MODERNIZING DISTRIBUTION NETWORK MANAGEMENT WITH LINKY SMART METERS - LESSONS LEARNED IN GREENLYS PROJECT

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ABSTRACT

Lyon has been chosen to experiment 200 000 new Linky smart meters. These meters offer new data, services and possibilities. They represent the fundamental brick to develop smart grids and notably give an opportunity to enrich the historical poor vision of DSO on the LV (Low Voltage) network.

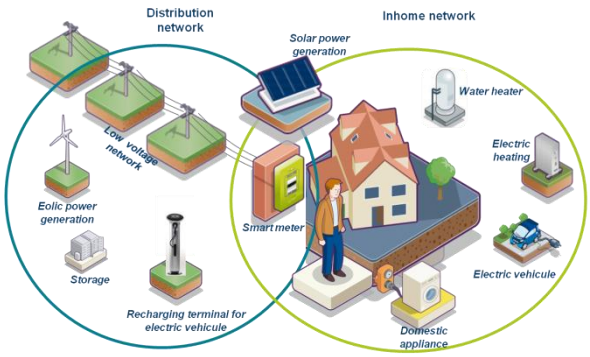
Lyon area is also a place where takes place one of the most important French smart grid projects: GreenLys.

This paper describes the experiments based on Linky Smart meters tested under the scope of GreenLys, and the teachings for the distribution network management.

INTRODUCTION

Linky smart meters roll-out has been confirmed by the French government in July 2013: 35 millions of meter will be changed between 2015 and 2021.
From 2009 to 2011, 300 000 Linky smart meters have been installed as experimentation in two regions of France: one rural are next to Tours and one urban in Lyon.

Smart metering is at the junction between the customers and the distribution network:



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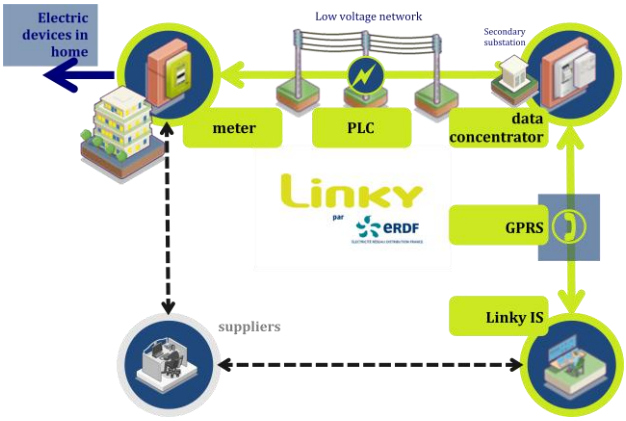
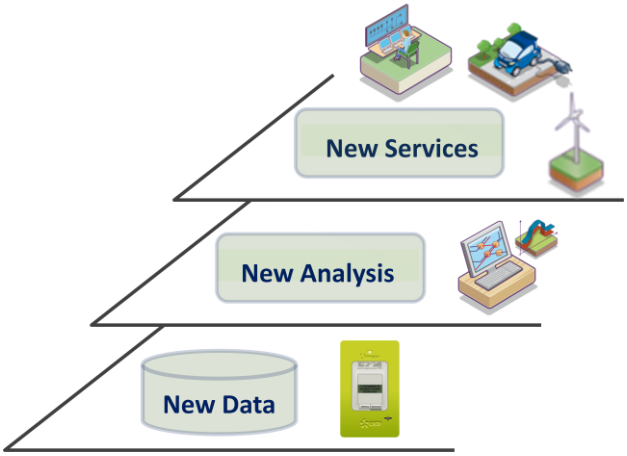
More than a meter, Linky is a system: it is a communicating platform which supplies information of the LV network. It communicates by Power Line Communication (PLC) from the meter to the data concentrator localized in the secondary substations. Subsequently, the data are sent by GPRS to the central system.



Data collected and provided by Linky represent the basements of new analysis and services which allow major changes in distribution network management.



