SMART INFO AND ENERGY@HOME: THE SOLUTION TOOL TO ADDRESS AND ASSESS CUSTOMER PARTICIPATION TO THE ENERGY MARKET

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ABSTRACT

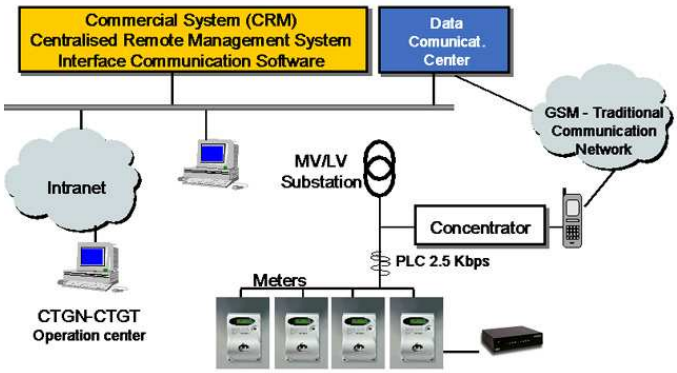
The Smart Info project is developing a new generation of devices aimed to establish a direct link between the utility and the clients, which will be provided with information about their electric consumption. Such information shall enable the clients to be aware of their usage of electric energy allowing them to take actions in order to pursuit a more efficient utilization of energy. The proposed system shall also play the role of a key element for the development of a domestic network where the home appliances will be able to communicate among each other and with automatic load control systems. The collaboration of the available devices in the digital house shall provide advanced services in order to achieve a more efficient use of energy, which will enable automatic management of energy demand in real time. This project leverages the AMM solution and it is based on the same infrastructure, which grants solid grounds for a successful and reliable solution.
Moreover, the project will adopt open and standard mechanism to enable the interoperation between the Smart Info and other clients' devices. This choice seeks the integration with already existing products and solutions and any further development of the domotic appliances market. For this purpose, ENEL started, together with Electrolux, Indesit and Telecom Italia, the Energy@home collaborative project.

INTRODUCTION

ENEL is the first utility in the world that has developed and operates an automated system to remotely manage more than 30 million electricity meters. The ENEL Automated Meter Management (AMM) Solution, named **Telegestore**, started to be deployed in 2001, and gained excellent results through the time. 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.
Today, the electricity market has entered into a new era characterized by increasing focus on environmental protection, energy saving and a "customer oriented" approach. Within this framework, the active participation of the customer is a valuable instrument to achieve a more efficient use of energy, because it will help to modify consumptions allowing advantages such as peak reduction, consumption moved to off-peak hours or when renewable production is higher. These services will provide significant advantages for the entire energy system and economical benefits for customers, which will be offered tailored offers for their participation.
In this new era, energy services represent one of the most exciting challenges and a great chance for Distribution System Operators (DSO). In this framework, the Italian Government has enacted the 115/08 ordinance stating that the Electricity Authority (AEEG) shall define the rules and the minimum requirements of new services that the Italian utilities will have to deploy to their customers in order to simplify the access to consumptions data.

TELEGESTORE'S ARCHITECTURE

The Telegestore solution is a three levels infrastructure: from the meter to the Central System, through a data concentrator installed in each secondary substation.
The main Telegestore elements are depicted in the following picture.



Picture 1 Telegestore's architecture

Data are transmitted through the energy distribution grid between Meters and LV-Concentrator (LVC), while Public Communication Networks enable the communication between LV-Concentrator and Central System.
The first part of the communication is achieved through low band Power Line Communication (PLC) technology. The same PLC communication channel, used between the Concentrator and the Meters, can be used to host additional devices, such as the Smart Info, that are therefore enabled to exchange data with the other elements under the same Concentrator. Hence, since the beginning, the design of the ENEL Telegestore infrastructure has been constantly carried out looking at additional system functionalities and devices to provide energy services to the final customers.
With this design every domestic socket can be an "access point" to the exchange information with the utility.

THE ENEL EXPERIENCE

Since 2002, ENEL has testes displays that, thanks to a two-way communication via PLC, enable the indoor visualization of the energy data and the central acquisition of customer feedbacks.
At the beginning of 2008 Enel has carried out a large market test involving thousands of customers in more than 50 cities, building up a high representative cluster of the Italian market.
In order to guarantee unconditioned test results, Enel has outsourced the management of this market test to a market research institute particularly experienced in the identification of representative panels in the Italian market. This third party has designed and run the market test according to Enel requirements and analyzed the final customer feedbacks. In the market test, Customers were provided with a device similar to the Smart Info connected to a display.

