EARLY-STAGE SMART GRID DEPLOYMENT: LEVERAGING DNO'S LEGACY ASSETS.

Rosa MORA
SIEMENS – Spain
maria.rosa.mora@siemens.com

Alberto LOPEZ
CEDETEL – Spain
alopez@cedetel.es

Alberto SENDIN
IBERDROLA - Spain
asendin@iberdrola.es

Iñigo BERGANZA
IBERDROLA - Spain
iberganza@iberdrola.es

ABSTRACT

The purpose of the paper is to communicate the progress of the third year of the Active Demand Management project (GAD Project [1]) in different areas, especially related to testing of communication requirements of SmartGrids using network simulation software. This experience will support the agents of the Electrical Sector in order to assess new regulatory requirements, improve service quality and overall energy efficiency, being the key tool in defining a new electricity marketplace.

INTRODUCTION

According to **2020 strategy**, Energy Sector needs to reduce by 20% current CO2 emissions, to improve a 20% in energy efficiency and to introduce at least a 20% of renewable energy sources. There are some important roles to play at different sector levels:

- Modern **generation turbines** are improving their efficiency in order to achieve better consumption ratios and life time cycles
- **CO2 capture plants** are phasing into the real field implementations; **renewables** are playing a bigger piece into the mix generation
- **Energy Transport** is also improving in materials, gas isolation in lines and stations, HVDC lines deployment (High Voltage Direct Current), massive storage to ensure different networks interconnection.

In this paper we would like to emphasize the new distribution network possibilities due to **Smart Grids** introduction and deployment in the Electrical Sector ([2], [3], [4] and [5].
Consumers are at the end of the grid: industrial, medium size business and final users. How to deal with the **last mile consumption and small and distributed generation**, is really the point to address with a new generation of applications. Smart Grids functionalities will get the right information from the right point, and help the Control Centres to make the right decisions
Energy Sector will apply the lessons learnt in the Telecom sector to deploy communications among the lines, in a safe and reliable way, taking into account the strong commitment with Society: no zeros, no blackouts. The paradigm is changing: from passive devices and few telecom network, to distributed intelligence with up to date telecom networks.

The installations will have to be updated to support new functionalities to monitor and control the electrical network, a new communications network will be deployed massively over the electrical network, to maximise the return of investment (ROI) of existing and new investments.
A big effort is now on the standardization process, as already existing devices and protocols for both telecoms and electrical sector will have to be updated, stress tested and piloted, as there could be different solutions to reach the best performances, different life cycle coexistence and play a support role to improve the current service of the electrical network to our society: the Smart Grids objective should be to add intelligence to the network and minimise the effect of a growing population and demand. On top of this, the challenge utilities face is to roll out real networks for millions of customers.

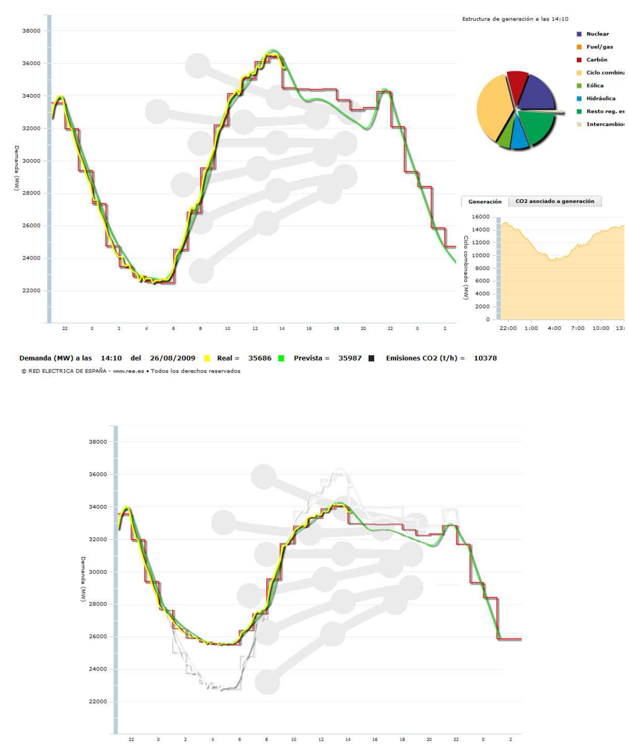


Figure 1: Electricity Demand Curve tracking in real generation vs. Electrical Demand Curve flattening improves electricity generation efficiency. Demand Curve: The effect of these contributions is that a powerful network working system is needed to estimate, control and integrate all sources. **Demand Management** (curve flattening): Spain variation is from 42 GW to 24 GW from daily peaks to night valleys. Demand management tools should be design and put in place in order to reduce of utility loads during periods of peak demand, while at the same time building load in off-peak periods. *Source REE[6]*.

