in order to minimize the costs related to consumables (batteries) replacement in terms of materials and operations (1)	**67%**
U_{12}	U12. The Smart Meter must be provided with an anti-fraud and anti-tampering system to detect and prevent both measurement fraud and device tampering. These functionalities will sense the attempt to infringe the meter integrity or meter measure capability and will issue an alert message towards the AMR/AMM system in the Control Room	**67%**
U_{18}	U18. The Smart Meter should be sediment and abrasion resistant	**67%**
I_3	I3. The meter and the related solution should be as simple as to require no special competences but the usual hydraulic skills to install	**67%**
I_4	I4. It has to be ensured the automatic centralised backup and synching of configuration parameters from the old meter to the new one at replacement time.	**67%**
U_{11}	U11. Remotely Operated Leakage Detection - a) Semi-Automated Distributor Meshed Network sided leakage detection, b) Fully Automated Household sided leakage detection.	**67%**
U_{14}	U14. The communication must remain stable and reliable regardless of meter locations (basements, dedicated meter rooms, technical rooms, etc.)	**50%**
M_4	M4. Capability to execute an On the Air Smart Meter Remote Firmware Update	**50%**
U_{19}	U19. The meter could have a battery self recharging system. In that case battery should be a rechargeable one.	**33%**
U_{15}	U15. Reverse Flow Detection and Management - in case of reverse flow the Smart Meter is able to sense it and to autonomously close the valve to prevent network pollution sending a special alert message to the Control Room	**33%**
U_9	U9. Meter valve management functionalities (flow limitation, manual on site reopening remotely enabled, automatic closure reaction time for emergency)	**33%**

Req. #	Description	% Occurrences of «fundamental» requirements
M_2	M2. The hydraulic section, regardless of the measurement technology of the meter has to be apart from the electronic communication section in order not to infringe metrological certification in case of maintenance activity with the need of removal of the electronic section or for replacement in case of communication technology update or upgrade.	**33%**
U_2	U2. On site measure verification capability - the Smart Meter should offer a functionality and a automated or semi-automated process to detect a potential measurement error (negative or positive) and possibly to trigger an alert (in case of automated process)	**33%**
U_{25}	U25. NM and MDM Control Room Layer Systems must be scalable in case of PoD and related Smart Meter fleet increase	**33%**
M_1	M1. The meter should have a measurement technology to minimize frost damages, be it mechanical or electronic	**33%**
D_1	D1. Capability to separate electronic waste from hydraulic components	**33%**
U_{16}	U16. The meter, with reference to the combinations table beside the rightmost column of this grid, can be of the following sort: Main Meter, sub-meter, new gen and retrofitted old gen. Every typology must be compliant with the solution	**17%**

Table 12 - Final and ranked global set of SmartMet functionalities SoA

From this global ranking we can extract our subset of requirement list as seen in Table 11 in the same sorting order of

Table 12 and we get:

Req. #	Description	Ranking
I_1	**Interchangeability / Interoperability**	1
U_3	**Adoption of Open standards and common / consistent data modeling**	2
I_4	**Centralized management and back up of data of the replaced meter and subsequent restore and synching to the new installed meter**	3
U_6	**Water pressure sensing**	4
U_{10}	**Local Display and Local communications availability**	5
U_{11}	**Leaks detection. Network side**	6

Table 13 – Selected requirement ranking after

Table 12

4. Conclusions

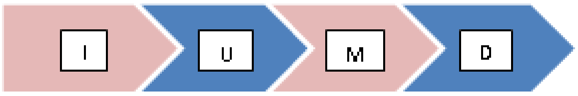
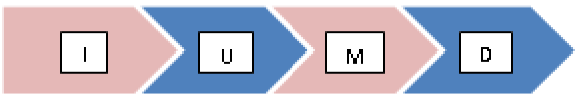
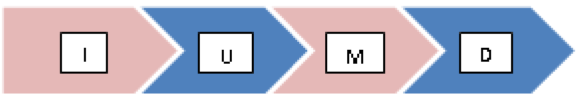
4.1. Analysis criteria