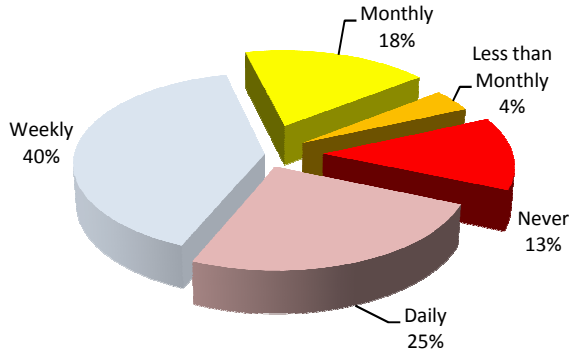
:ture 2 Display used in 2008 Market Test

This market test was designed to:

- Verify the energy services customer acceptance
- Evaluate the impacts on the customer energy behaviors
- Test in field the technical solutions and the operative procedures.

The feedback analysis demonstrated that:

- The display has a strong appeal on the customers, which asked for more specific and personalized services
- The service has impact on the energy customer behaviors. Better results can be achieved integrating metering data with information collected by additional sources
- These services are technically feasible, because integrated in an infrastructure fully operational over the whole grid.



Picture 3 Usage of Display in 2008 Market Test

THE SMART INFO DEVICE

The Smart Info has been designed in order to leverage the Telegestore Infrastructure and the experience achieved through technological and market tests.
The Smart Info has been designed with a very high level of flexibility in order to be ready to offer a wide and diversified set of services, thinking overall on the many potential devices to be used as client interfaces (e.g. personal computer, smart phones, indoor display, TV).
In addition, the Smart Info will be part of the domotic environment, enabling new advanced energy services, through the collaboration of different stakeholders. For example, domotic appliances shall automatically modify their consumption according to electric grid conditions.

The main three drivers, used to identify the candidate solution have been:

1. **Uniqueness of Telegestore**: the Smart Info shall be integrated in the already existing infrastructure.
2. **High production volumes:** the Smart Info shall be potentially provided to many or all the Customers that have already been provided with ENEL Smart Meters. Hence its design shall take into account the cost saving coming from economies of scale
3. **Long term perspective:** the identified solution shall be flexible enough to integrate different future communication technologies, especially the ones used in domotic applications.

The chosen solution adopts a modular approach:

- A **base block** (the Smart Info itself): it is a plug device to interface with the existing grid and supporting minimal functionalities.
- The **Additional Blocks** (AB) whose purpose is to enrich the base functionalities supporting both additional services and the management of more evolved interfaces

Therefore, the Smart Info will also have interfacing capacity with Auxiliary Blocks to satisfy advanced functionalities. The interface with Additional Blocks is achieved via **USB port** and a single communication protocol for all the possible Additional Blocks. In this way the core, Smart Info can be a very simple and standard device, delegating complexity and specialization to external hardware and software.

Hereafter is shown the list of services enabled by the Smart Info and its Additional Blocks.

Base services Smart Info + Display or Personal Computer	
Base consumption data visualization	Services oriented to the final customer
Alarm signalization (e.g. overload)	
Contractual information	
Visualization of service messages	

Advanced Services Smart Info + Additional Blocks		
Advanced Consumption data visualization		Services oriented to the final customer
Visualization of cost data		
Energy efficiency	With power awareness only	
	Using Smart appliances	
Cost reduction	With cost awareness only	
	Using Smart appliances	
Monitoring of electric vehicle recharge		
Monitoring of self-production		
Additional Monitoring of energy demand		Services DSO oriented
Demand modulation request		
Metering data collection for third parties (not only electrical)		
Rational and efficient use of smart appliances		Services enabled for third parties

In the following pictures are shown some Smart Info design concepts, where it is possible to see how Additional Blocks (in this case a wireless communication module) can be connected to the Smart Info via the USB port.

Picture 4 Smart Info Design Concepts

The communication protocol used on the USB port, is derived from the one used in Telegestore PLC channel between the Smart Meter and the Smart Info. From this perspective, the Smart Info can be considered the instrument to provide utility data into the domestic environment.
The following table shows a summary of the data exchanged between the Smart Info and its additional blocks.