GreenLys is a smart grid demonstration project led by ERDF and started in 2012 for four years. It experiments the operation of a smart grid over the whole electricity supply chain. It takes place in Lyon and Grenoble. Lyon is an urban dynamic area: it is strongly concerned by the development of new uses and objects like electrical vehicles, renewable energies and energy demand management ([1] and [2]). LV grid is in the front line of the resulting changeovers although DSO (Distribution System Operator) has historically a rather poor knowledge of it. The 200 000 Linky smart meters installed represent an opportunity to gain a better understanding, develop and experiment new possibilities of LV smart Grids to accompany the energy transition ([3]).

RELIABILITY ENHANCEMENT OF LV ELECTRICAL CALCULATIONS

LV electrical calculations are based on two main items: load models and GIS (Geographic Information System) network description.

Models improvement

Models are the heart of the electrical calculations; ERDF has developed its own one: Bagheera. It is a probabilistic model that estimates the theoretical electrical charges of the customers used to calculate the electrical states of the grid (transits, voltage drops, losses). Based on the main characteristics of each customer, Bagheera associates to each of them a load profile. These load curves reflect the customers' hourly power demand with the distinction of business days and holidays. Then, according to grid configuration, physical characteristics of the electrical equipments and customers power demand, the electrical states are calculated for each element of the grid.

Previously, Bagheera standard load profiles were customized for each customer with the consumption data collected twice a year. With Linky system, measurements data are supplied once a day: index and load curve. Individual load curves with a 10 min, 30 min or 1h time-scale can be collected although their utilization has to comply with the limits set by the CNIL (French independent administrative authority entrusted with data protection legislation). The quantity of index available for each customer largely improves the accuracy and the reliability of Bagheera models.

Consolidated cartography

Every meter is communicating through one LV phase of one secondary substation. Linky system stores this information. Cross-checking GIS and Linky data helps to enhance the accuracy of the assets database (precision of the customers connection points).

Enriched cartography

Previously, in the absence of precise information, statistics hypothesis of balance between phases on the LV network were used. This approximation leads to important inaccuracies in specific cases. The information of the connection phase of the single-phase smart meters is now transmitted by the Linky system, and included in the GIS.

Adapted calculation software

ERDF has developed its LV and MV (Medium Voltage) calculation software, ERABLE, based on DIgSilent PowerFactory ([4]). The phase information is integrated in this new environment, and phases balance studies are now possible. The figure 1 shows an example of LV network on ERABLE: the three colors symbolizes the phases, the abscissa axe represents the length of the feeder, and the ordinate the voltage. The first figure is the initial state: the voltage drop of the blue phase is clearly more important than the green one: the phases loads are not balanced.

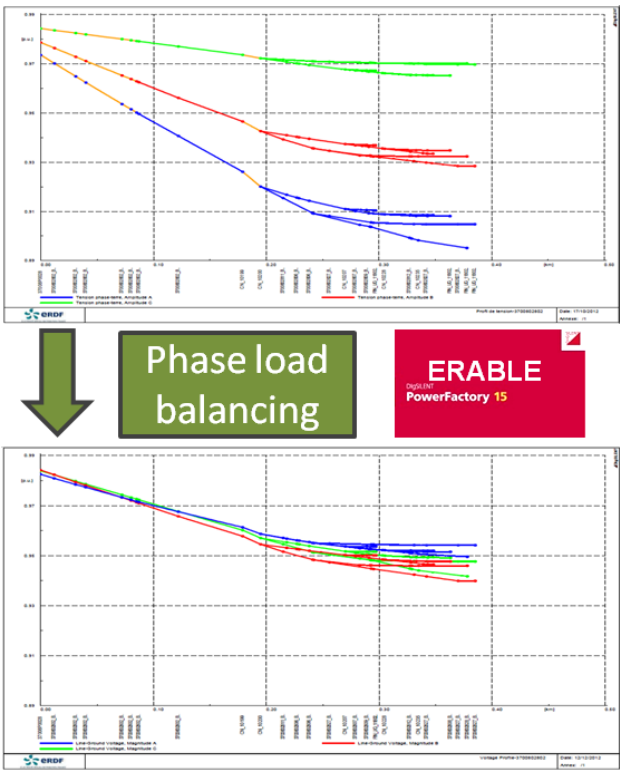


Figure 1: load balancing of LV network

Phase load balancing algorithms are included in ERABLE, and it proposes solutions to optimize the repartition by modifying the phase of determined customers ([5]). In this example, three customers have been moved from the blue phase to the green one.

