NEW FUNCTIONALITIES OF SMART GRID ENABLED NETWORKS

Dan Catalin STANCU
Dumitru FEDERENCIUC
Electrica -Romania
dumitru.federenciuc@electrica.ro

Nicolae GOLOVANOV
Univ. Politehnica Bucuresti-Romania
nicolae_golovanov@yahoo.com

Dorel STANESCU
SDEE Transilvania Sud
dorel.stanescu@electricats.ro

ABSTRACT

Electrica the largest DSO company in Romania is faced, as all DSO in Europe, with many challenges in the near future. Two years ago the International Public Offering procedure passed successfully. Since then there was a constant effort to develop a strategy that take into account the new evolutions on energy market.

Here we present the three main directions taken in recent years:

The company response to the present need for acquisition of more and more information required for market operation is focused on Smart Metering large scale implementation and development of Meter Data Management Systems.

The company response to new regulation that reduce the number of admissible interruptions and reduction of SAIFI, SAIDI, ENS indices accordingly is the investment into SCADA and DA systems taking into account the DER/RES environment.

Third direction is the introduction of digitalization and Smart Grid concept and IT/C constant development

INTRODUCTION

Europe's power network was changed substantially due to integration of large DER capacities and of fast charging nodes, both putting a substantial stress on existing low voltage installation. Even a low penetration of these disruptive technologies can cause equipment overloads, voltage deviations that exceed permissible operating thresholds and bidirectional power flow in distribution networks.

DSO has the role to improve the network efficiency and to "smarten" it's operation using a resource not taken into account some years ago: user flexibility.

As seen in figure 1. DSO will have a key role in future market as a facilitator between more active prosumers and their correspondent suppliers.

Demand flexibility (DSF) can be achieved for the system by providing household, commercial or industrial control signals and/or financial incentives to adjust their consumption in strategic nodes.

Smart Grid services require specific high-level services groups according to the network functionalities. In some cases these functionalities could be broken down further into smaller sub-functionalities.

