THE NEW PARADIGM OF METERING IN PORTUGAL

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ABSTRACT

The electrical power sector has been in permanent development during the past decade starting from the wholesale market towards the retail segment. Following that trend, the metering activities have accompanied that progress, and reached their boom with the embracement of smart metering.

In the recent past, the electricity grid was characterized by its verticality and unidirectional flow from generation to consumption. The interactivity with clients was nonexistent and there was no major need for providing information, apart from the strictly needed billing data. This paradigm suffered a remarkable adjustment, with the introduction of renewable energy connected not only to the transmission grids but also in to distribution grids. Indeed, renewable generation offered not only variable production to the grids, but also bidirectional energy flows. Furthermore, the emergence of smaller generators extended the challenge to the low voltage level (230 V) and the promotion of electricity efficiency, locally and internationally, through the European directives, namely the 20/20/20 target, has given a more active role to consumers in the electricity sector.

The referred factors, together with the expansion in the grid, largely supported by the growth of renewable energy, resulted in more information to deal with and, subsequently, more systems to manage such data. Therefore, under this paradigm, the Inovgrid project was highlighted - EDP Distribuição designed an approach for its implementation, bearing in mind that clear value creation for customer must be both achieved and perceived. Moreover, as customer's reaction is of primary concern, frequent surveys are conducted near the target population, providing a deep understanding of the evolving perception. This method results in a more efficient and open relationship with the consumers.

Furthermore, the Inovgrid project brought several benefits for the energy sector's value chain as a whole. Amongst them, the following can be emphasized: rigorous measurement of the monthly consumptions from low voltage costumers, putting an end the consumption's estimates; increasing the effectiveness of responses to various requests; contracted power optimization; allowing historical consumption analysis and online tracking of corrective measures to commercial and industrial customers; improving control over commercial losses. These are all relevant gains to social equity and to the economic and financial sustainability of the electricity system.

All in all, we have travelled from a concept in which the customer was a user of services defined unilaterally and unidirectionally, to a client centric one, focusing not only economical on aspects but also on social and behavioural features. This vanguardist model allows a new approach on many aspects, namely, energy efficiency, CO2 reduction and smart consumption patterns which represent, above all, an active customer's need for information.

INTRODUCTION

The electricity sector is facing a deep evolution, following not only the pressure from the European directives and from the regulators policies, but also due to technology advances, namely in the metering and in the system information's areas. Within this field, EDP Distribuição (EDP Group) (EDPD), Distribution System Operator (DSO) in Portugal, launched a pioneering project in the smart metering and automation's area. This project, denominated inov**grid**, has the utmost intention of breaking with the historical unidirectional grid's topology, placing the client in its centre. One of the major steps to reach this goal is the installation of smart metering in all Low Voltage (LV) clients in Portugal.
The present paper is divided in three mains chapters. A first one, where are described the advantages of the inov**grid** model for the several players of the electricity sector. A second chapter, that explains the practical experience of the inov**city** project, held in Évora, selected by the European Commission and Eurelectric as single case study, between more than 200 smart grids projects in Europe. In this section, some outcomes of the case study are highlighted, as well as feedback from the clients. Lastly, in the third chapter, it is demonstrated the work that is being carried out in Évora in commercial and industrial clients.

A NEW PARADIGM

The inov**grid** project is based on 3 driving forces, which are intended to respond to the new challenges of the energy sector: remotely metered energy, microgeneration (MG) and smart grids. These aspects are the pillars for the new paradigm of the electricity sector. They all aim to contribute for an approach focused on the client and in the promotion of energy efficiency. Besides, the decentralized production is also in the centre of this concept, as DSO's should adequate the grids for a generalized integration of MG, without affecting neither the quality of service, nor the reliability of the system. To accomplish the above mentioned, there must be an upgrade on the grid's intelligence capability and on its associated devices, as well as an integrated management and control architecture with distributed processing capacity, which, above all, are the principles of smart grids.

