IOT SERVICES FOR A SMART LV GRID MANAGEMENT

Nadège CLERC
Socomec - France
nadege.clerc@socomec.com

Ivon BEYL
Electricité de Strasbourg Réseaux - France
ivon.beyl@es-reseaux.fr

Hubert HOELTZEL
Socomec - France
hubert.hoeltzel@socomec.com

ABSTRACT

As LV grids are evolving, the way to manage them has to change as well. DSOs have to face technical and economic issues, existing and new, while optimizing OPEX and CAPEX. In the same time, IoT technologies and connected things are emerging in Smart grid developments. The issue here is to develop new cloud services to have an easy and scalable LV grid management tool, similar to a LV SCADA.

INTRODUCTION

"Electricité de Strasbourg Réseaux", or "ESR", is the DSO of the regional electric network for more than 400 municipalities in the "Bas-Rhin" area, around Strasbourg. Subsidiary of ES-group and EDF, ESR is the main regional DSO in France.
Using SOCOMEC solutions for the electric measurements of the MV/LV transformers outputs for more than 15 years, ESR DSO launches a project with SOCOMEC to explore a digital LV grid management.

EVOLUTIVE DSO CONTEXT

The increase in decentralized Renewables production, energy storage, the use of electric vehicles and load shedding will disrupt the traditional grid and will create new challenges for those responsible for operating grids.
To face these new constraints on LV grid, a LV monitoring system is needed.
Main concerns are detailed in the following figure.

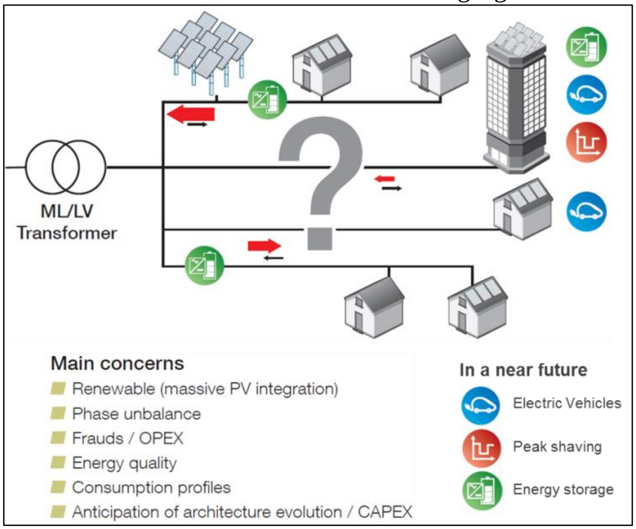


Figure 1: New constraints on the LV grid

IOT OPPORTUNITIES

Considering its promises, IoT (Internet of Things) is nowadays the main concern for a lot of businesses. The widespread deployment of connected things gives to a lot of companies the opportunity to design new services with high added value. IoT solutions are now mature to ensure an overall and coherent ecosystem from data collection to Big Data analysis.

Figure 2: Value chain of an IoT platform

Detailed IoT solutions:

- **Connected Things**: Equipments with integrated communication features to send data to external analysis solutions.
  To manage a LV grid, connected things can be LV monitoring devices installed after a MV/LV transformer on the distribution board.
- **Network**: Connectivity solutions to several network providers (Field protocols, LPWAN, IP, 2G, 3G, LTE).
  MV/LV substations have often no wire connection, so a wireless network solution needs to be defined following DSO needs (gateway, modem, datalogger,..).
- **Cloud Hosting**: public or private Corporate IoT platform (secured, scalable, complex event processing), support for tailor made applications and digital services.

With its "Digital@Socomec" strategy, SOCOMEC has launched a new corporate IoT platform to set up skills and services supporting digital projects.

IoT key issues for a DSO

How will IoT solutions make the LV grid safer and more efficient?

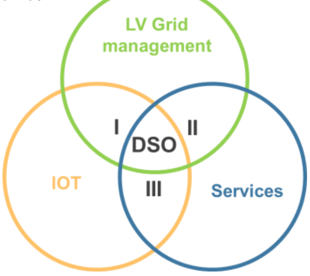


Figure 3: IoT & DSO opportunities

Implementing an IoT solution for the smart monitoring of MV/LV substations will deeply change a DSO organisation and working methods.

Thanks to **a centralised platform**, DSO will be able to monitor in real time the full LV network from its strategic nodes, the secondary substations. The real time data recovery allows a high reactive and proactive control of LV networks.

In addition, historical data from LV substations, coupled with Big Data processing technologies, allows DSO to **analyse and model** in details LV networks characteristics and the influence of various parameters (temperature, sunlight, seasonality,..). All these models will help DSO to face new constraints coming on LV networks with smart grids developments (Renewable energies integration,..) and to optimize the lifetime of key equipments such as transformers.

The **security** is a main topic in an IoT environment, especially for the electric public network, ensuring communications integrity and the protection of hosted data in this new kind of platforms.

Thanks to the high **scalability** of an IoT platform, DSO may want to plan gradually the deployment of this smart monitoring solution respecting its economic and technical constraints.

