Getting smart energy systems to scale

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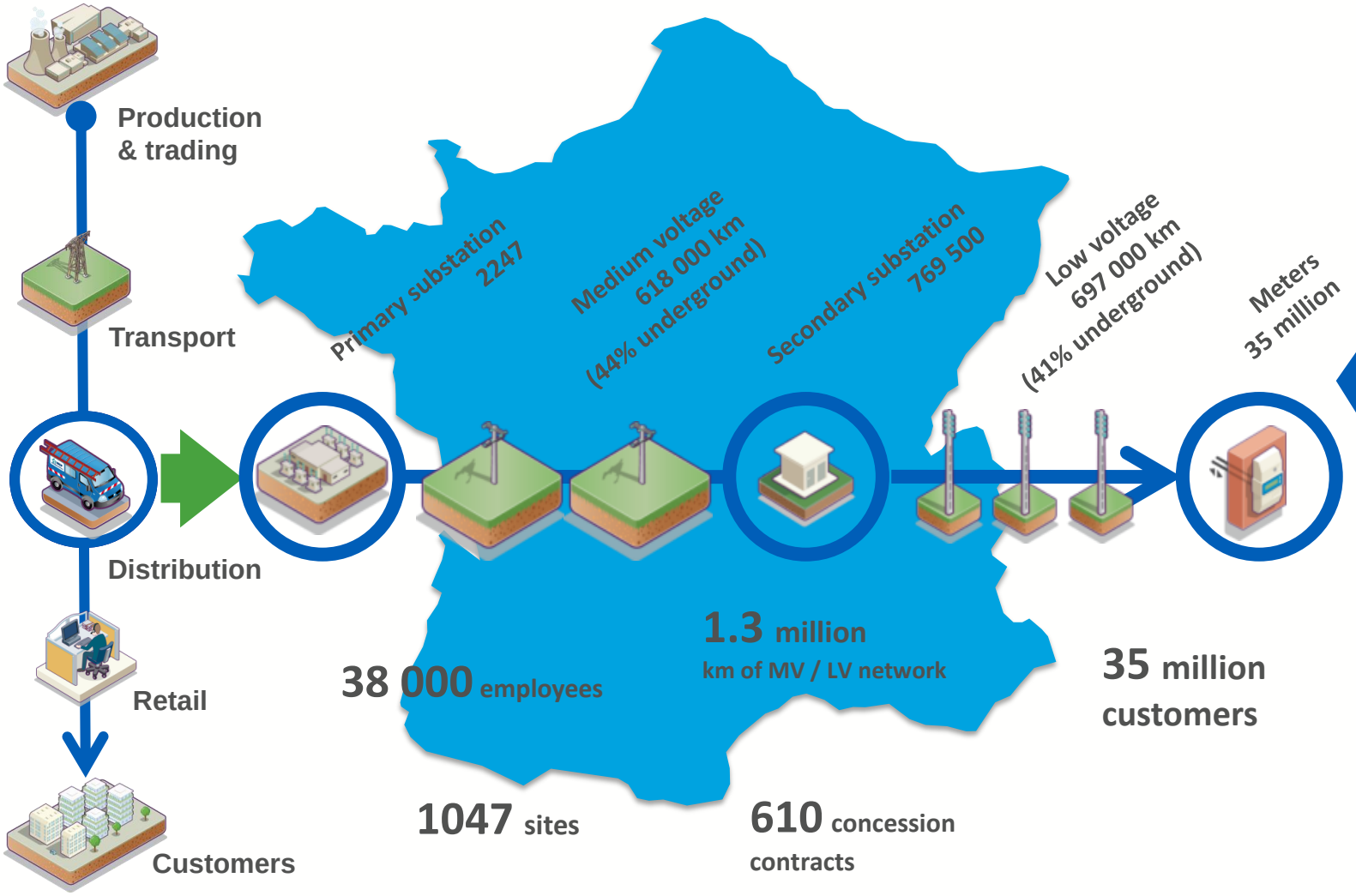
March 1st, 2016

At a Glance : ERDF operates the electricity distribution networks in 95% of the territory in mainland France



Key figures

- € 13.3 billion revenues and € 3.2 billion CAPEX
- 404 000 new customers connected / year
- 11 million field operations
- 396.2 TWh delivered with less than 6% losses
- 19.8 GW of RES connected to distribution network (end of sept 2015, 338 000 sites)
- SAIDI 64 mn (99.98 % of availability)

