INOVGRID, A SMART VISION FOR A NEXT GENERATION DISTRIBUTION SYSTEM …

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ABSTRACT

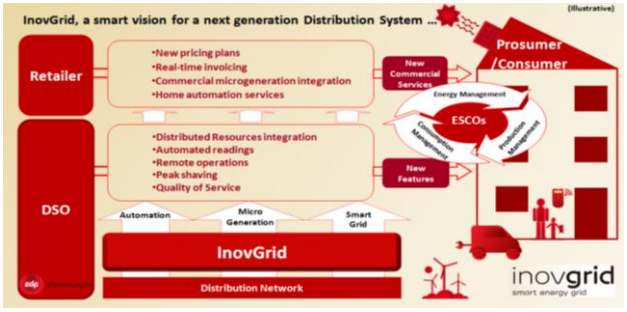
Smart Grids are spreading steadily and becoming one of the cornerstones for utilities transformation. Today the world is facing complex challenges in the energy sector, and utilities have a central role in bringing innovative solutions not only to shape their businesses but also to foster the development of an adequate ecosystem where new ideas can flourish. EDP Distribuição translated its Smart Vision in the InovGrid project, which is already running as a large scale pilot in the city of Évora in Portugal. The InovGrid project encompasses several interrelated areas, and acts as an open platform that sets the common ground. Electrical vehicle (EV), micro-generations, consumers, producers, demand side management, public lighting, storage, multi-utility architectures, cyber-security, data privacy, distributed energy resources (DER) and renewable energy sources (RES), inter alia, are all pieces of a large puzzle built on top of the InovGrid, EDP's Distribuição first step towards a next generation distribution system.

With the InovGrid infrastructure already in place, data is being collected and analyses have been made resulting in robust findings at various levels: energy efficiency increase, with significant consumption reductions; technical and commercial operations with much faster response times and direct improvement of service quality; technical and commercial losses reduction, with encouraging results based on a more detailed knowledge about customers and the grid behaviours; easier integration of RES and other emerging technologies (e.g. EV); and last but not the least, a profound organizational transformation that will culminate in a new paradigm of grid and company management structure.

INTRODUCTION

When the Eurelectric and the European Commission Joint Research Center selected InovGrid in 2011 as the single case study for the assessment of European SmartGrid projects and published the respective reports[1][2] in their websites, the project had already a significant track record of findings supporting a robust SmartGrid Cost Benefit Analysis. In fact, the current world macroeconomic context, imposing alternative types of generation, combined with the objectives of reliability and security of supply while promoting competitiveness in markets induced a genuine change in power grids. This new paradigm rests in several dimensions, such as a more efficient use of energy, increased capacity of renewable generation and distributed resources integration, better observability and controllability of the grid while reducing operation costs, customer empowerment by increased information, market transparency improvement providing the regulator better observability, thereby resulting in benefits across the whole electricity sector value chain, in particular for consumers.

Conscious of this challenge EDP Distribuição (EDP Group) Portugal, the incumbent distribution system operator, with more than 6 million customers, developed the InovGrid project installing a Smart Grid solution in the city of Évora Portugal, for over 50 thousand end users. So far, this demonstration in Évora, the first Iberian Smart City, allowed the evaluation of the technical and commercial benefits of the project through Key Performance Indicators (KPIs), contributing for knowledge sharing through European projects and a larger scale on-going national expansion. Moreover, it gave EDP Distribuição a real hands-on experience of an organization dealing with a new paradigm of distribution networks operation and management, bringing transversally across the company new ways of dealing with old problems and new solutions to increase performance, quality of service and customer satisfaction. The organizational transformation that started with a smart vision for the next generation DSO, and that is materialized in the InovGrid project, is spreading at an increased pace within the organization, being EDP Distribuição in the leading set of DSOs that are at the forefront of the process that is adding smartness to their business.