Business models

The DSO traditional business model for this type of services is mainly based on CAPEX model, with a full investments in equipments, servers and software.

An IoT environment leads to the emergence of new business models which can be now proposed to a DSO. These models are based on the principle of "**Pay per use**", ensuring DSO to pay the right price for the monitoring services sized specifically for their real use.

These models also guarantee **flexible evolution** of the service subscription, avoiding heavy investments in expensive technological tools.

Mainly based on **OPEX budgets**, these models have the advantages of smoothing the costs of the deployed technologies while guaranteeing DSOs greater independence and possible migration to most relevant and consistent solutions following their evolving expectations in this new context.

THE PROJECT

Background

ESR network is composed of 5 600 MV/LV secondary substations of which 4 700 are monitored with electromechanical meters or power monitoring devices. The most important value for the DSO is the apparent power peak (Smax) at the transformer output.

A manual reading system shows lots of disadvantages:

- It is a source of error with low data reliability.
- The theorical frequency of data collection of once or twice per year may not be respected depending on the operators' availability.
- Reading only a maximum value is very limited, with a lack of efficiency. There is no data memory, storage, processing.
- The cost of a manual intervention is high.

  Until now, this operating mode made it possible to optimize the installed transformer powers meeting the changing market demand. Today, with the advent of new technologies, the return on the monitoring investment is low with a manual operating mode.

Main objectives

The main objective of this project is to design a digital LV grid management system, adding value, with a cost-effective approach.

Technical objectives are:

- To automate and centralise information transmissions
- To analyse and understand the LV network
- To anticipate grid evolutions optimising investments
- To test new IOT technologies and assess the added values.

The "POC" (Proof Of Concept) solution

This POC aims to design the future smart monitoring platform for DSO's.

Equipments of the POC:

- measurement devices set up in the LV substations
- communication equipments for the data transfer to the IoT platform
- wireless communication networks
- IoT platform for data storage and processing
- specific web application offering services for DSO.

This project is deployed on 5 distribution substations with a total of **8 MV/LV transformers** of ESR's network.

The monitoring proposed in this POC concerns the secondary of the transformer and LV fuse feeders.

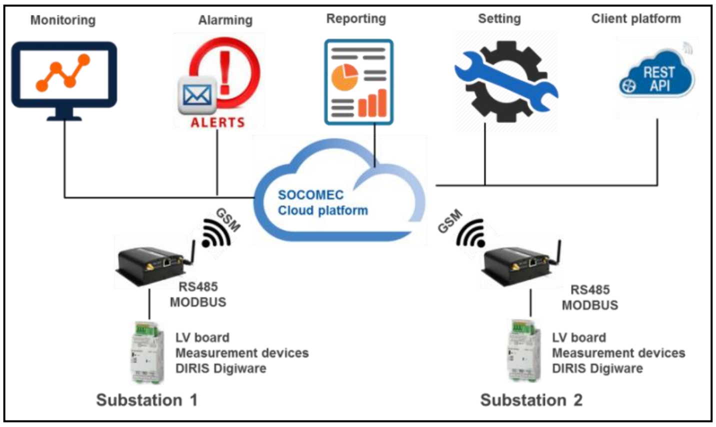


Figure 4: IoT architecture

Detailed objectives of the POC are:

- Centralization the monitoring of MV/ LV transformer substations via an IoT platform hosted in a Cloud
- Storage and hosting data collected from measurement devices located in the substations

- Analysis of a wide range of electrical values, as well as others factors such temperature
- Supporting the operation of MV/LV networks (load shifting, genset implementation,..)
- Alarming in case of drift with reference values
- Editing of periodic reports in reference to EN 50160
- Remote access to equipment for configuration changes or firmware upgrades.
- Design of connectors in REST API format to interface with third-party applications (DSO applications or external applications).

The monitored values are:
- Voltage (3V and 3U)
- Currents (I1, I2, I3 + I Neutral)
- Powers (P, Q, S)
- Power Smax Time stamped
- Power factor
- Frequency
- Energy (Ea+, Ea-, Er+, Er-, Es)
- Rate of voltage and current harmonics distortion (THD U et I)

Additional possible data under study are:
- Temperatures of the transformer and the substation
- Air-conditioning or lift pumps in operation
- door closing sensor
- Noise level.
- …

The monitoring service proposed in this POC includes:
- Map with DSO's substations location and identity label, for an easy selection of the monitored substation
- Ranking of the most loaded transformers, with KPI maximum load (S max / S nominal) and average load (S average / S nominal)
- The real-time visualisation of all values at the monitored point (secondary of the transformer or LV feeders)
- Curve plotter with a selection tool of multiple variables allowing a complete analyze on the same timetable of the LV network behavior
- Alarm report configured to view events in the monitoring application and to send SMS alerts to DSO staff
- Alarms on additional data to study (door opening,..).

This project is starting with a first operational web application including the functions showed in the following figures. The idea is to develop this tool to add relevant data and analysis to have a real grid monitoring tool, with appropriate setting and alarms.