IMPROVEMENT OF QUALITY OF ELECTRICAL SUPPLY

A better response to customers claims

RQA is a prototype developed in the GreenLys' framework: it is a software based on Linky smart meters data that displays reports about power cuts and voltage excursions captured at the customers connection points. A voltage excursion is a voltage deviation of more than 10% of the rated voltage (230 V for single-phase meters). In case of customer claim, the ERDF dedicated team has a direct access, through RQA, to the list of all the power cuts and voltage excursions recorded by its smart meters.

If a customer reports a power cut to the emergency call center, operators interrogate the customer smart meter with a "ping request": according to the results and customers information, they can deduce if the problem is located on the customer's electrical installation or on the grid.

Hence, with the combination of RQA and "Ping Linky", ERDF troubleshooting actions more efficient and the answers to the customer are faster and more accurate.

A proactive treatment of supply anomalies

RQA offers the possibility to rank by severity the power cuts and voltage excursions seen by smart meters on a specified network. Sudden quality losses can be detected before the existing national annual quality diagnosis. The figure 2 represents an example of this detection and correction during the year 2012:

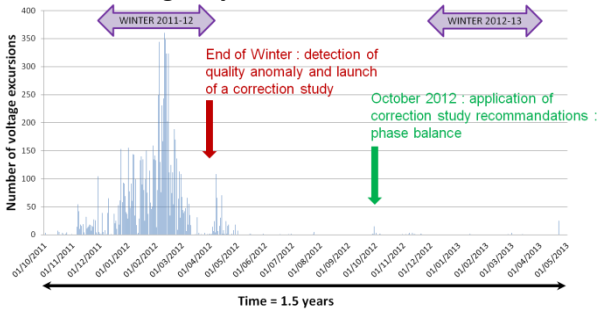


Figure 2: Example of detection and correction of a supply anomaly

A new procedure is under experiment: during the winter, when the majority of voltage drops happen, the network operations office and LV project management run monthly analyzes at the secondary substations level of the voltage drops captured by the meters. The voltage violations due to non typical network situations (works etc.) are eliminated. Consequently, a weekly subscription is made to get the load curves of all the meters of the substations concerned by new and unexplained voltage drops. Then, these load curves are integrated in ERABLE to make electrical studies based on measured data. Hence, priority troubleshooting actions can then be realized within the same month. Such a level of reactivity was previously limited to power cuts and anomalies reported by customers. Correcting in a so short period of time voltage anomalies reported or not by customers, explained or not by traditional tools, is a major improvement.

ENHANCED RESPONSIVENESS OF LV NETWORK MANAGEMENT

A new communication channel

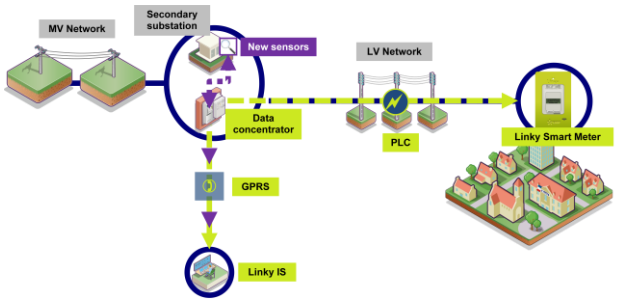


Figure 3: New sensors placed in Secondary substation communicating through Linky system.

External equipments can use the Linky communicating platform to supply information to ERDF Information System (IS). ERDF is currently experimenting new sensors located into the secondary substations as shown on figure 3. They are connected to the Linky data concentrator and their measurements (temperature, active and reactive power, intensity) and alarms (MV default) transit through Linky communication channel to the Linky IS.

In a close future, experimentation will be carried out on MV fault detectors (located on most of the secondary substations, the grid operators use them to localize MV faults or their warning signs). The innovation remains in connecting them to the Linky data concentrator: at a very low marginal cost, MV supervision agencies will collect remote fault indicators for a large amount of secondary substations. They will be able to faster localize the faults, and hence, the MV supervision will be more reactive and efficient.