Key dates regarding the deployment of Linky smart metering infrastructure

- 2007-2009 : Working groups with stakeholders, led by regulator CRE, to exchange on technical specifications of smart metering infrastructure
- 2010-2011 : Industrial experimentation with 270 000 Linky meters deployed in urban (Lyon) and rural (Tours) areas. Objectives :
  - Validate hypotheses of cost-benefit analysis
  - Ensure interoperability of equipments from multiple suppliers
  - Check reliability of communication architecture and interfaces with Information Systems
- 2011-2013 : Working groups with stakeholders, led by Ministry in charge of Energy, to
  - share results of experimentation,
  - validate technical choices and deployment strategy, and
  - ensure social acceptability of deployment
- July 2013 : decision by Prime Minister authorizing full-scale deployment
- December 2015 : Linky deployment has started
- End of 2021 : projected end of deployment

ERDF demonstration program includes 18 Smart Grids projects in France and in Europe

HOUAT ET HOËDIC
Secure the power supply of two islands

SOLENN (SMART GRID)
Contribution of smart grids to manage the electricity demand and to develop alternative to load shedding

smart GRID VENDÉE
Optimise consumption and production over a region

Pilotes Linky
An experiment on nearly 300,000 smart meters

SOGRID
Development of a new PLC communication chain to enhance the control of the grid

NICE GRID
Contribution of a smart solar-powered district and of storage of electricity to handle demand peaks

ISSYGRID – le 1er réseau de quartier intelligent
Optimisation energy through an entire district

ERDF participates in several European projects on the theme of smart grids

ADVANCED
GRID4EU
evolvDSO
iGREENGrid
TRANSFORM

Poste Intelligent
Contribution of digital technologies to boost the efficiency of primary substations

BienVEnu
A trial approach to new solutions for EV connections to recharging terminals in residential housing blocks.

enteea
Integration of high wind energy capacities in rural grids

GreenLys
Contribution of smart grids for the electricity system in urban areas equipped with Linky

Watt & Moi
Provide on a Webiste information to consumer on their electricity consumption

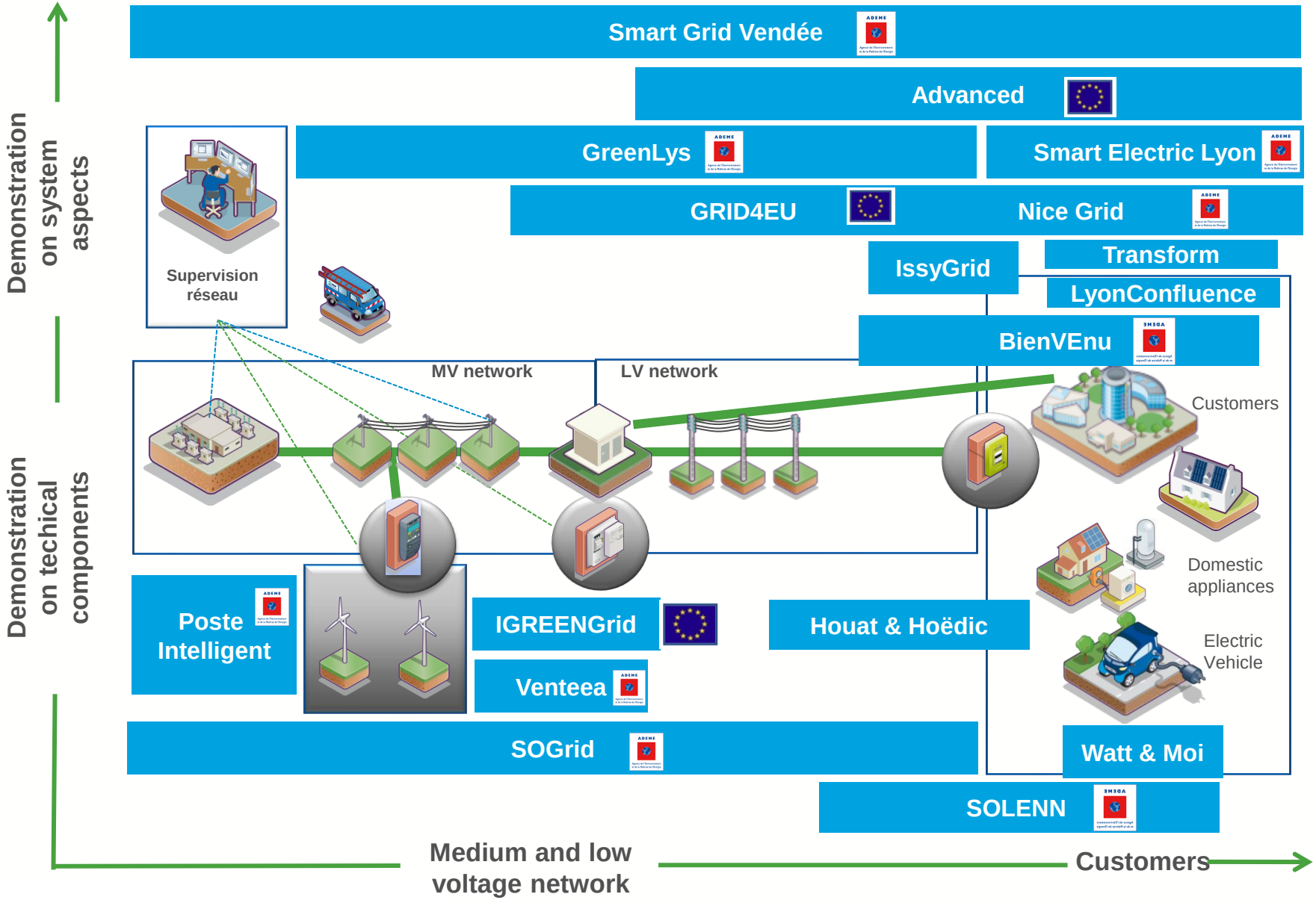
LYON SMART COMMUNITY
Management of electric vehicles, smart buildings and solar energy