A. Enabling the network to integrate users with new requirements

- simplify and reduce the cost of the connection process

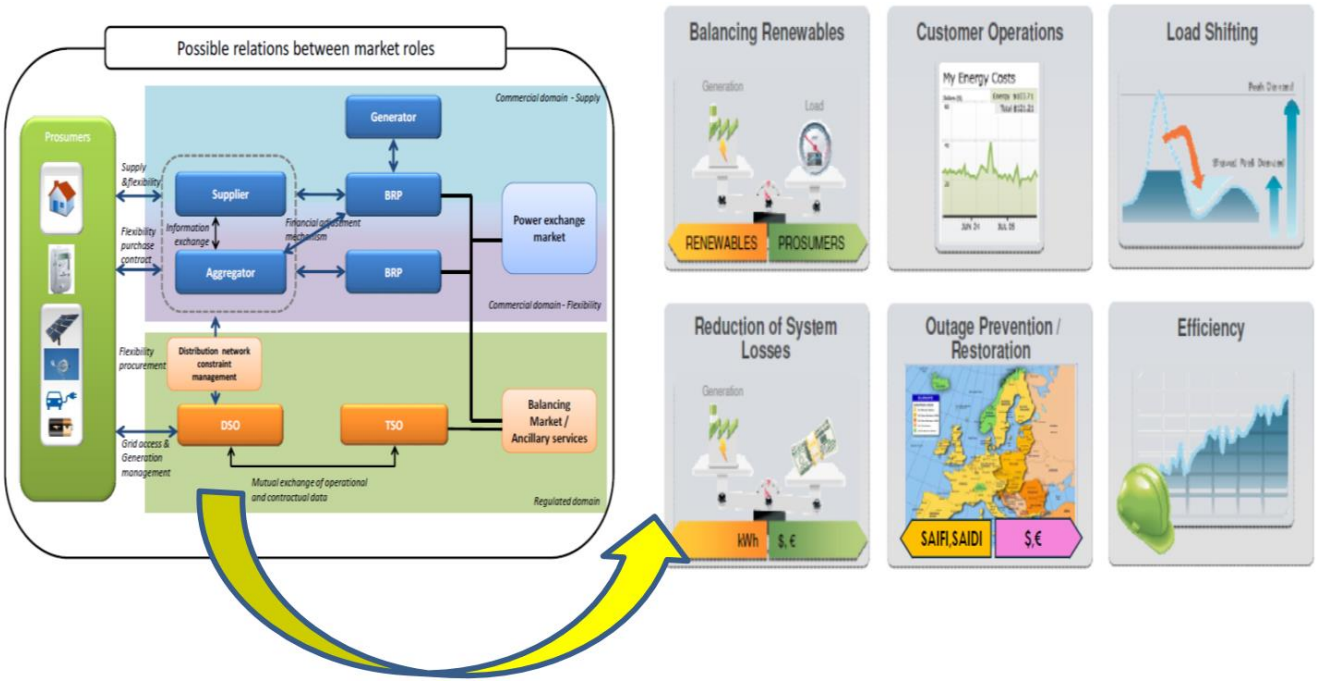

Figure 1- DSO role in future market (source: Eurelectric [17])

subject to maintaining network integrity/safety;

- facilitate an 'open platform' approach – close to 'plug & play';
- facilitate connection of new load types, particularly EV;
- ensure that the most efficient DER connection strategies.

B. Enhancing efficiency in day-to-day grid operation

- improved automated fault identification and optimal grid reconfiguration after faults reducing outage times:
- using dynamic protection and automation schemes;
- strengthening Distribution Management Systems of distribution grids.
- enhanced monitoring and control of power flows and voltages.
- enhanced monitoring and observability of network components.

C. Improved monitoring of network assets.

D. Improving market functioning and customer service

Solutions for participation of all connected generators and VPPs in the electricity market, allowing market participants to offer:

•time of use energy pricing, dynamic energy pricing and critical peak pricing;

demand response / load control programmes;

- grid solutions for EV recharging.
- smart control of the recharging process through load management functionalities of EV.
- grid support to intelligent home/facilities automation and smart devices by consumers.

E. Enabling and encouraging stronger and more direct involvement of consumers in their energy usage and management:

- Sufficient frequency of meter readings, measurement granularity for consumption /injection metering data (e.g. interval metering, active and reactive power, and so on).
- Remote management of meters.
- Consumption/injection data and price signals via the meter, via a portal or other ways including home displays.
- Individual continuity of supply and voltage quality indicators via meter, via portal or other ways including home displays.
- Identification of technical and non technical losses through power flow analysis, network balances calculation and smart metering information.

F. Ensuring network security, system control and quality of supply, System security assessment and management of remedies.

All these functionalities are examined using examples from current projects developed in Romania underlining the best practices in concordance with current standards and regulations.

BENEFITS OF MDM IMPLEMENTATION

Meter data management (MDM) is a software system that performs long-term data storage and management for the vast quantities of data delivered by smart metering systems. This data is imported from the head-end servers managing the data collection in advanced metering infrastructure (AMI) or automatic meter reading (AMR) systems. MDM is a key component in the Smart Grid infrastructure.

Figure 2 presents the architecture and interconnection of the proposed MDM System. Functional interoperability with other systems will be achieved using standardised communication protocols and Common Information Model (CIM).

MDM constitutes the technical support used to monitor the Distribution Grid on High Voltage and Medium Voltage. Collected measurement data is used to analyse network power losses and the quality of the distributed power (voltage levels in the Distribution Grid nodes a.s.o.) and even the Distribution Services Standards (SAIFI, SAIDI a.s.o.). It also provides access to the measurement data for all parts involved in the energy market in order to create the conditions necessary for retail markets. (Demand Response and Virtual Power Plant functions), these being a part of the services provided by the DSO.

All reports generated by MDM- Big Data need to fulfil their assigned purposes and functions for each level. On one hand, they are stored in the MDM systems that generated them, and on the other hand they will be transmitted -according to DSO/ELECTRICA procedures– to the competent services/entities (processes uniformity).

This will ensure Electrica's investment costs optimization providing "data back-up" and "business continuity".