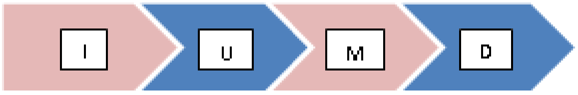
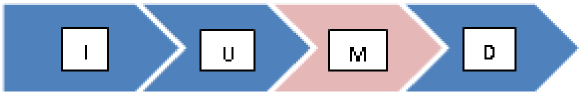
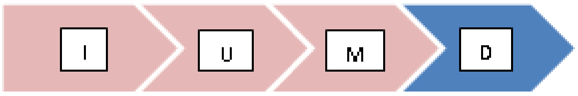
In the previous paragraphs we have been considering the functional requirements under three different point of view.

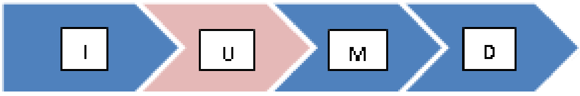
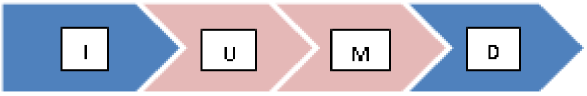
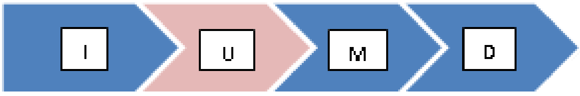
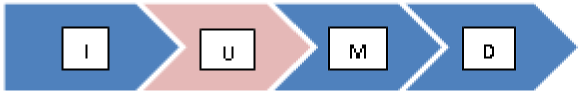
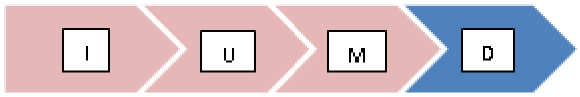
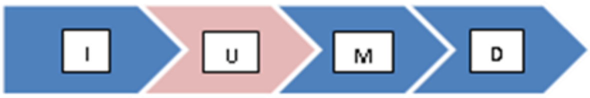
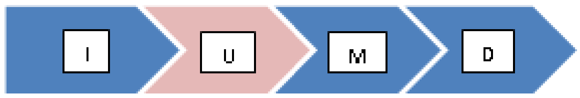
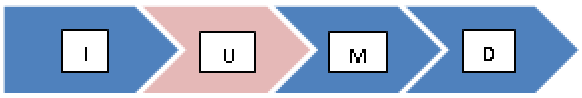
The first one was to analyze whether or not the desired requirement was implemented in a Baseline solution set or in, what we conventionally called, State of the Art solution set. From this activity, a first list of uncovered functionalities came out (see

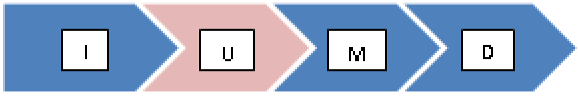
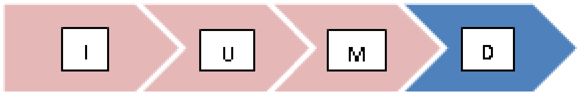
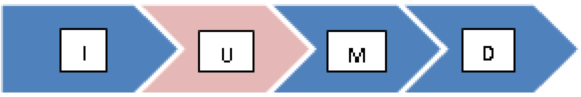
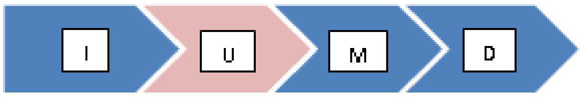
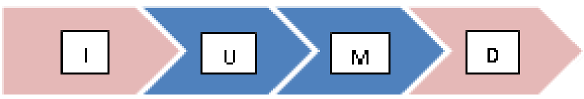
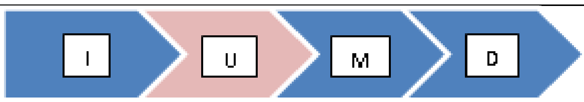
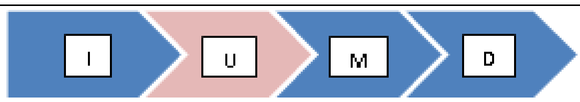
Table 8).