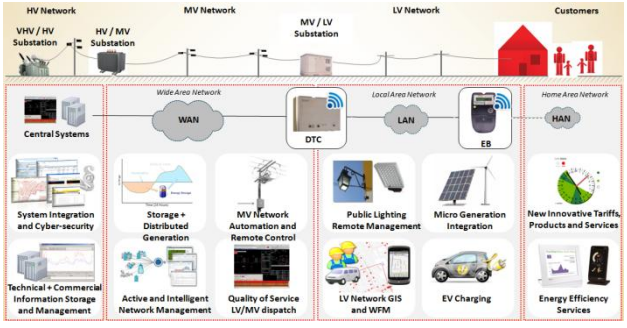


The InovGrid project aims at equipping the electricity grid with information systems and intelligent equipment capable of automating the network management, improving service quality, reducing operating costs and fostering energy efficiency and environmental sustainability, addressing present DSO business' challenges with innovative solutions for energy efficiency, e-mobility, storage and new types of load and generation. The overall solution, developed together with technological and research partners, consists of several components, managed at a central level and articulated among them, allowing EDP Distribuição to fulfil the objectives for the project through an integrated architecture. This approach leverages on an optimal exploitation of each DSO systems' potential as well as the synergies between them, enhancing cost reductions in system integration and better processing the large volume of new information coming from the InovGrid infrastructure. A complete Smart Grid ecosystem is now well under way, leveraged by the InovGrid open platform, with multiple interfaces that touch a vast set of actors in the electricity value chain: from consumers, who are also producers, micro-generators, energy services companies (ESCOs) which provide new types of products and services, to electricity retailers, others DSOs, transport system operators (TSOs), electrical vehicles (EVs), and further companies that seize this large amount of new information are able to come up with tools to create value and setup new businesses benefiting various stakeholders.

INOVGRID ÉVORA

The city of Évora, with about 54,000 inhabitants and an area of 1307 km^2, has been chosen for the implementation of the InovGrid project. The distribution network in Évora municipality is supplied by two 60 kV substations with 15 kV and 30 kV feeders. In these feeders there are MV switching breakers. These 25 feeders supply a total of 655 secondary substations (SS). The overall installed power of the SS that supply clients is 163 MVA, including 2600 LV feeders. The LV distribution network in Évora has no restoration possibilities in the event of a fault. Thus, the possibility of installing storage devices and the implementation of load shedding and demand side management (DSM) becomes very important for network operation. The clients totalize almost 215 MVA of contracted power. Plus, there are also some MV and large LV clients. In what concerns distributed generation, there are 223 microgenerators, mainly solar PV equipments, with an installed capacity of 701 kW, and a growth rate of 48% year on year, which increases the challenge in this area to integrate all this new Distributed Generation. The EDP Box (EB) and the Distribution Transformer Controller (DTC) are the main components of the InovGrid infrastructure. The EB, with its smart metering functions, is the energy management device located at every delivery point, allowing the replacement of the conventional meters. It has the capacity of local interaction with other devices through an HAN (Home Area Network) interface, such as local displays. The DTC is a local control device installed in MV/LV secondary substations comprising a measurement module, control module and communications module. It collects data from EBs and MV/LV substation and performs data analysis functions, monitors the grid and provides an interface with commercial and technical central systems. It is a vital organ of the network's intelligent control providing a set of functionalities that are at the heart of a true Smart Grid system. It communicates upwards with the SCADA/DMS and the Metering and Energy Data Management Systems via a Wide Area Network (WAN) based on GPRS communications and downwards with the EBs by GPRS or PLC (Power Line Communications).

This new infrastructure originated the emergence of a new system called Sysgrid, which not only allowed to deal with a large volume of the available information but also to act on the several equipments while at the same time ensuring the corresponding interaction between existing players systems in the distribution network. This new system provides an overview of all existing devices, allowing the operation of a truly active network, acting as a middleware between the infrastructure and the many other systems, such as the Active Management Systems, Commercial Systems, SCADA and the geographic information system. Huge changes have been made in the IT systems in order to adapt and create several interfaces and business processes to allow an integrated approach leveraging on the emerging synergies. The Sysgrid design was made modular and expandable in order to include new features in each equipment (EDP BOX and DTC), and other related with new services derived from energy data management, without affecting features already covered.



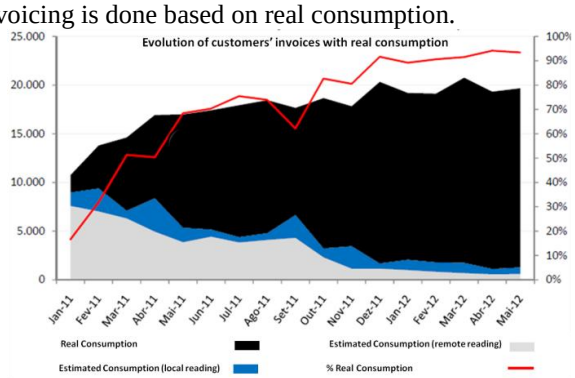
During 2 years, more than 30,000 EDP Boxes and 300 DTCs were installed in Évora, including all customers and substations, in order to have the entire municipality covered. However, the technical side of the project was only a part of the picture and had to be complemented with the sociological and human side, and much effort was invested in clarifying consumers, local authorities, and other interested parties, as it is essential to build a trustful relationship among all, leading to a global willingness to transform the city in the InovCity. An informative store was set up in the city centre, as well as

several other key organizations, like the city hall or the university, where information was permanent with communication tools. Moreover, local media was always involved and clarification sessions were held across the city.