The cost reduction for Big Data technologies is one of the major concerns of utility companies and is achieved through both by using appropriate hardware systems and software applications with reduced processing time as well as identifying optimal data storage solutions.

Using a single Big Data (Data Mining & Data Analytics) software package, depending on the licence for each software will reduce the investment effort considerably. Using different versions for the database virtualization will lead to cost reductions in data transport and manipulation and more effective use of the data with reports including only the information needed in the decision making process.

DEMAND RESPONSE SUPPORT

The MDMS can potentially support demand response programs at various levels. At the most basic level, the MDMS is the repository for historical consumption information and therefore is essential for utilities to track the effectiveness of any specific event or an overall program.

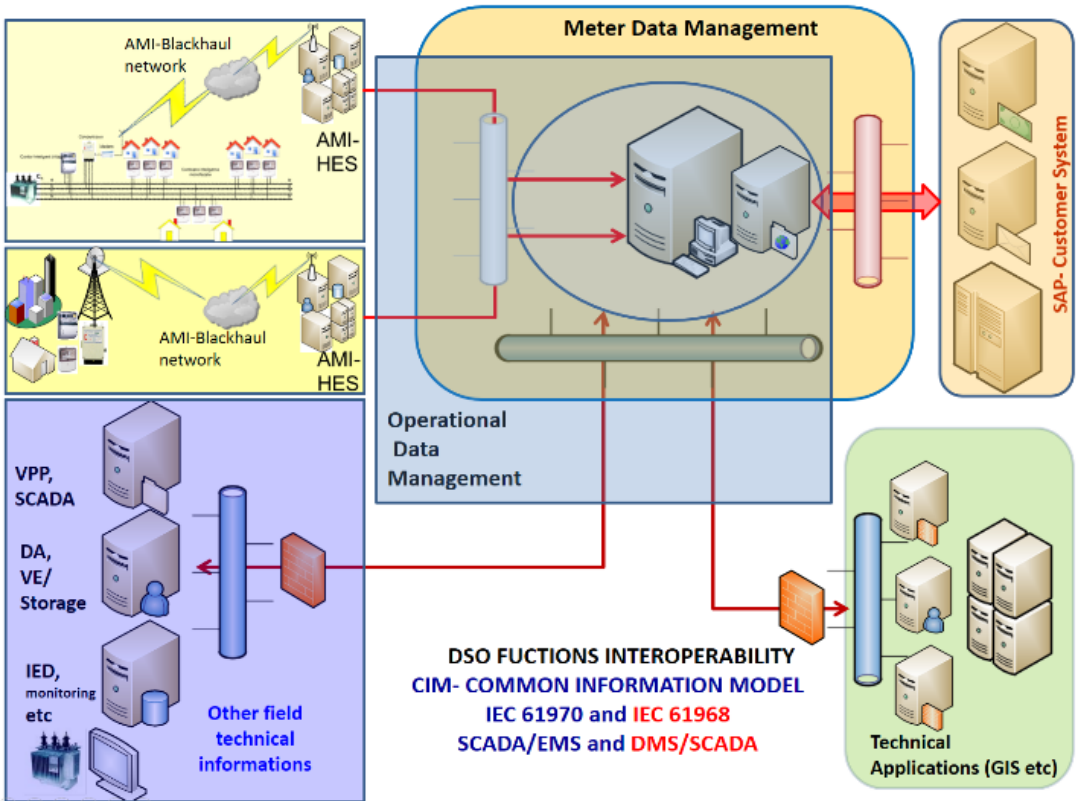

Figure 2 MDM Functional interoperability

In a more active role, the MDMS, through its asset management functionality, can maintain the asset information for any hardware associated with the demand response program — thermostats, control devices, and so on. The MDMS data structures should enable the assignment of customers to specific demand response programs. Some utilities want the MDMS to assist in managing pre-paid meters such as setting consumption thresholds, monitoring usage against the threshold and alerting at specific thresholds of usage.