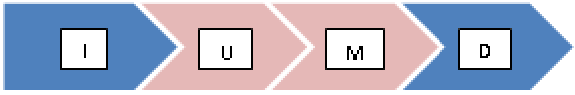
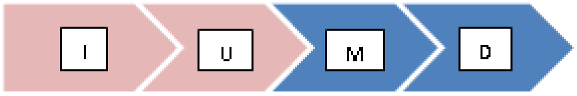
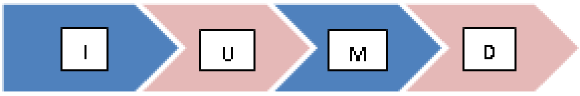
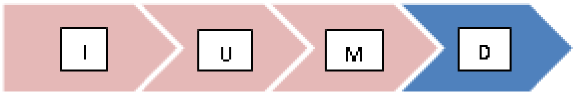
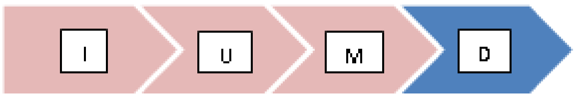
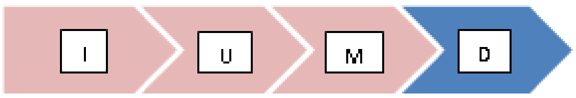
The second was about the importance in terms of impact on the solution lifecycle phase a certain requirement could have. The more lifecycle phases were involved with the requirement dealt with, the more important was the requirement (see

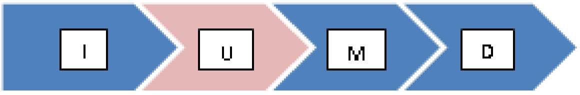
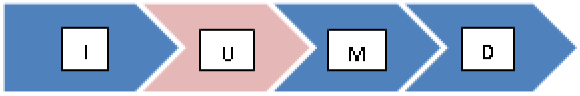
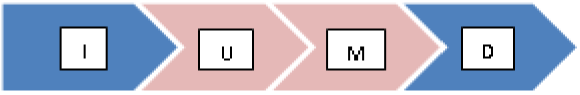
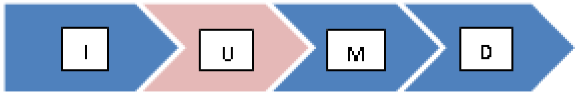
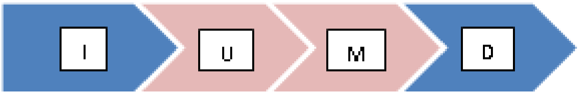
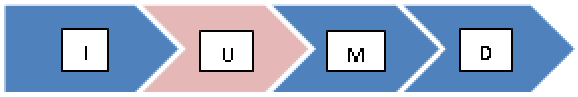
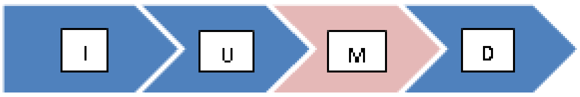
Req.#	Req. Description	Lifecycle Impact	Remarks
I_1	Interchangeability vs Interoperability		Requirement very important. It impacts all over life time made exception of Disposal
I_2	Mechanical Constraints - Hydraulic connection system compatible with the actual existing one (such as connections to screw)		Mechanical constraints shall be managed from the very beginning and impact I&R and M&R
I_3	Ease of installation - The meter and the related solution should be as simple as to require no special competences but the usual hydraulic skills to install		It has an impact on installation and in case of replacement in the maintenance phase.
I_4	It has to be ensured the automatic centralised backup and synching of configuration parameters from		Same as above.