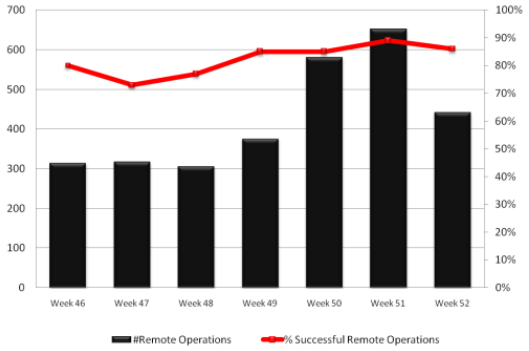
RESULTS ACHIEVED

With the advent of new information coming from the Smart Grid infrastructure, several teams inside EDP Distribuição were summoned to perform detailed analysis on different aspects, such as energy efficiency (including public lighting); technical and commercial losses reduction; technical and commercial operations efficiency, technical and commercial quality of service; and also RES integration and new emerging technologies. Value drivers were defined and KPIs were setup to measure concrete results.

Concerning energy efficiency, a complete study was conducted, by an independent organization with strong university links, and results (including 1 year of full data) show a consumption reduction of 3.9% in the test group (vs. the control group) with an error margin of 2.1%, clearly supporting that consumer empowerment by added information can bring significant benefits to the overall consumption reduction. In what regards technical and commercial operations, several operations have become automated (e.g. contracted power changes, connection, reconnection, disconnection), where before local presence was mandatory, today all can be done centrally saving costs and adding an added layer of comfort to consumers. Real consumption invoicing is one other major disruptive aspect, as before invoicing was mostly done with estimations, consumers' behaviour changes would not be reflected until the next real reading which could take in the worst cases about 3 months. Today 97% of the invoicing is done based on real consumption.



Commercial and technical losses were also tackled, as it is now possible to perform energy balance analysis, measuring the energy flow coming from the secondary substation and comparing it to the consumptions of all clients under that secondary substation. Before the InovGrid project, the information that the utility had about the Low Voltage (LV) Network was very limited and dispatch centres were able to work in reactive mode only, i.e., only after an alert from consumers were they aware of a problem in the grid. Today, the remote access to the EBs and their integration in the system allows to not only receive an alarm in case of a failure in the LV network, but also to verify a fault reported by a client without sending a team to the location. All the gathered information was used as input for a solid Cost Benefit Analysis using the EPRI methodology and carried out together with JRC and Eurelectric.



FURTHER DEVELOPMENTS

The year of 2012 was a milestone for the beginning of the development and expansion of the InovGrid project. The solution developed in a partnership with national manufacturers was opened to the market aiming to reduce the risk and improve competitiveness on equipments' supply chain (engaging new manufacturers), pushing cost efficient solutions. The open market also brings new challenges, since interoperability between different products and manufacturers throughout the InovGrid infrastructure becomes mandatory and a goal to be fulfilled. The path to achieve interoperability relies on the usage of standard communication technologies and protocols, as well as using clear and detailed product specifications. EDP Distribuição acknowledged it and moved on to use PLC PRIME technology and a standard DLMS protocol with an open, uniform and detailed data model at the LAN communication level of the InovGrid infrastructure. The seek for an already available, cost effective, robust, reliable, flexible and with higher bandwidth communication technology to support Smart Grids services was also a factor on selecting PLC PRIME as primary communication technology for the near future.