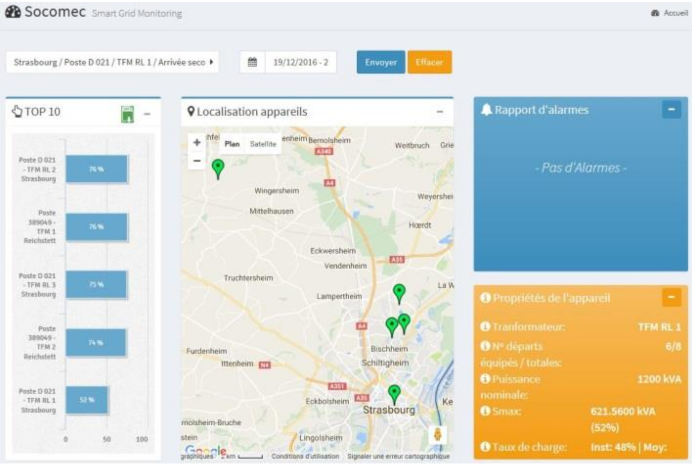


Figure 5: Overview of the LV grid

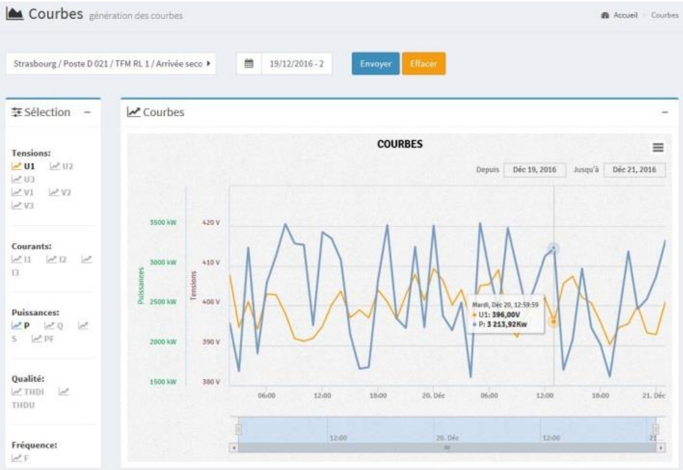
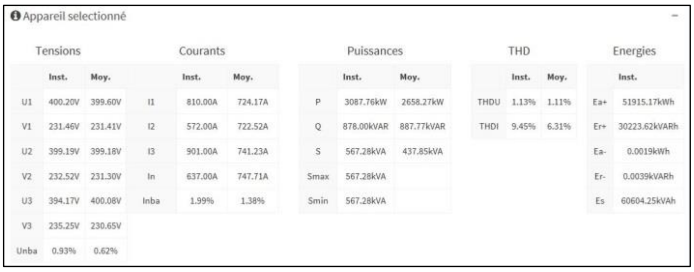


Figure 6: Curves of a selected transformer


Appareil selectionné

	Tensions Inst.	Tensions Moy.		Courants Inst.	Courants Moy.		Puissances Inst.	Puissances Moy.		THD Inst.	THD Moy.		Energies Inst.
U1	400.20V	399.60V	I1	810.00A	724.17A	P	3087.76kW	2658.27kW	THDU	1.13%	1.11%	Ea+	51915.17kWh
V1	231.46V	231.41V	I2	572.00A	722.52A	Q	878.00kVAR	887.77kVAR	THDI	9.45%	6.31%	Er+	30223.62kVARh
U2	399.19V	399.18V	I3	901.00A	741.23A	S	567.28kVA	437.85kVA				Ea-	0.0019kWh
V2	232.52V	231.30V	In	637.00A	747.71A	Smax	567.28kVA					Er-	0.0039kVARh
U3	394.17V	400.08V	Inba	1.99%	1.38%	Smin	567.28kVA					Es	60604.25kVAh
V3	235.25V	230.65V											
Unba	0.93%	0.62%											

Figure 7: real time data of a selected transformer

MAIN BENEFITS

- LV grid overview and status with real time data and appropriate analysis
- Accurate knowledge of loads & productions balance
- Solutions analysis for decentralized productions
- Optimised, scalable and flexible investments
- Complete cloud solution without need of IT infrastructure and skills for DSO.

PLANNING

The POC agreement between ESR and SOCOMEC has been validated in September 2016.
Additional measurement devices and communication equipments have been installed in November 2016.
Some communication problems should be solved end of January (modem / SIM card).
A first mockup of the application was ready in November and a second version has just been installed on the cloud.
This solution will be fully operating from February to December 2017**.**

CONCLUSION

This monitoring and cloud solution is an innovative concept of LV grid management, integrating renewable energy, IoT technology and new working methods.
What is important is the scalability of the solution and the better understanding of the network which will help DSO to take the right decisions, focused on the priorities, optimizing OPEX and CAPEX investments.
Around the world, there is a real and increasing need for this type of monitoring, adapted to DSO reality, bringing additional benefits to the deployment of smart meters infrastructure.
In June, first results of 5-months operation will be showed with the designed improved application.