OUTAGE MANAGEMENT SUPPORT

A high priority area for many AMI implementations is real-time support to outage management. The basic process is simple. The MDMS receives and processes as many last gasp statuses from individual meters as possible and supports verifying restoration to individual meters prior to closing the outage. But subtleties can improve an AMI systems ability to support outage management. Utilities providers want the MDMS to filter known service orders to reduce false positives and to filter momentary outages. Utilities providers also want the MDMS to be able to throttle last gasp messages so that processing the events does not impact OMS performance, while still tracking all messages for asset history. Some utilities providers want to identify high priority or bell weather meters that will come through even if throttling thresholds are implemented.

CUSTOMER PRESENTMENT

Utilities providers believe customer usage behaviour can be changed if they have access to information on their consumption. It is the basis for implementing time of use rates and demand response programs. The MDMS is a crucial link in making consumption information available to customers. Some utilities providers are focusing on passive communication features such as web applets to present customers with consumption information and providing energy usage analysis tools to internal and external customers. Other providers are focusing on presentment tools integrated with demand response programs to actively communicate events and thresholds to the customer.

DIGITIZATION CONCEPT- DIGITAL SHIFT OF ELECTRICITY DISTRIBUTION

Electrical distribution systems digitization is evolving rapidly.

Despite the uncertainties regarding the future roles of the distribution system operator (DSO), digitization has reached the transformer substations through existing standards and technologies. And continues to influence the entire DSO business sector.

DSO's Investments in the operation of the energy markets aiming to ensure the necessary measurement data created enough problems in operation and management, and handling digital data and digital communications are a constant topic of discussion, topic

sometimes called Big Data.
DSO is running data collected from the IED automation systems on the PC's installed in each substation command centre using the SCADA systems.
EU report on digitization defines the digitization of the power system as "the process of implementation and operation of a set of assets used to monitor, transfer and analyse data generated by each of the parts involved in the power system "with a set of rules between TSO and DSO. The Common Information Model ensures the data interoperability (IEC61850, IEC61970/IEC61968)

DISTRIBUTION NETWORK MODERNIZATION AND DEVELOPENT USING THE SMART GRIDS CONCEPT

Consequently, in the current stage of development and modernization, the distribution network must face both the challenges of environmental requirements (DER integration) as well as those related to the wholesale and retail energy markets operation respecting the Performance Standards for power distribution services regarding the infrastructure .
In this regard, Electrica SA investments, proposed by IPO