Req.#	Req. Description	Lifecycle Impact	Remarks
	the old meter to the new one at installation time.		
I_5	The metering system size must allow easy installation with little or no masonry works		Same as above.
U_1	Bi-directional Communication		The impact is from first commissioning operations to maintenance procedures
U_2	On site metrological check, verification capability - a process must be defined to measure bias (negative or positive) and to trigger an alert		On site metrological check shall be required and managed during M&R
U_3	Open Standard: The Smart Meter, Data Transfer and Control Room Layer should offer an open, solid, tested, efficient and resilient interconnection standard and data modeling support		Impact all the life time and therefore all the phases exception made for Disposal
U_4	Schedulable On Demand Communication		Useful when in operations or in maintance for special procedures
U_5	Self Powered Devices (battery)		Battery operation requirement impacts all phases also Disposal

Req.#	Req. Description	Lifecycle Impact	Remarks
U_6	Self Diagnostics and alerting: water pressure, low battery and other relevant messages		Self explanatory
U_7	Product lifetime 16 years		Self explanatory
U_8	Required Water Tightness protection >= IP68		As above
U_9	Flow Control - Meter valve management functionalities (flow limitation, closure, reopening, fast automatic reaction time for emergency)		As above
U_{10}	Front display for direct reading of the most important selected registers of the meter by the customer and local communication from a local port for field engineer operations		Field technician can use the display for installation just like end customer when in operation and again field technician in maintenance
U_{11}	Network Sided Leakage Detection		Typical function to be specified and useful during operation
U_{11}	Household Sided Leakage Detection		Typical function to be specified and useful during operation
U_{12}	Fraud Attempt - The system will issue a fraud alert message towards the AMR/AMM system		Self explanatory

Req.#	Req. Description	Lifecycle Impact	Remarks
U_{12}	Anti Tampering - The system will sense the attempt to infringe the meter integrity and will issue a tampering alert message towards the AMR/AMM system		Self explanatory
U_{13}	The network devices, regardless of the technology, must be compliant to the Network Manager communication standard		The NM must be capable to operate with the Smart Meter from the installation onward.
U_{14}	The communication must remain stable and reliable regardless of meter locations (basements, dedicated meter rooms, technical rooms, etc.)		Self-explanatory
U_{15}	Self diagnostics about Reverse flow detection and management		These function impact operational phase
U_{16}	Meter Typology: the solution has to match both household meters and building meters		Typology of meter affects installation and disposal
U_{17}	Toxic agents and chemicals protected devices		Self-explanatory
U_{18}	The meter should be sediment and abrasion resistant		Self-explanatory
U_{19}	Self Rechargeable - The meter could have a battery self		Impacts Operation and Maintenance

Req.#	Req. Description	Lifecycle Impact	Remarks
	recharging system		
U_{20}	The solution minimizes the request of equipped sites (e.g. gateways, repeaters, translators, etc.) and is economically convenient.		Self-explanatory
U_{21}	Water Meter Materials - A full plastic/composite meter housing is not acceptable. At least the joints/threads should be metallic		Impacts Usage and Disposal
U_{22}	The communication should be wireless from the meter side to the control room side		Self-explanatory
U_{23}	Management system (MDM) software functionalities must be defined beside those of Network Management System		Self-explanatory
U_{23}	Network Management System has to be provided as part of the solution for monitoring, reporting and administration of network devices		Self-explanatory
U_{24}	Capability to measure flows in both directions -		Self-explanatory