Consumer/Producer

The new paradigm of metering in Portugal relies not only on the European efficiency directives (the 20/20/20 target), but also in the demand's optimization and in the maturation of the decentralized production. The phenomenon of MG, has suffered an amazing increase in Portugal, which reinforces the boost of the consumer/producer role in the electrical power sector.

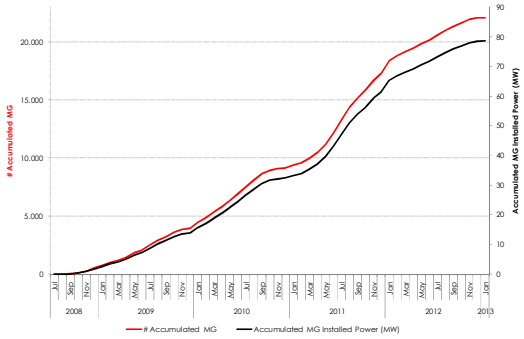

Figure 1 – MG's evolution in Portugal since 2008.

For this increase, besides the relevancy of the incentive remuneration schemes of the government, it was crucial the focus that the inov**grid** project offers. In fact, this emerging consumer/producer figure is one of the main beneficiaries of the inov**grid**'s concept. Firstly, having an active role in the optimization of his electrical consumption, which will result in a reduction of the electricity's associated costs. Secondly, through the production and consequent sell of energy, with the inherent remuneration. Thirdly, the new available services, such as innovative tariff schemes and pricing plans will also reduce the energetic bill of these small producers. Lastly, the setting up of smart meters will suit the contracted power of each client to his real consumption, which is a considerable step towards the social equity of the electricity system.

Adding to these advantages, one aspect that can be explored by these consumers/producers with the inov**grid** model, is the possibility of becoming active agents in the wholesale electricity market. Considering the real-time data that they will have access, as well as the electronic devices that can be useful to consumption analysis, some may considerer managing their own offers on the electricity market, instead of having other agents performing in their place. In fact, for small installations, this hypothesis is merely academic, as it involves a complex set of background algorithms. Nevertheless, for large installations, or entities that cover a considerable number of installations on their portfolio, this mechanism can be a lucrative option.

Distribution System Operator

EDPD, as local DSO in Portugal, has the incumbency of managing the distribution network in its three voltage levels: High Voltage (HV), Medium Voltage (MV) and LV. Although the HV grid is run in real time, based on a Supervisory Control And Data Acquisition (SCADA) platform, the LV network is still far from that target.

Over the past years, in order to optimize the supervision of the grid, several investments have been made both in technology and communications to offer the grid more autonomy. As a matter of fact, smart meters are a vital step towards the real time management of the LV grid. This new paradigm will contribute to level up the grid's automation grade as well as the remote management capacity of all network devices. By doing so, the grid becomes equipped with highly adaptable and dynamic behaviour components, which tends to reduce the network operational and maintenance costs and will improve both quality and reliability of supply.

Furthermore, EDPD is also building front line systems to manage the incoming data from smart meters. These new systems are being projected to have a highly adaptable architecture, in order to answer the inherent challenges of the inov**grid** project. These flexible capacities will be crucial for the functioning of the electricity market, because EDPD sends all relevant data for retailers and for the system operator through them. Besides, they will also be useful for the detection of commercial losses, as it will be possible to compare consumptions of homologous periods for a particular installation.

Electricity Wholesale Market

The agents of the electricity wholesale market will also be able to take advantage from this new paradigm, due to the set of new products and services that the inov**grid** concept will bring. One of the major gains for all the agents will be the possibility of real-time consumption data, which is a vital step to overtake the barriers of the consumptions' estimations.

Presently, each of the clients connected to the higher voltage levels, VHV, HV and MV, have a meter installed that stores consumption information every 15 minutes. All the information stored in each meter is daily acknowledged by a central that communicates with the

meter and stores all the data. This means that for these voltage levels, the amount of energy consumed every 15 minutes is known. Regarding the LV clients, although the totality of Special LV clients (SLV) (clients supplied in LV with a contracted power over 41,4 kVA) have their installations already equipped with remotely read meters, most of them are only locally read every three months. In order to solve this lack of information for each 15 minutes, consumption profiles are applied to LV measurements. Despite the profiles' application methods to the LV, the consumptions for all the 15 minutes in a day are hardly balanced with the energy entering the distribution network. To level those differences, an adjustment factor is introduced, which represents the energy consumed in LV that is not included in the profiled LV consumptions.