SMART ELECTRIC LYON
Experimentation of innovative offers and services for clients

Two main objectives

- Develop robust and industrial technologies in time to face future challenges
- Identify viable business models for all actors of the electric system (covering investments and sharing benefits)

This innovative program covers all technical fields of Smart Grids



In parallel, ERDF is preparing the industrial deployment of smart grid solutions

- Most demonstration projects will finish between 2016 and 2017.
- In order to maintain the momentum created in the industrial ecosystem (100+ consortium partners involved), ERDF is preparing a first roll-out of the most promising smart grid solutions to-date in a specific area

4 objectives

The deployment will occur on a specific geographic area yet to be chosen by the government

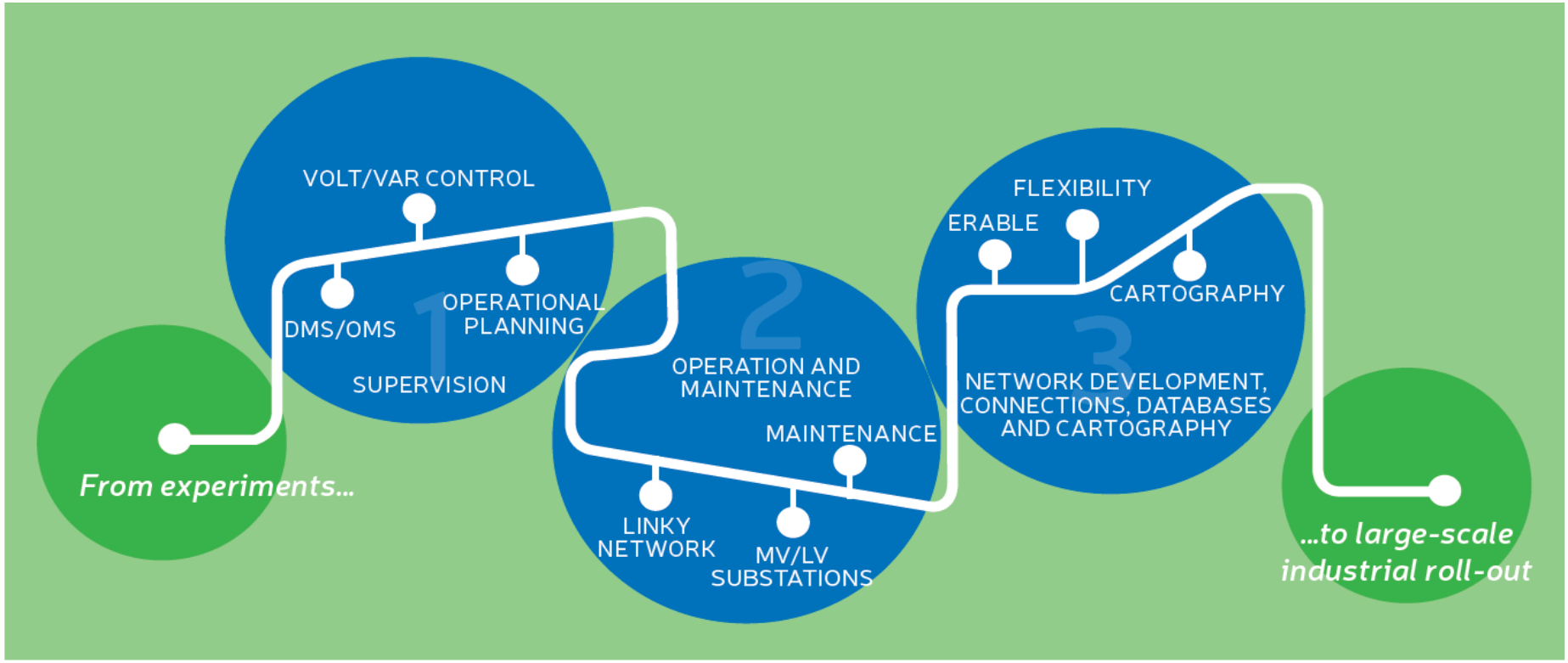
A geographic area with the following technical features :