Req.#	Req. Description	Lifecycle Impact	Remarks
	this is necessary for measurement accuracy and for reverse flow detection		
U_{25}	Scalability : MDM and NM systems must be scalable		Scalability of solution shall be required at the very beginning and impact OP phase
U_{26}	MID approval, Meter Class		Self-explanatory
U_{27}	Measurement Rate - Reading Recording (at least every 15 minutes)		Measurement rate affect operation (accuracy of data collected)
U_{28}	Data Frequency Transmission (at least once in a day)		It can have an impact on both Usage and Maintenance for special procedures
M_1	Frost Damages - The meter should have a measuring solution to minimize frost damages, be it mechanical or electronic		Self-explanatory
M_2	Design philosofy - The hydraulic section, regardless of the measuring technology of the meter have to be apart from the electronic communication section in order to infringe metrological certification in case of maintenance		Impacts only Maintenance

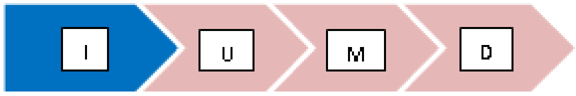
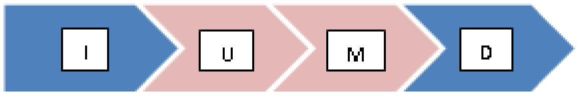
Req.#	Req. Description	Lifecycle Impact	Remarks
	activity		
M_3	Meter Technical Lifecycle 16 years. Battery must have a lifecycle of 16 years regardless of operations behaviour (e.g. from how many times in a day communications occur)		This is a function whose effects are at the Usage and Management, Maintenance and Disposal phase
M_4	Remote Firmware Update		Self-explanatory
D_1	Capability to separate electronic waste from hydraulic components		

Table 10)

The third point of view is based on a ranking operated considering how many times, in percentage, a requirement has been evaluated as "fundamental" in the WIBGI sessions (see D2.1) discarding those requirements under a threshold of 33% (see

Table 12).

4.2 Evidence of a potential technology gap

The final result is a restricted list of six functional requirements whose lack creates a potential functional shortage in terms of market offer, that are highly impacting on the lifecycle phases of a potential solution and definitely considered by the SMART.MET Procurers as really relevant as to their needs.

Req. #	Description
I_1	**Interchangeability / Interoperability**

U_3	**Adoption of Open standards and common / consistent data modeling**
I_4	**Centralized management and back up of data of the replaced meter and subsequent restore and synching to the new installed meter**
U_6	**Self Diagnostics and alerting: water pressure, low battery and other relevant messages**
U_{10}	**Local Display and Local communications availability**
U_{11}	**Leaks detection. Network side**

Table 14 – final list of requirements to investigate in next step

A further investigation is thus clearly needed and a good way to start is represented by the Open Market Consultations events. These events will favor a unique opportunity to describe the SmartMet initiative to an interested audience and to exchange information, questions and answers and to capture the feeling of the market operators in the field of Smart Metering.
Those session will be supported and reinforced by a questionnaire that will be submitted to the participants subsequently on voluntary basis. The results will be laid down in D2.4.
In parallel, State of the Art analyses will be deepened by patent and literature review, which results will be laid down in D2.5.
Both activities will enable the SMART.MET team to confirm - or not! - the currently presumed technology gap.

5. Bibliography and References

[1] EU Directive on energy efficiency (2012/27/EU)

[2] EU Directives concerning common rules for the internal market for electricity and gas (2009/72/EC)

[3] CEN-CLC-ETSI TR 50572:2011 'Functional reference architecture for communications in smart metering systems'

[4] Smart Metering deployment in the European Union http://ses.jrc.ec.europa.eu/smart-metering-deployment-european-union

[5]Smart metering standardization at ETSI http://www.etsi.org/technologies-clusters/technologies/internet-of-things/smart-metering

[6] COMMISSION STAFF WORKING DOCUMENT : Cost-benefit analyses & state of play of smart metering deployment in the EU-27 - 2014

