ABSTRACT
The increase of regulatory pressure, the growth of energy demand and the recent trends in liberalization processes determine the continuous need for improvement in procedures.
Lisbon operations area is part of the Portuguese Distribution utility - EDP Distribuição – essentially comprised by urban areas with more than 2.7million inhabitants concentrated in 2896 km². The underground cables represent almost 70% of the 7 000km distribution network, and areas served by overhead lines are gradually becoming urban areas.
Although Lisbon operations area only represents 3% of the Portuguese mainland, it covers 28% of the Clients and 27% of electric energy consumption.

Fig. 1 - Lisbon operations area Overview

This project includes sustainability and environmental control programs, such as Transformers Oil PCB inspection and replacement whenever needed, pursuing EDP group’s main investment strategy in renewable energies and sustainable processes, along with the utilization of the most recent technologies, such as smaller solutions so that electrical equipments are more adequate to our municipalities’ needs.

In order to achieve the best network operation, minimizing interruption periods, more and more MV/LV Transformer Cabinets (T.C.) are being adapted with remote control systems. These equipments allow the MV network to be easily adapted in an almost automatic way, reducing manual intervention need and hence improving the public image of the company.

One other effort being made towards team management optimization is related with the creation of conditions for remote work in distribution through internet and GSM/UMTS based applications, making communications with the teams on the field easier, faster and easily traceable if needed – Work Force Management (WFM).

Other step is the automatic remote invoicing from external services providers directly into the company’s information systems, with very strict restrictions, as well as direct update of commercial information, turning the management of commercial interventions on the network much faster.
These procedures are also starting to be implemented for network fault interventions.

Workforce management tools, as well as maintenance strategies and data management are the keys to improve operations efficiency.

The main strategy for success is to focus on improving the core business activities. To do so, we need to define what is important to retain within the company and which activities can be outsourced to external services providers, turning our goals into their goals and helping us to turn EDP Distribuição into a reference utility in operations management.

INTRODUCTION
Lisbon operations area (DRCL), as a part of EDP Distribuição, has the responsibility to manage the distribution network at high (HV), medium (MV) and low voltage (LV).

Our main goal is to assure that all the clients receive the best possible treatment as far as delivered energy is concerned, and commercial assistance regarding energy metering. In order to do so, it is needed to optimize the existing network capabilities, all its new developments and the management processes.

Concerning the environment, micro-generation solutions are becoming more and more implemented by the existing clients who want to become energy producers simultaneously.

NETWORK EQUIPMENTS
In order to optimize the network available resources, a transformers rotation system is in permanent development.
Bearing in mind the transformers capacity, swaps are made
replacing transformers with excess capacity to areas with higher demand. This simple procedure allows network improvement with no need for further expenditure.

Concerning the environment, one of the more ambitious plans is to verify and replace, whenever needed, transformers infected with PCBs.

One of our main concerns is to operate the network with optimal transformers use, achieved by their utilization near to the nominal power (S_n), minimizing electro-magnetic losses and reducing the need of new MV/LV transformer cabinets’ construction, concern which is especially important in highly density neighborhoods – urban areas.

**WORK FORCE MANAGEMENT - WFM**

In order to improve operations efficiency, WFM is being implemented replacing less efficient processes in commercial services, network operations and incident follow-up.

The work assignment to the teams on the field relies on internet based systems; this new methodology is gradually replacing voice communications and paper supported processes, with the big advantage of keeping digital records of all the communications made.

The work is managed in back office work places where the tasks are assigned to the teams on the field. The person managing the back office has the ability to make individual work assignments in special cases or for urgent tasks, when special teams might be required, or even send a work package assignment for either that moment or the next day.

The field teams have a PDA with a specially developed application which receives work tasks from the back office; these tasks contain detailed information leading to the full understanding of the work needed, and also some more data held in the corporative systems that might be useful for any complementary job.

As long as a task is being developed, the team moves are being updated by them on the device, according to pre-defined stages. The PDA application sends the updated information to the back office which saves all the information and updates immediately all the corporative systems, reducing the possibility of error in manual updates and allowing the call center operator to provide to clients detailed and accurate information about the progress on any specific task.

![Fig. 2 – PCBs contaminated transformer being carefully removed](image)

The WFM developed software along with the PDA, being a user friendly interface, helped reducing major errors in the corporative systems updating, about the tasks developed on the field. Before WFM, the tasks were done in the field and the corporative systems update was made manually by dedicated teams. With WFM we reduced one human step in systems up to date, minimizing misunderstanding errors in the data retrieved from field. The major challenge in the implementation of WFM was the knowledge transfer rules from the previous Back Office to the teams on the field.

![Fig. 3 - Information flowchart](image)

WFM increased efficiency, as it is an easier and faster way to manage teams, while keeping the corporate systems automatically updated; it also allows quality improvements and a centralized control of measuring efficiency programs. This is possible because all the information is saved in the system, so that every stage of the processes can be thoroughly analyzed, a task which was almost impossible with the voice team communication and the manual update of the systems.

The WFM PDA also includes a GPS Navigation tool to plan itineraries. To increase efficiency the navigation tool includes a record of all the MV/LV transformer cabinet...
location, featuring a quick response to urgent tasks as teams can be managed in a more flexible way, without concern of whether a worker is acquainted with a geographical area.

The rapid response provided with WFM is also partially responsible for the improvement of MV network reliability measured by the main indicator: TIEPI - Equivalent Interruption Time for Power Installed (minutes of lost load).

