

FIRST RESULTS IN ENDESA SMART METERING ROLL-OUT

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ABSTRACT

Endesa and Enel leveraged the synergies of the corporate group formed by applying Enel's knowledge and experience in the field which, in addition to the broad technology experience of Endesa, guarantees success in the joint development and implementation of a new-generation smart metering system. Endesa has already started the installation of such new AMM solution that will be fully deployed on its 13 million customers in Spain within end 2019; such deployment represents currently the main smart metering roll-out on going in Europe.

INTRODUCTION

ENEL is the first utility in the world that has developed and operates an automated system to remotely manage more than 32 million electricity meters. The ENEL Automated Meter Management (AMM) Solution, named Telegestore, was fully deployed from 2001 to 2006 and is strongly supporting Enel achieving an operational excellence in terms of operational cost and quality of service (Figure 1).

Thanks to this solution, metering data can be remotely collected and sent to energy retailers; moreover, the Telegestore is able to remotely perform most of the typical contractual operations, such as: activation of new furniture, deactivation, modification in contractual power, etc. In 2010 the Telegestore performed more than 300 million remote reading and around 20 million operations.



Figure 1 – Enel operational excellence

Based on Telegestore success, Italian Authority for energy and gas (AEEG) published a national decree obliging Italian DSOs to install smart meters to their own customers within 2011.

Spanish Energy Authority (CEM) issued a Royal Decree in line with the European target of 3rd Energy Package. Such decree establishes that Spanish DSOs have to replace the electromechanical meters with new smart

meters within 2018. With this aim Endesa, the largest Utility in Spain, started to develop a smart metering solution in 2006. Once Endesa entered into Enel Group a joint working team evaluated the possibility to apply the Enel Telegestore solution on Endesa's LV network and defined the changes to make the Telegestore solution compliant with Spanish regulation requirements as well as the Endesa's business ones. The Cervantes project - so called internally by Enel and Endesa - thanks to the mentioned synergies among Enel group companies will allow Endesa to complete the deployment in accordance with the deadline defined by Spanish Authority.

THE CERVANTES TECHNOLOGY

The main component of the system is its new smart meter, which replaces the traditional meters. The new meter has obtained full certification (MID B y D) and also the national certification (RD 1110/2007 and Order ITC/3022/2007), on May the 28th of 2010 by the "Energy Technological Institute" in Valencia and is kitted out with state-of-the-art technology. It has the same dimensions and fixing points as the traditional meters: it allows not to change the installation process as well as the meter site. The main advanced functions are: remote reading, power control, remote programming, meter "plug&play" function, remote cut-off and reconnect, quality-of-supply parameters, periodic synchronization, load management capability, events and alarms registration. The solution has been designed to be easily updated in a remote manner in case any other functionality needs to be applied within the lifetime of the field components.

The component enabling the communication between the meters and the central system is the concentrator, which is installed at the secondary substations. This concentrator communicates with meters using powerline carrier (PLC) technology and with the central systems via GPRS. Data is securely transmitted between meters and concentrators and between concentrators and the central system using a new generation of robust, reliable technology based on the open communication protocol 'Meters and More' (www.metersandmore.eu),

**meters
AND more**
OPEN TECHNOLOGIES

Meters and More technology works on the system interfaces defined by the European Smart Meters Coordination Group (SMCG) and fulfils functional, security and communications requirements defined by the OPEN Meter project, which in its conclusions recommended that the Meters and More technology should become an European standard without any required changes (www.openmeter.com). Meters and More is in process of standardization through Cenelec TC13 WG02, under the name of CLC/prTS 50568-x SMITP. It has been also included as upcoming standard in the Smart Grid Report First set of standards (Mandate 490/Smart Grid Coordination Group).



The new solution is based on the field proven robustness and reliability of the Italian solution and includes some innovative features in terms of both components and functionalities. The Cervantes solution has been designed to target a high level of technology innovation in accordance with functional, economic and time-schedule requirements of the project.

The positive results achieved by Enel in Italy using Power Line Carrier have supported the choice to confirm such technology in the Cervantes solution (Figure 2), including in the new field components (meters and data concentrators) the **last generation of PLC modem**. It means in particular: (i) a data transmission real bandwidth up to 4.8 kbps (a double value respect to Telegestore one), (ii) introduction of new effective functionalities (i.e. network impedance and signal/noise rate measurements) that increase communication between meter and concentrator; (iii) different modulation mechanisms to improve meter reachability rate. This reachability rate and the effectiveness of communication are fundamental for meter management more than the bandwidth: the innovation included in the Cervantes solution has been chosen in accordance this target.