Embedded Annex

Annex I

Annex I - Base Line Solution Framework v 3.4 Phased.xlsx

				CILE	Eau de Paris	Eau de Paris	Promedio	Promedio	Promedio	SDEA		LEGENDA	
			Requirements	**Hydroko**	**EDP Homerider**	**EDP Suez**	**Acciona Arrow**	**Contazara**	**Elster**	**Itron**		**Baseline**	**SotA as of 15/5/2017**
Installation and replacement (PhaseI)	I1	8	Interchangeability vs Interoperability	no	no	partially	no	no	partially	partially		no	no
	I2	7	Mechanical Constraints - Hydraulic connection system compatible with the actual existing one (such as connections to screw)	yes	yes	yes	no	no	no	no		yes	yes
	I3	32	Ease of installation - The meter and the related solution should be as simple as to require no special competences but the usual hydraulic skills to install	no	no	no	partially	partially	partially	yes		yes	yes
	I4	37	It has to be ensured the automatic centralised backup and synching of configuration parameters from the old meter to the new one at installation time.	no	partially	partially	partially	partially	partially	yes		yes	yes
	I5	22	The metering system size must allow easy installation with little or no masonry works	yes	yes	yes	partially	partially	partially	yes		yes	yes
	U1	28	Bi-directional Communication	yes	partially	yes	yes	yes	yes	yes		yes	yes
	U2	3	On site metrological check, verification capability - a process must be defined to measure bias (negative or positive) and to trigger an alert	yes	partially	partially	partially	partially	partially	partially		yes	yes
	U3	10	Open Standard: The Smart Meter, Data Transfer and Control Room Layer should offer an open, solid, tested, efficient and resilient interconnection standard and data modeling support	no	no	partially	no	no	partially	partially		no	no
	U4	30	Schedulable On Demand Communication	no	no	no	partially	no	partially	yes		yes	yes
	U5	18	Self Powered Devices (battery)	yes	yes	yes	yes	yes	yes	yes		yes	yes
	U6	13	Self Diagnostics and alerting: water pressure, low battery and other relevant messages	partially	no	no	partially	no	partially	partially		no	no
	U7	21	Product lifetime 16 years	yes	partially	partially	partially	partially	partially	partially		yes	yes
	U8	12	Required Water Tightness protection >= IP68	yes	yes	yes	yes	yes	yes	yes		yes	yes
	U9	6	Flow Control - Meter valve management functionalities (flow limitation, closure, reopening, fast automatic reaction time for emergency)	yes	no	no	partially	partially	partially	no		yes	yes
	U10	31	Front display for direct reading of the most importat selected registers of the meter by the customer and local communication from a local port for field engineer operations	no	partially	partially	partially	partially	partially	partially		no	no