For the electricity market to function properly, EDPD supplies, daily, all the consumptions data, as well as all the renewable production information to the system operator and to the companies operating on it. Each retailer receives one file, with information for every 15 minutes, for every client of its portfolio and a consequent aggregate per voltage level. The system operator, though, is given data of all retailers.

Retailers use the data provided by EDPD to make their forecasts and, subsequently, the offers in the different market sessions. Generally, the forecast does not match what happens in real time and the system operator has to buy/sell the deficit/excess of energy, in an operation denominated balancing mechanism. This procedure typically penalizes the retailer; therefore, there are several studies in the forecast area in order to minimize the difference between the market offers and what happens in reality.

The roll out of the inov**grid** project, aiming the installation smart meters in all LV clients in Portugal, will offer a new set of variables to the forecasts algorithms. As a matter of fact, having real-time consumptions of the clients provides retailers an innovative dimension of work, as presently they formulate the forecasts based on the data from two days before. Expectedly, performing predictions with an input data that is closer to real-time, will result in less economical losses in the balancing mechanism for retailers, i.e., the forecast is expected to be more accurate when is based on a data as close to real-time as possible. Lastly, precise predictions from retailers are also an advantage from the system operator's point of view, as they will end in less energy to compensate in the balancing mechanism.

Moreover, retailers will be offered more accurate and detailed information of their clients, which will give the opportunity of levelling up the relation to the client. Within this scenario, retailers will have the know-how to provide their clients new services and adaptable tariffs. There is no doubt that the materialization of the inov**grid** project will result in a custom relation between retailer and client.

In the client's perspective, ending the standardized relation with the retailer is obviously a remarkable achievement. This scenario gives the final client the power to decide which retailer best suits his demands, not only in terms of costs reduction, but also in innovative services. All in all, these circumstances will grant retail market more competitiveness, which is a gain for the electrical power sector as a whole.

Regulator

The regulator itself will also benefit from the results of the inov**grid** project. Firstly, because the information available of the distribution grid will be target of a significant upgrade. This improvement will be not only in quantity, but also in quality, which will allow the regulator to develop more detailed and complex studies on the grid, in subjects that presently lack information.

Furthermore, the electricity market's efficiency and competitiveness are two of the foremost values required by the regulator, which should be achieved with the roll-out of the project.

CONSUMER´S BEHAVIOR TOWARDS SMART GRIDS

The municipality of Évora in Portugal, with a population of around 55.000 inhabitants and 1.307km^2, was chosen to be the inov**city**, where an automated meter infrastructure was deployed.

Convergence new technologies and services, were adopted by a great number of stakeholders, such as: prosumers, universities, municipalities, subcontractors and service providers. Évora's inov**city** has the dimension, the network and the context to support evaluation of the solution.

Some activities of communication and dissemination of the project were crucial to obtain the involvement of different stakeholders: the inov**city** showroom, the Energy Bus, the information all over the city of Évora, the organization of conferences and events, the presence in the local press or even the several visits from more than 30 nationalities, as well as public sessions of clarification of the project.

The involvement of the town hall and other local public authorities, the inov**city** site or even the 3D model at the inov**city** store were part of the ways that citizens could know, all the time, the information about the project at their town. It was also crucial the participation of Évora's University and the mailing with energy efficiency tips.

inov**grid** is currently used as an open platform, based on public standards, by other independent companies developing new in-home tools and services supporting customers' involvement, which allow to deeply empowering consumers to make smart decisions about electricity consumption. So far results of heavy consumption customers' with sophisticated energy management systems, like hospitals, museums, public

buildings and others show that significant energy savings are achievable and gains above 10% of consumption reduction were already obtained.