COMMUNICATIONS ARCHITECTURE

According to the defined business model, there are five main agents that support the Active Demand Management: end users, distributed energy generators, DSO, the Power Marketers and the TSO. These agents operate different segments of the electrical network structure, and these criteria will be used to define the new areas in the communications network:

- **Control Area:** physical and logical resources to guarantee the Communications between the TSO, the DSO and the Power Marketers.
- **WAN Area:** physical and logical resources to enable the Communications between DSO and the user devices at the buildings (counters, residential bridges, load controllers).
- **LAN Area:** physical and logical resources to enable the Communications between Load Controller and different devices at home (loads), with enough capacity to support intelligence and remote Management.

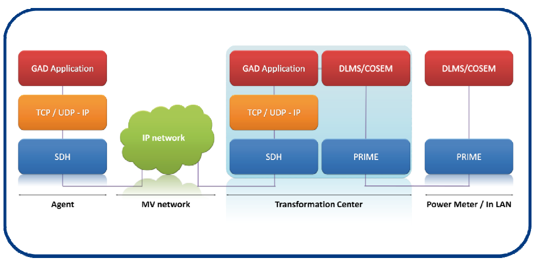


Figure 2 : General Architecture Overview. *Source: GAD project.*

Agent (TSO / DSO / Commercial) will use the DSO facility to reach end-user devices, thanks to this new concept in communication protocols. The electrical network is divided into several segments, with a differentiated physical layer (horizontal axis criteria: Control Centers at the Agents, High/Medium Voltage infrastructure (cables and substations), LV segment (cables and transformation centers, home installations). Use the OSI model to define the vertical layers and to define a final electrical communication model. In each matrix position, define the most suitable and status-of-the-art protocol to fit the end to end solution for residential segment.

LAST MILE COMMUNICATION

At this point, we would like to discuss the advantages of using narrow band **PLC CENELEC A OFDM** (PRIME Alliance definition) in the last mile, as this means the best business model case to ensure the minimum impact in investments ([7], [8]).

As a matter of fact, in 2010 IBERDROLA has been committed to launch the **first e-meter massive deployment in Castellón (Spain)** with PRIME standard, that means several thousand units working in the field to analyse technical, usage and business results.

Among other European or national projects, Iberdrola is also leading the GAD project in R&D phase, an initiative to support the **Demand Management** for final users at last mile. As the synergies in the Smart Grid applications are clear, it will worth to pilot and demonstrate the capacities of narrow band PRIME in order to support new services in the Electrical sector with a cost effectiveness criteria.

PRIME network for Smart Metering, and all the auxiliary telecom technologies to transport data to Control Centres, would be deployed both for remote metering, demand side management and electricity assets control and monitoring.

The capacity of these networks for these purposes must be assessed, and this is the reason why **Smart Grid** communications are being tested through simulations performed by CEDETEL under SIEMENS definition for the GAD project ([9], [10], [11]).
With this simulation-based Smart Grid analysis tools, we will be able to model communications from Control Centers of the Agents (Transport, Distribution, Commercials) till final users, going through Substation and Transformation Centers special communication devices. **Different protocols** have been chosen, integrated or even built in the different communication layers per electrical area, giving a **strong modularity** to the architecture model which have been included in simulation models, in order to load the appropriate parameters and study the results, advantages and risks prior to a pilot or a massive deployment **in different grids at national level** [12].