After the first installation in Évora, the project is expanding to 6 new locations across Portugal - Marinha Grande, São João da Madeira, Faro's Islands, Alcochete, Lamego and Guimarães. The goal is to install 150,000 EBs during 2013 (and corresponding DTCs) and keep an installation pace of 200,000 EBs/year during the following years until the start of the rollout. This expansion provides a unique opportunity to keep and enhance the engagement with external stakeholders and to disseminate the project inside the company, by involving people from different geographies and departments/areas. It's also an opportunity to keep testing and monitoring the adopted technological solutions in different network topologies and environments. The

approach is still to maintain the promotion of customer's engagement and empowerment, to monitor and control the LV network and to implement strong system integration and end-to-end processes. The evolution of the communication technology and protocols implies updates and further developments over the systems used in the first installation, with direct impact in different areas such as data collection, work force management and asset management. Improving security and data privacy over InovGrid infrastructure is also a major goal during this next step of the project, since it is considered a critical feature. EDP Distribuição is pretty much committed to this goal, discussing the issue at international level, such as the Smart Grid Task Force Expert Group 2 (Privacy, Data Protection and Cyber-Security in the Smart Grid Environment).

ORGANIZATIONAL TRANSFORMATION

The Smart Grids paradigm and the new challenges that come along with it triggered an organizational transformation that has already started in EDP Distribuição. Organizational structure, resources (human, systems and tools) and processes need to evolve to take full advantage of the InovGrid infrastructure. An early first step took place with the creation of a dedicated business unit to manage the installation and operation of the InovGrid infrastructure. This new entity exclusively dedicated to the InovGrid project, which includes a Supervision Center, is responsible for a wide and diversified set of areas – solution development, operation management, business development and institutional relationships. The systems and the business processes are already evolving and being adapted to support the on-going transition from the legacy on-site based operations to the remote based operations. This transformation will allow to optimize operations (faster and more effective), costs reduction and to deal with a growing amount of data. From the network operation and maintenance point of view, the challenge is to take advantage of the infrastructure and the new technical systems (Sysgrid and BTGrid) in order to reduce costs through remote monitoring and maintenance operations and assets management (improving performance), to have a faster and effective response to fault detection and subsequent power restoration and to improve network reliability and quality of supply. The SmartGrid deployment has relevant impact on network planning activities since more and new real, detailed and close to real time data is now available, such as load profiles, maximum demands registers, alarms and events related to secondary substations and LV networks. These will enable a more efficient, accurate and cost effective planning through deferred or avoided investments on the network. At the same time, the profile of the human resources is also changing, namely the ones related to field operations, since more specific and expert resources are needed to deal with new technologies and knowledge that support daily operations – tablets, PCs, communications.

TOWARDS THE FUTURE

Smart Grids are starting however their contribution to achieving Energy objectives is major, thus making them central to the strategy of utilities that want to prevail in the market of the future, with added strategic competitive advantage. Leveraging on current findings and conscious of the myriad of different dimensions of large complexity that Smart Grids bring, EDP Distribuição keeps working on establishing new business models and methodologies for business operation, taking into account international benchmarking done at European and Worldwide level. In fact, InovGrid is participating in several European initiatives (e.g. EEGI, SGTF) and projects (e.g. EcoGrid, Meter-ON, Stabalid, Reservices and S3C to name a few), coordinating the project SuSTAINABLE, where an investigation of possibilities and merits, and further development of solutions for coordinative action between different system operators controlling DER via Technical Virtual Power Plant (TVPP). These different participations have the common objective of knowledge sharing and contributing to a Smart Grid solution that has scalability and replicability across different geographies. Resulting from work done so far, InovGrid was labelled as "EEGI Core Project", showing that the project direction is perfectly aligned with Europe's targets.

CONCLUSION

Work done so far in the InovGrid project shows that Smart Grids bring not only considerable challenges to DSOs but also several benefits that can be reaped by the different stakeholders and players in the industry. The very encouraging results of the project first stages allow deriving several conclusions, namely i) the impact that customers have not only in the success of the project implementation, but also on the reaping of the benefits that arise from a better consciousness of their consumption patterns; ii) the positive impact that technology brings to the established DSO business processes by adding new ways of addressing challenges and fostering opportunities for value creation, despite the lack of standards and myriad of options available in the market; iii) the organizational transformation that is inherent to assimilation of this new paradigm of next generation distribution system.

EDP Distribuição believes that the InovGrid project is of utter importance to align its strategy with the European 2020 objectives, because it has an holistic approach to the different involved aspects and plays a central role acting as an integrated platform, which can leverage the development of new business models, that will allow to decarbonise the economy, inject more renewables in the grid and promote energy efficiency, thus giving a major contribution to meet the European Energy targets.

REFERENCES

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