Regarding residential LV clients, a very broad study, including data from more than 30 thousand customers was developed together with an independent company specialized in market studies including professors from Universidade Nova of Lisbon. This study, which includes a complete year data set, a control and test groups to ensure that external variables are averaged out, and that is being performed in a context of generalized consumption reduction, shows that the average daily consumption between the test group and the control group is reduced by 3,9%, with an error margin of 2,1% for a confidence interval of 95%.

This is a major finding, and is well above the estimated 2% that support the national business case analysis with a clear global economic net present value, and where consumers capture the large majority of benefits.

INOVCITY – INDUSTRIAL CLIENTS

Regardind the inov**city** project, SLV clients were target of a particular work. In commercial and industrial customers, EDPD installed smart metering devices capable of providing more detailed information on periods of data resolution of 15 minutes. Furthermore, the communication profiles were also changed, starting to be collected on a daily basis. In order to facilitate the access to the information, all collected data is available and systematized for viewing on web portal.

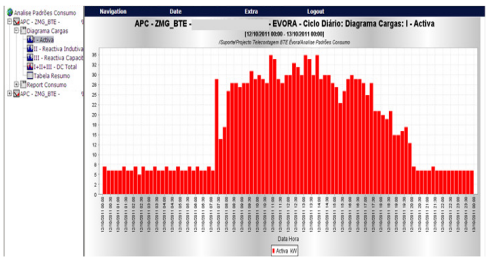

Figure 2 – Load profile view on web portal.

The data is presented in the form of power and energy, with graphical and tabular visualization. This fact allows customers, on one hand, to view their consumption in better detail, and on the other hand, to identify potential improvement opportunities, getting a more direct feedback of eventual corrective measures applied on their installations.

Moreover, SLV clients are granted a consumption's synthesis analysis report, containing information about the major characteristics of their installation, as well as the historical consumption per tariff period. The report also provides additional analysis on relevant issues, such as: temperature's influence on consumption; comparison of load profiles on homologous week days; appropriate contracted power sizing; standby consumption of the installation.

Based on this report, the entities that manage the installations are given some advice, so that they can adopt energy efficiency's behaviors.

With the intention of establishing a closer relation with clients, EDPD also makes available a mailbox. This way, customers are able to expose their questions and suggestions directly to the DSO.

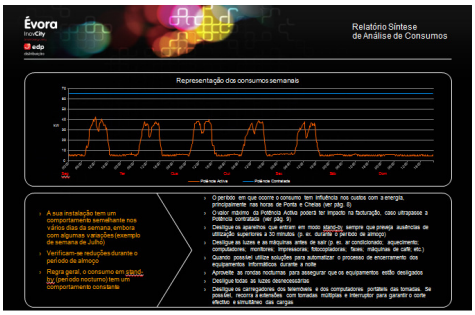

Figure 3 – Example of weekly load profile.

Regardless of not reaching its end yet, the outcome of this work carried out with Évora's industrial customers is confirming a relevant consumption's reduction in the target population, in comparison with SLV clients that are not covered by this study. In addition, there are also evidences of energy sustainability's conducts that are leading to decreases in the annual load profiles of these clients.

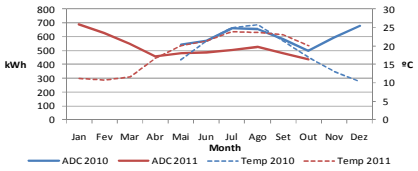

Figure 4 – Consumption's and temperature's evolution for a particular SLV client in 2010 and 2011.

CONCLUSION

To sum up, the materialization of the inov**grid** project is placing the client in the centre of the electricity sector, which represents a transition from a mere economical concept to a social and behavioural one. Furthermore, this project offers advantages for all key players of the market, from cost's reduction for the client, to grid's investment optimization and technology renovation, not forgetting the accuracy and detail improvements on the information that retailers are given.

In Évora's inov**city**, significant achievements have been made regarding consumption's reduction in residential clients. Moreover, in commercial and industrial customers a particular work was carried out close to the target population, which involved offering web reports and advices based on their daily consumption, so that they could be able to adopt energy sustainability's conducts. The outcome shoes that consumption's reduction on these clients can reach above 10%.