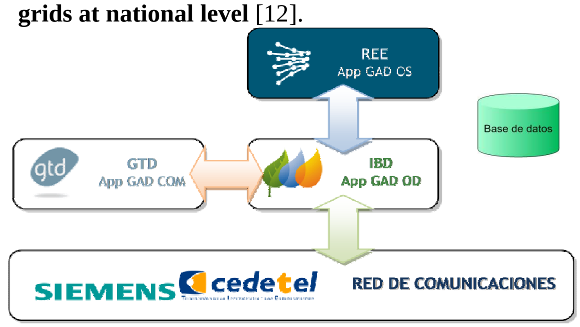
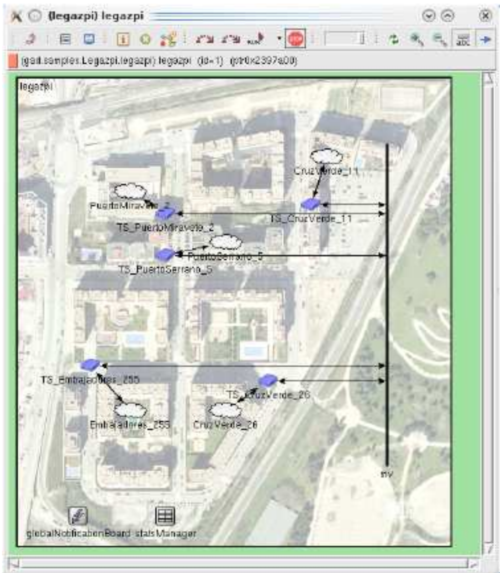
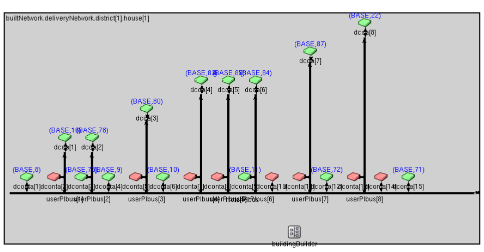


Figure 3 : Interactive simulation structure. *Source: GAD project.*

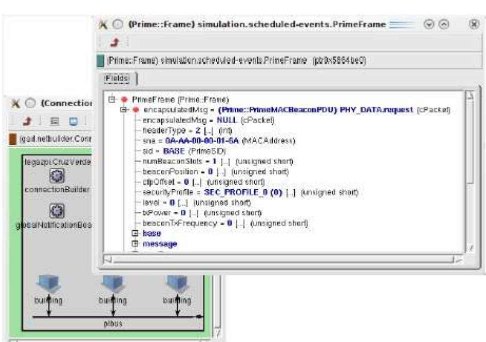
As an example, given a certain electrical topology in a transformation centre, the communications scenario supporting this network is studied using behavioural event-driven models of devices:



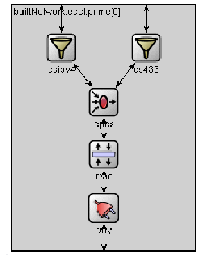
With this data, the topology can be reproduced and predefined parameters can be loaded in the system to specify the network characteristics and the representation of the communication devices could give the users information till e-meters facilities and even LAN devices to monitor and control the consumer premises:



Here we have a detailed example of a PRIME stream in the lower level of a simple network topology:



A detailed view of the internal modelling of PRIME protocol:



Statistics allow communication and electrical specialists to make decision about demand management, assets management, network planning, lines and devices quality testing and other applications that could arise in the future. With these simulations, energy policy may be analysed taking into account client models to produce new recommendations to improve the national grid.

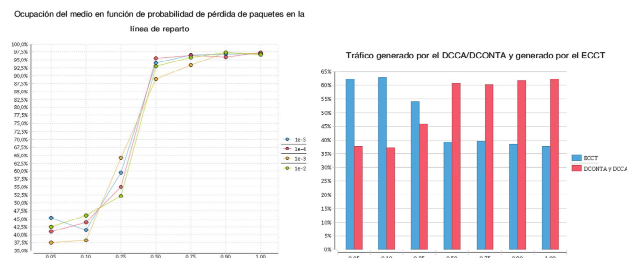


Figure 3 (3.1 till 3.6): Automatic Smart Grid simulations analysis output. *Source: CEDETEL / SIEMENS in GAD project***.**

CONCLUSIONS:

PRIME could lead to the favourite solution to implement low cost applications in last mile, exploiting narrow band communications in electrical sector. Network simulations of SmartGrid applications provide further knowledge of overall system metrics and behaviour reducing network deployment efforts. Pilot SmartGrid networks are under study in 2010 to help in system integration tasks.

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For more info, please refer to the project home page http://www.proyectogad.es/.

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