- Presence of a significative urban area (> 125000 inhabitants)
- Overall area of more than 8000 m2
- Representative mix of rural & urban areas
- Presence of large customers representing significant flexibility reserves
- Significant power networks with at least 30 primary substations and 30% of MV overhead networks
- A minimum of 10 primary substations where prod max > 20% of demand max

Industrial projects based on mature solutions related to innovative topics such as demand-side management, RES integration, electric mobility, smart city

Technical roadmap for deployment after 2018

- A prioritization of smart grid solutions has been defined and forms the backbone of ERDF technical roadmap for their implementation from 2018.



Key questions to be addressed in preparing the industrial roll-out

- Aligning technical specifications with operational needs :
  - Which components and for which use cases are these new equipments needed?
  - How do we anticipate for future needs ?
  - What are the impacts on standards?
- Internal transformation : how do we anticipate the transformation of the workforce skill sets?
- Aligning smart grid component deployments with telecom and information systems roadmaps
- Assessing commercial readiness level of new technologies:
  - When will the industry be ready to bid for competitive tenders ?
  - How can we help startups grow enough to fit in our purchasing processes ?
- Intellectual property issues :
  - Who owns the IP on the equipments we would like to deploy ?
  - How do we protect ourselves from patent trolls and essential patents ?
- Interoperability of equipments : how much work is needed to ensure interoperability of equipments from multiple manufacturers and with multiple generations of equipments ?

Thank you for your attention

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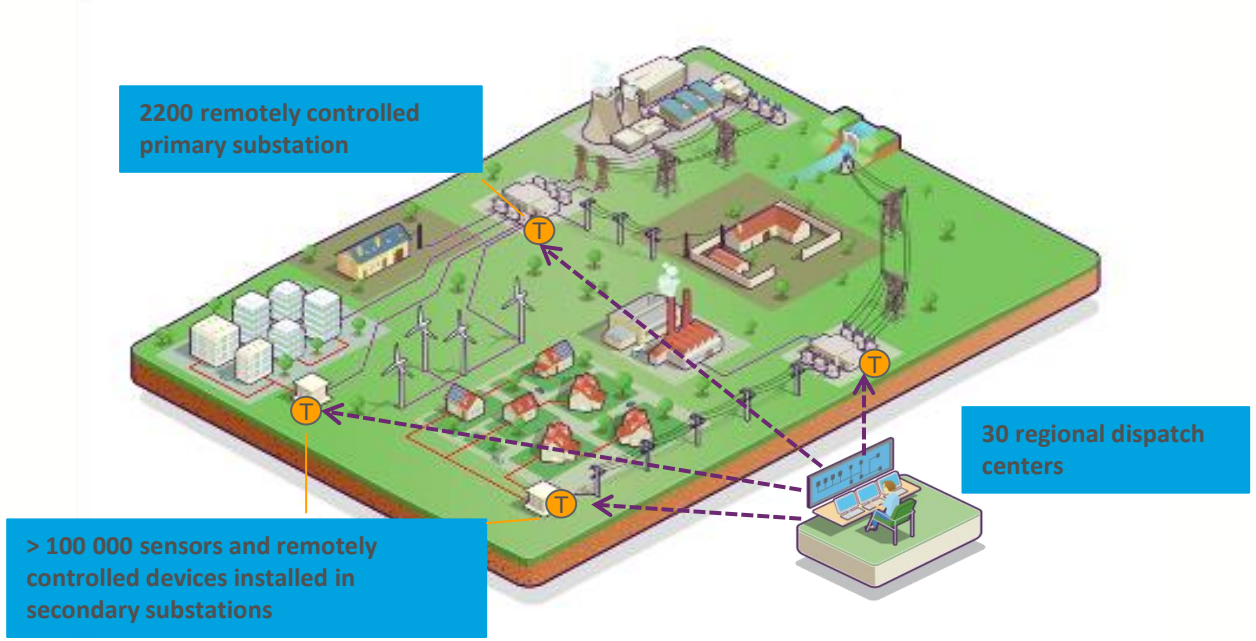
Backup slides