A new tool for LV network management

SEQUOIA is an ERDF application that combines data from GIS and from SIT-R (ERDF SCADA-DMS (Supervisory Control And Data Acquisition - Distribution Management System)). In the GreenLys framework, a new module bridging SEQUOIA to Linky IS has been developed. It gives the possibility to display on a map information providing from smart meters. The figure 4 shows LV network, red small dots represents LV electrical connections which are linked to non-communicating smart meters.

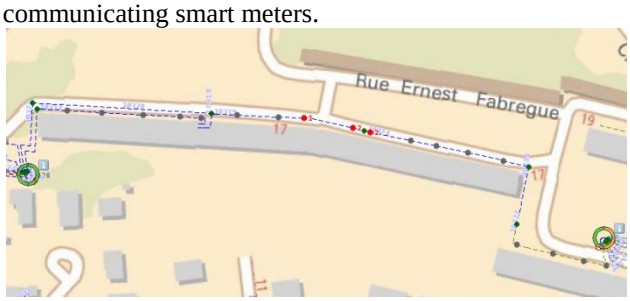


Figure 4: LV network displayed in SEQUOIA

This module is dedicated to the smart meters alarms (severe over voltage, communication loss) treatment. Alarms are numerous, and they have to be clustered and filtered (according to their types, the network topology, their time and date stamp, etc.) to give high valuable information.

The figure 5 represents the number of cut off meters of a LV grid over time:

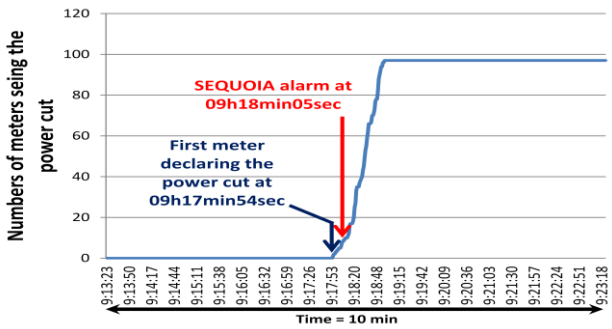


Figure 5: example of SEQUOIA alarm

In this example, a power cut has been made for building works, and using the Linky IS inputs, SEQUOIA module was able to display a power cut alarm eleven seconds after the event occurred.

LV supervision is a major headway in network management, but it is still in qualification phase. The potential impacts on network management are considerable and the first experience feedbacks are promising.

As shown on figure 6, in case of LV fault, SEQUOIA will receive and display an alarm in the operation office. The operations office will be aware of this incident without needing a customer call, and hence, reparations will happen earlier, and the LV incident will be shorter.

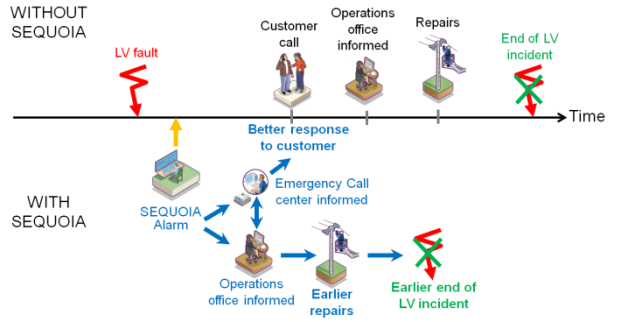


Figure 6: Impact of SEQUOIA for LV fault

CONCLUSION

Linky is a powerful tool for LV network management and MV to a lesser extent. GreenLys project constitutes an innovation accelerator which enables the development of new prototypes: the first experience feedbacks are positives and enriching and they supply the Smart Grid reflection in France.

After finalization and improvement, these innovating tools will be industrialized and will accompany Linky deployment in France. In parallel, new perspectives are studied on the LV network: electrical state estimation improvement, LV voltage control, self-healing and finally automation management.

Acknowledgments

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[5] G.Roupioz, X.Robe, F.Gorgette, 2013, “First use of smart grid data in distribution network planning”, *Stockholm CIRED conference.*