				CILE	Eau de Paris	Eau de Paris	Promedio	Promedio	Promedio	SDEA		LEGENDA		
			Requirements	Hydroko	EDP Homerider	EDP Suez	Acciona Arrow	Contazara	Elster	Itron		Baseline		SotA as of 15/5/2017
Installation and replacement (PhaseII)	U11	4	Network Sided Leakage Detection	no	not given	not given	not given	no	not given	no		no		no
	U11	5	Household Sided Leakage Detection	yes	not given	not given	not given	partially	not given	yes		yes		yes
	U12	26	Fraud Attempt - The system will issue a fraud alert message towards the AMR/AMM system	no	yes	yes	yes	yes	yes	no		no		yes
	U12	27	Anti Tampering - The system will sense the attempt to infringe the meter integrity and will issue a tampering alert message towards the AMR/AMM system	no	yes	yes	yes	yes	yes	no		no		yes
	U13	34	The network devices, regardless of the technology, must be compliant to the Network Manager communication standard	no	no	yes	yes	yes	yes	no		no		yes
	U14	36	The communication must remain stable and reliable regardless of meter locations (basements, dedicated meter rooms, technical rooms, etc.)	yes	partially	partially	partially	partially	partially	no		yes		yes
	U15	24	Self diagnostics about tampering alert, Reverse flow detection and management	yes	partially	partially	partially	partially	partially	partially		yes		yes
	U16	1	Meter Typology: the solution has to match both household meters and building meters	NewGen Submeters	not given	not given	yes	yes	yes	not given		no		yes
	U17	11	Toxic agents and chemicals protected devices	partially	yes	yes	partially	yes	yes	yes		yes		yes
	U18	15	The meter should be sediment and abrasion resistant	yes	partially	yes	partially	partially	partially	yes		yes		yes
	U19	19	Self Rechargeable - The meter could have a battery self recharging system	no	no	no	partially	yes	partially	no		no		yes
	U20	35	The solution minimizes the request of equipped sites (e.g. gateways, repeaters, translators, etc.) and is economically convenient (*)	yes	yes	yes	yes	partially	yes	not given		yes		yes
	U21	16	Water Meter Materials - A full plastic/composite meter housing is not acceptable. At least the joints/threads should be metallic	no	yes	yes	yes		yes	not given		no		yes
	U22	39	The communication should be wireless from the meter side to the control room side	yes	yes	yes	yes	yes	yes	no		yes		yes
	U23	33	Management system (MDM) software functionalities must be defined beside those of Network Management System	no	not given	no	partially	yes	partially	yes		yes		yes
	U23	40	Network Management System has to be provided as part of the solution for monitoring, reporting and administration of network devices	no	partially	yes	partially	partially	partially	yes		yes		yes
	U24	25	Capability to measure flows in both directions - this is necessary for measurement accuracy and for reverse flow detection	no	yes	yes	partially	yes	partially	yes		yes		yes

				CILE	Eau de Paris	Eau de Paris	Promedio	Promedio	Promedio	SDEA		LEGENDA	
			Requirements	Hydroko	EDP Homerider	EDP Suez	Acciona Arrow	Contazara	Elster	Itron		Baseline	SotA as of 15/5/2017
	U25	9	Scalability : MDM and NM systems must be scalable	yes	not given	not given	not given	yes	not given	yes		yes	yes
	U26	23	MID approval, Meter Class	yes	yes	yes	yes	yes	yes	yes		yes	yes
	U27	2	Measurement Rate - Reading Recording (at least every 15 minutes)	not given	not given	not given	not given	not given	not given	not given		not given	not given
	U28	29	Data Frequency Transmission (at least once in a day)	not given	not given	not given	not given	not given	not given	not given		not given	not given
Maintenance (Phase III)	M1	14	Frost Damages - The meter should have a measuring solution to minimize frost damages, be it mechanical or electronic	no	partially	partially	partially	yes	partially	no		no	yes
	M2	17	Design philosofy - The hydraulic section, regardless of the measuring technology of the meter have to be apart from the electronic communication section in order to infringe metrological certification in case of maintenance activity	no	no	no	partially	yes	partially	yes		yes	yes
	M3	20	Meter Technical Lifecycle 16 years. Battery must have a lifecycle of 16 years regardless of operations behaviour (e.g. from how many times in a day communications occur)	no	partially	yes	partially	partially	partially	partially		no	yes
	M4	38	Remote Firmware Update	no	no	yes	no	no	no	no		no	yes
Disposal (Phase IV)	D1	41	The hydraulic section, regardless of the measuring technology of the meter have to be apart from the electronic telecom section in order not to break metrological certification in case of maintenance activity	yes	yes	yes	partially	yes	partially	yes		yes	yes
												Baseline	SotA as of 15/5/2017

Rule for Baseline/SotA Assessment:

1) solution #1 OR solution#2 .. OR solution #n "yes" -> "yes"

2) solution #1 NOR solution#2 .. NOR solution #n "yes" -> "no"