The quality measured by TIEPI is defined by the effects of outages verified in a geographic area in a certain period of time, concerning the outages number, duration and affected power installations related to the total installed power for the considered geographic area.

\[ TIEPI = \frac{\sum_{j=1}^{k} \sum_{i=1}^{x} D_{ij} \cdot P_{ij}}{\sum_{j=1}^{k} P_{ij}} \]

\( D_{ij} \) – Interruption Time i in delivery point j [hours]
\( P_{ij} \) – Installed power in delivery point j – Delivery points considered are MV/LV Substations [MVA].
\( k \) – Total quantity of delivery points in the considered geographic area.
\( x \) – Number of interruptions in the delivery point j.

INFORMATION SYSTEMS

Corporative systems are the support of all the work developed in our company; therefore, systems integration is a valuable tool to improve our efficiency.

Along with WFM, there are some other systems extremely important in operations roll-out.

**Power-On**

Power-On is an integrated system for the networks’ operational management for all voltage levels. This tool uses as a background the network geographical information (GIS).

By changing one network element in Power-On, due to a malfunction, for example, the system automatically indicates the affected network, the clients affected be the outage and the priority actions to be made in order to re-establish the energy supply to all the clients, as fast as possible. For this to be possible, there had to be a taskforce in the network geographical information update for the entire network, with a special effort in the case of LV. There was also a need to transform the network data held in a schematic form from the prior program in use to the new geographically based system.

Power-On also communicates with SCADA / GENESYS, turning the network management faster and easier.

Power-On together with WFM and the increasing amount of remote controlled MV/LV Transformer Cabinets, lead to major improvements in TIEPI.

**Project Design tool**

In order to guaranty a fast and efficient network update, new projects for network expansion are developed over a design tool which allows the use of the existing network, on GIS, as a work basis – Design Manager (DM).

DM is more than a design tool, as it helps in project management all the way since its planning until finally providing direct integration of the network expansion into the existing one.

**Third party systems integration**

Many of the developed system tools are designed to fit our external services providers (ESP) needs. Examples of this success option are the WFM Back office, over the prior
systems for fault and incidents follow up, as well as the Commercial field operations control.

The commercial field operations control systems are developed to fit both EDP Distribuição and the external services providers’ needs, since it is an activity that has already a 95% share of external field executions.

In a three year period all of our clients are at least visited once, often at their own request, for tasks such as to adequate or check the metering system for new contract options. (In the set of actions considered on the meters, meter reading is not considered, as this is done every three months.)

In order to optimize Commercial fields’ operations processes, a simple contract was designed with only a few tasks which include a large set of activities that might be developed over the metering equipments. With this method, we can associate the payment of only one task for each work order executed by our ESP.

The task payment is processed by the system as a consequence of the work order update. All this information is totally updated by ESP, as an auto-invoicing system for the tasks made in the field.

This process has major advantages for EDP Distribuição which only has the need to control quality of the executions and the type of payments to the work done in the field. For the external service providers the major advantage is the fast payment for the tasks performed.

Remote Metering and Control Installations
Focusing on the network optimization and management in order to minimize outages effects, a large number of MV/LV Cabinets are being equipped with remote control systems according to the importance of the supplied clients, network load and the difficulty to access the installations.

The installation of remote control metering equipments also contributes to the operations optimization. In DRCL all MV clients are already equipped with remote energy metering.

The most common method is to couple a GSM modem to the energy meter. This solution is also being gradually installed in LV special clients (S>41.4 kVA) and in micro-generation.

Other solutions are being tested in DRCL network, using either GSM or Powerline Communication Systems (PLC) regarding the expansion of remote metering to all LV clients – Inovgrid.

MICRO-GENERATION
Pursuing the main aim of reducing CO emissions with energy production according with EU regulation and the normative levels established in Kyoto Protocol, Portuguese government defined measures and a new methodology to give incentives to low voltage clients to produce energy for own consumption, installing their own energy production equipments. These equipments are required to use renewable energy sources, such as solar, wind or co-generation.

The process for a regular client to become a producer is extremely easy, one just has to register in a specially designed internet portal, choose between the generation solutions presented and the equipment installers, with no need for the usual exhaustive project design and approval. The presented solutions often take place using the existing low voltage supply installation. The produced energy is measured through a meter with a GSM modem in order to provide the information to the distributer, whenever needed.

The produced energy is limited to half of the contracted power for energy consumption.

The existing regulation defines special monetary conditions for customers who simultaneously install equipments for water and heating systems, if the maximum produced power is under 3.68kW.

The maximum allowed power is limited to 5.75kW, although values above 3.68kW are no longer entitled to monetary aids provided by the government.

All the produced energy is introduced in the low voltage distribution network and the price paid for a kW is always above the regulated price for its purchase.

Clients who suffer from low voltage problems, can now solve them by themselves, installing a Micro-generation system.

However, there is one limitation for self produced energy inflow into the network: the sum of all the micro-producers’
power cannot exceed 25% of the installed power in the MV/LV transformer cabinet for its supply area; otherwise, it would cause power flow problems on the network.

CONCLUSION

The representation and characterization of the electric networks, jointly with the cartographic base in a digital format used for referential installations, constitutes a strategic resource for network knowledge.

The technological developments are key tools to reinforce network operations, opening the door for the standard network development into smart grids through processes already taking place – Inovgrid.

All the network development can improve its management, since the increasing knowledge of our clients’ needs and demands will help us to provide a better answer to their needs, allowing us to achieve the goal of being a network operator reference utility.

REFERENCES