Smart Info Data	
Metering data	Active and negative energy in *current* billing period and in different tariff intervals.
	Active and negative energy in *previous* billing period and in different tariff intervals.
	Maximum power of active and negative energy in *current* billing period and in different tariff intervals
	Maximum power of active and negative energy in *previous* billing period and in different tariff intervals
	Average positive and negative power (different integration periods)
	Reactive Energy in different billing periods and tariff intervals
	Active and reactive energy of current day and previous one.
Contractual and configuration information	Contractual power and power thresholds.
	Customer ID
	POD (Point of delivery) code
	Tariff intervals configuration
	Credit left (for pre-paid contracts)
	Date and time (from the Smart Meter)
	Last alarm with type and timestamp
	Meter device details
	Bidirectional transmission of custom data.

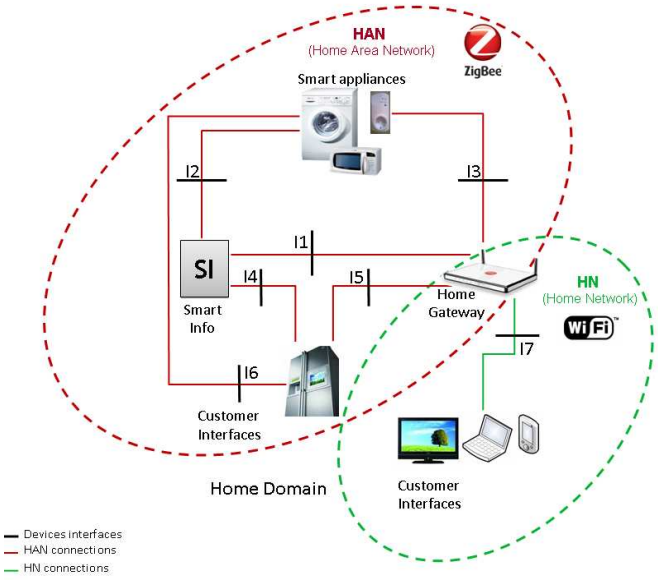
THE ENERGY@HOME PROJECT

In order to enable energy service to residential customers, ENEL started, together with Electrolux , Indesit and Telecom Italia, the Energy@home (E@H) collaborative project.

Picture 5 E@H Logo

The aim of the project is to develop a ZigBee based communication protocol that enables provision of Value Added Services based upon information exchange related to energy usage, energy consumption and energy tariffs in the Home Area Network (HAN). The project envisions a protocol that shall be used to build an integrated platform to allow cooperation between the main devices involved in residential energy management.

The architecture (described in [1]) of the E@H system is shown in the following picture.



Picture 6 E@H Reference Architecture

The main actors in E@H architecture are:

- The **Smart Info** that shall be equipped with a dedicated Additional Block to enable E@H protocol;
- The **Smart Appliances**, able to cooperate in order to adjust power consumption by modifying their behavior, while preserving the quality of service and user experience;
- The **Smart Plugs,** able to collect metering data and to implement a simple on/off control on the plugged energy loads other than Smart Appliances;
- The **Home Residential Gateway**, which acts as the central coordinator of the entire home. It allows data exchange between the devices operating in the Home Network, in the Home Area Network, and in the Internet;
- The **Customer Interfaces**, i.e. all the devices used by the customer to monitor and configure his/her energy behavior.

These classes identify the main categories of devices in the Home Domain, without any limitation to the possibility for a device to implement functionalities from more than a category. As an example, an advanced Smart Appliance, provided with a rich user interface, could also implement functionalities typical of a Customer Interface.

On December 2010, the E@H members have issued protocol specification v0.9 [2] that is the release candidate to become E@H specification v1.0. Moreover, v0.9 has been endorsed by ZigBee Home Automation Committee, in order to be incorporated in future releases of Home Automation profiles. Furthermore, E@H members are in contact with the CECED (Conseil européen de la construction d'appareils domestiques) to evaluate the possibility to adopt E@H specifications.

CONCLUSIONS

ENEL main goal is to give to the customer an *active role* in the energy System. The Smart Info is the starting point of a “step by step” activity plan to allow this active role, starting from the increasing of the consciousness on the energy consumption, moving on the pushing of virtuous energy behaviors and approaching the integrated management of the Distributed Energy Resources and the Customer Loads in order to assure the energy efficiency first locally and then at the energy distribution level.

REFERENCES

[1] Energy@Home project, *Energy@Home Use Cases*, Rev. 1.2, April 24, 2010

[2] Energy@Home project, *Energy@Home Technical Specifications*, Rev. 0.9, December 23, 2010