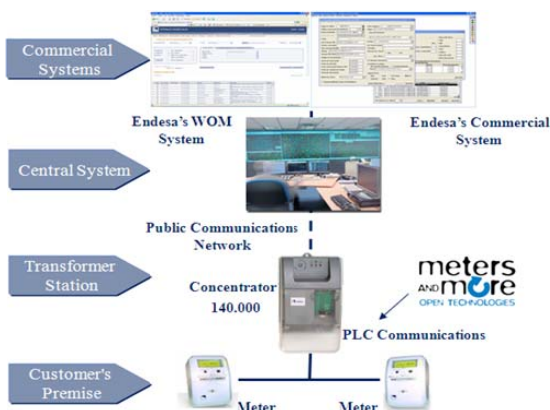


Figure 2 – Cervantes solution architecture

In addition to the abovementioned PLC communication

innovations, other important improvement have been inserted in the field components as well as in the central SW system:

- new CPU that allows to optimize the development and management of new meter software.
- **Automatic rearm by remote:** Enel and Endesa jointly developed an innovative functionality that allow the customer to rearm the meter directly by its own premises after a power cut-off. The Cervantes meter has an internal cut-off element that works like a power/energy control switch, which means, it opens when a customer requires a higher power than the contracted one, in the same way as a traditional power control switch. The innovation is that the rearm can be carried out by switching any of the protection devices that are already in the customer home (main switch, power control switch or differential breaker), thereby avoiding the installation of an additional device for the reinstatement of supply within the customer's house. Therefore, this new feature supposes important savings in costs, deployment time and less trouble for the customer.



Figure 3 – Cervantes meter

- **Meter autodiscovery and automatic system configuration:** meters are detected in an automatic way by the concentrator, without any need of prior configuration of what meters it has to look for. This feature allows a **plug-and-play installation** and operation, thus avoiding the need of having a detailed and continuously updated geographical information system for the low voltage grid. Automatic adaptation of the system configuration to topological changes in the grid. The system detects which meters have changed connection with concentrator due to topological changes in the low voltage grid (typically due to operations for grid maintenance and development). Manually informing and updating these changes is not necessary because the system adapts in an automatic way. This feature It allows to save time by simplifying the processes of grid work
- Innovative data concentrator: the update of data concentrators allowed to **include new functionalities towards a Smart Grids deployment**, in particular enabling acquisition and management of data, alarms and info from different devices installed on the DSO

network. It's possible also thanks to the inclusion of standard interface into concentrator design (i.e. USB). AMM SW modules fully integrated with Endesa Legacy and in operation from day-one: it's allowing Endesa to exploit smart metering benefits from the beginning. Other innovative features have been included by Enel in such SW modules such as (i) high and distributed scalability to manage different quantities of field components and from different management point; (ii) easy integration and configuration with existing DSO Legacy systems; (iii) completed automation thanks to meter autodiscovery and to the improved automation of all operational procedure; (iv) system independence from TLC communication technology (GSM, GPRS, PSTN, etc). Leveraging on the inclusion of the last innovative technologies in the meter's components, the new Cervantes solution will be able to increase more over the performances reached in the Italian smart metering system.

THE FIRST RESULTS IN ENDESA SMART METERING ROLL-OUT

The smart metering system is operative and fully integrated into our commercial and technical systems since 2010, and is designed to handle over 200 million yearly readings and remote operations on requests from the retailers. All smart meters remote operations are managed from one location, the Endesa Smart Metering Operation Centre, from where the company supervises the meters and concentrators already installed and monitors the correct execution of all automatic remote operations. Around 15.000 concentrators have been already installed by December 2012 that are gradually allowing to remotely operate the 3 million meters installed in Endesa customers' premises.