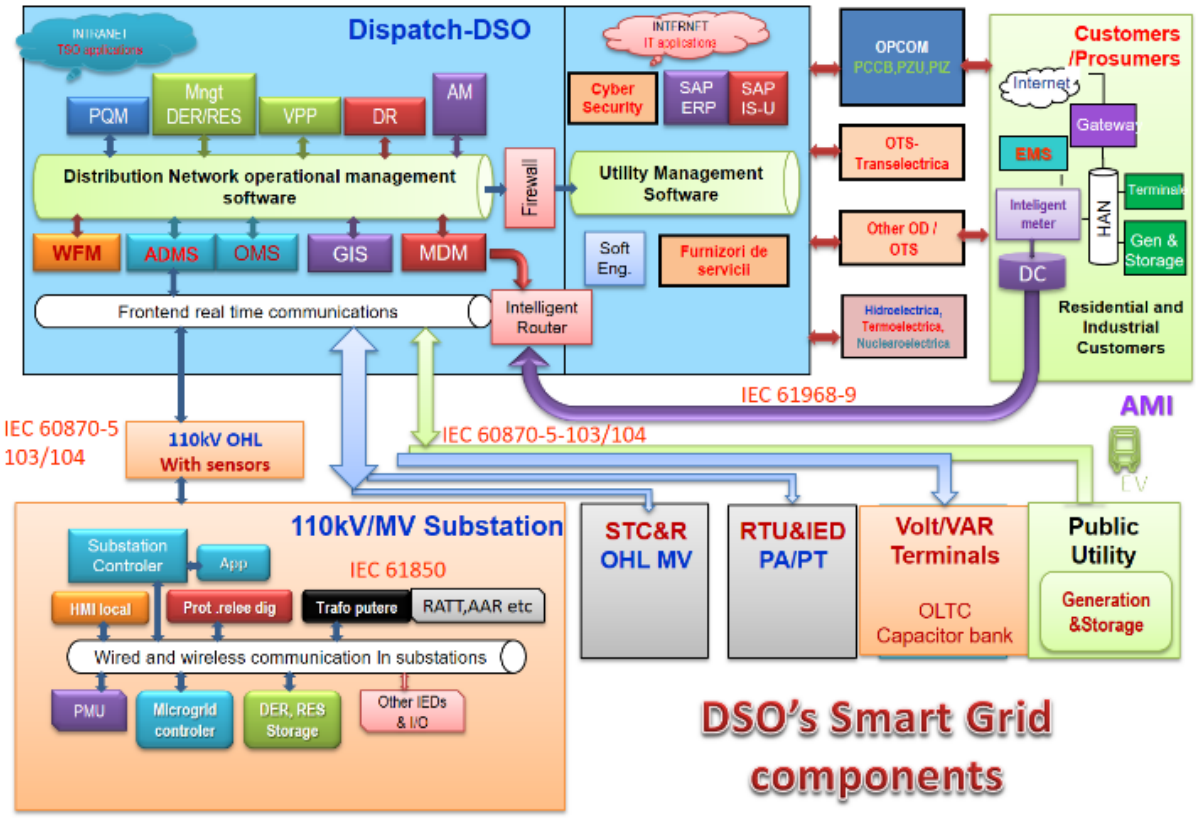

Figure 3 Communication standards between components of a Smart Grid enabled DSO

ASSET MANAGEMENT

Deploying and maintaining an AMI system is a major undertaking because the utility is responsible for the individual assets and tracking the performance of the assets. There is a need for platform to perform the asset management of the AMI system and many utilities would like that to be the MDMS. This could include the entire lifecycle of the AMI assets from installation and installation planning through retirement. The asset management functionality a MDMS could provide must be adapted to each utility provider needs and is based on their specific systems and business processes already in place to support meters and meter inventories.

for the third regulatory period (2014-2018), were important steps in need of proper management thereby the infrastructure refurbishment to meet the requirements for the integration into the European Electricity market providing energy and operational efficiency according to the regulator's requirements.
Main Smart Grid components and their interconnections are presented in figure 3.
Among the investments intended to replace electrical equipment administrated by ELECTRICA with more efficient ones are:

- The refurbishment of 110kV bays with performant 110kV circuit breakers and digital protections;
- The usage 110kV/MV and MV/LV low loss/ Energy Efficient power transformers;
- Switching the distribution network components

operating at 6 and 10kV voltage level to 20kV voltage level.

- The usage of performant low voltage network components in order to reduce the risk of injury;

Among the investments aimed to enhance the degree of operational activities automation we are mentioning:

- upgrading the SCADA/DMS systems at DO level at the same time with refurbishment and SCADA implementation at the transformer stations level.
- Extending the power quality monitoring system(PQM) at the customer level.
- Expanding the axis automation system by insertion of reclosers, remote control switches and feeders, and RTUs
- Expanding the existing smart metering systems and promoting new pilot programs of smart metering.
- Incorporating DER in SCADA/DMS systems

CONCLUSIONS

We consider that the term "smart grids" continues to be used, while "digitization" meets the political agendas regarding the development of data services by DSO and TSO.

DSO's role as a data provider of data is currently being discussed intensively. Not many DSO have a vision for their new roles in a smart grid environment, but they realise that their tasks in the energy market will become more complex

They see their role being gradually adapted to the new situation. Regulators should assess these categories of investment and the associated services and should include them in the distribution tariffs.

Only a few DSO acknowledge the possibility to provide new services such as prefigured surveillance of the smart grid and promotion of energy efficiency awareness. For this reason, only few of them pay attention to this category of investments.

In order to increase the operation automation of the DSO needs to promote investment in smart grids components, while paying a particular attention to ensure standardization in the interoperability (processes uniformity) requirements.

The acquisition of software platforms type Asset Management, OMS, WFM, MDM etc., requires a special attention and the regulator needs to be consulted in implementing the best practices.

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