Figure 4 – Endesa control room

High levels of reachability are being achieved on a day-by-day basis, allowing Endesa to leverage on the benefits of this smart metering solution. The following figure illustrates the achieved reachability in the mass deployment:

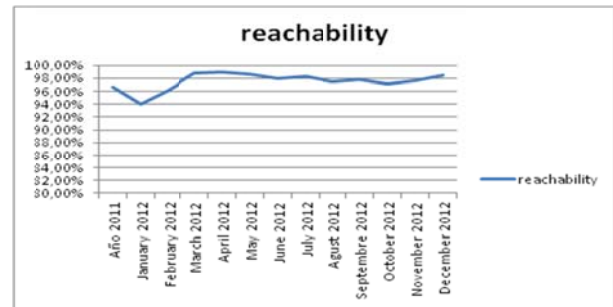


Figure 5 – Meter reachability rate (%)

These results are reached in particular due to the innovative features of Meters and More that have improved the robust and reliable technology operated by Enel in Italy. Those features could be summarized as below:

1. Technology innovation in the meter:
 - a. New microprocessor: more advanced and powerful CPU, maintaining its cost-effectiveness, allows to manage all software application, optimizing the SW development.
 - b. Use of advanced electronic components, also to optimize the space inside the meter.
2. Meter design: thanks to the mentioned innovation, the new meter has a reduced size, compliant with DIN standard, and is being installed without any additional accessories.
3. Remote rearm: the customer could restore its electricity supply using its existing in-home breaker, with relevant economic and operative benefits.
4. Thanks to the re-engineering of data concentrator, it has been possible to enable new functionalities to support the upcoming implementation of Smart Grids concept, in particular allowing the acquisition of data, alarms and information even not directly related with metering business.
5. New communication protocol: the use of the open Meters and More PLC communication technology, based on the successful results achieved in the Italian system, makes the new smart metering solution as a benchmark worldwide. In addition, Enel Group has leveraged on the long-term collaboration with the leading microchip manufacturer, ST Microelectronics, to update a new PLC modem compliant to Meters and More in order to improve the transmission performance through:
 - a. Band up to theoretic 28.800 bps and real 4800 bps;
 - b. Introduction of innovative functionalities and measurements such as network impedance measurement and signal/noise ratio, that optimize the performances in the communication;
 - c. Different modulation mechanisms to improve meter reachability while assuring interoperability with the solution used in Italy.

In addition to normal operations, different stress test sessions have been carried out by Endesa in order to check the system performance in very strong conditions in the field load profile reading tests have been performed to calculate the maximum number of load profiles data that can be retrieved in 24 hours.

A very complex communication tree was chosen to perform the test with 100 meters connected to 1 concentrator and up to 3 repeaters (4 levels of meters) as shown in Figures 6 and 7 below.

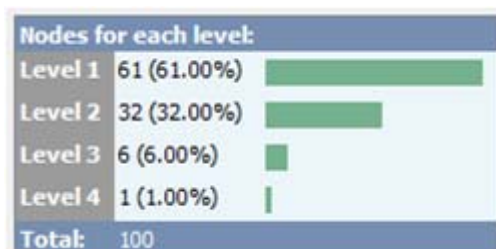


Figure 6 – Meter reachability rate in the 5-level

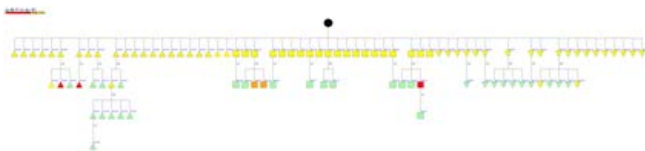


Figure 7 – Meter communication tree

The results showed that 15 minute load curves for 7-days in a week were retrieved in less than 3 hours in all cases, which means that concerning PLC communications the procedure can be launched daily for all the configurations tested. In fact, currently load curves are operated in the mass deployment to allow to give additional near real-time information to customers in various pilot scenarios.

CONCLUSIONS

Enel Group is confirming its leadership and position as worldwide reference thanks to the Cervantes project carried out jointly with Endesa in Spain. It confirms not only the experience and know how reached by Enel in smart metering and smart grids during the last 10 years but also the positive results achieved working in synergy with its affiliated company facing different challenges in a different country.

The Cervantes project is the main smart metering roll-out on going in Europe and since day-1 it's demonstrating a high level of performance thanks to the enhancements included in the development of the new generation PLC communication protocol, Meters and More.

The percentage of reachability and the speed and accuracy of the PLC communication make Meters and More the best performing solution currently implemented on field. Moreover Enel Group is already leveraging on this updated innovation to start up also in Spain and

Latinamerica advanced Smart Grids projects such as electric vehicle recharging infrastructure and active demand solution.

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