For the last 20 years, the progressive networks automation has led to a huge performance improvement

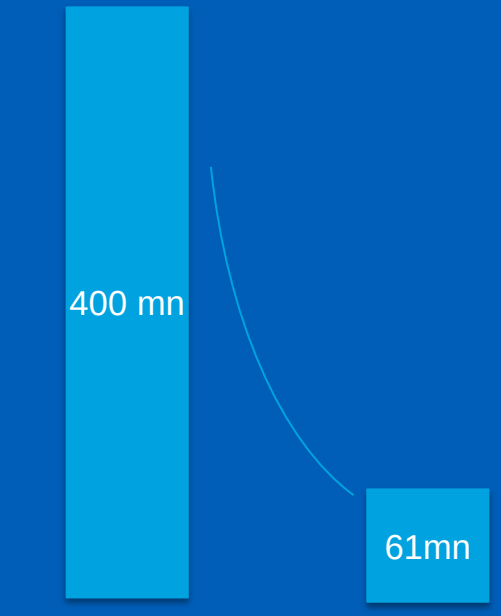
French medium voltage networks are already « Smart »



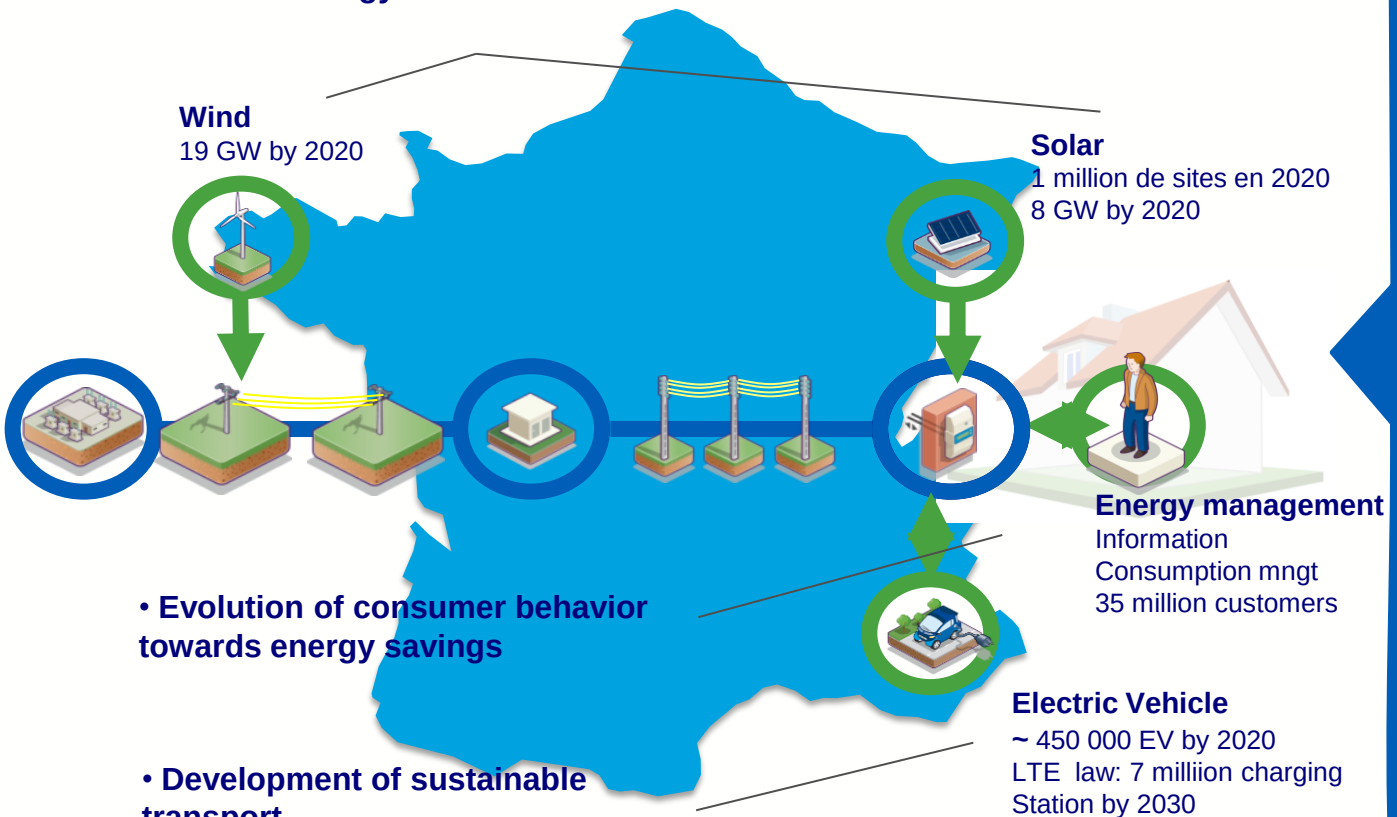
Today, **30 regional dispatch centers supervise the French distribution netwoks**:

- ⇨ Detect automatically incidents and manage them thank to advanced sofwares (localisation, self healing,
- ⇨ Control remotely the primary substations (HV/MV) and more than 100 000 devices installed in the secondary substation (MV/LV)

The average time of power cuts has sharply reduced in France since the early 80's



This evolution is strengthened by the Energy Transition and is a change of paradigm for distribution network



Challenges & solutions

- An irregular production which causes an asynchrony between production and consumption
- A variable and diffuse power consumption due to EV charging

- **Optimise the location of renewable energy production sites vs. Capabilities of the existing network**
- **Increase the monitoring of the networks (in particular LV network)**
- **Enhance the control and the reactivity of the distribution network**

Linky, a key component of Smart Grids, of which mass roll-out (35 M meters) will extend until end 2021

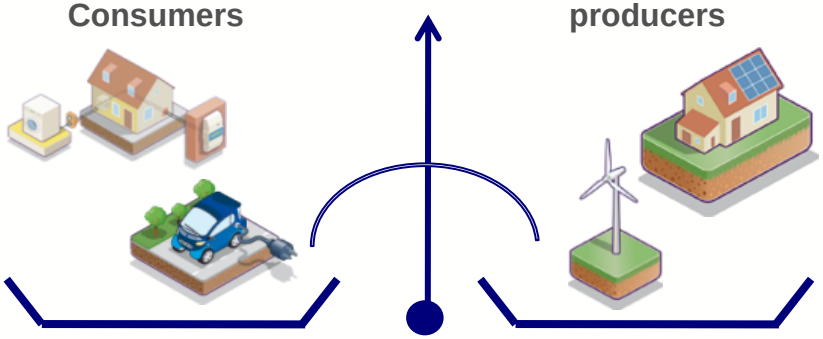
Act remotely
via the meter

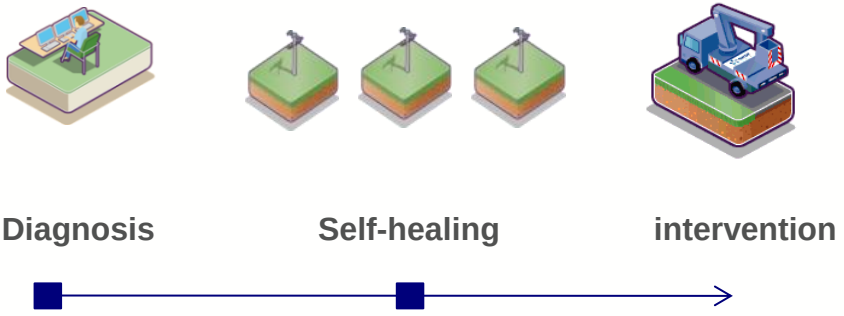
Linky meter — concentrator — IT

A communication platform to realise remote operations

Contribute to the balancing
Between production / consumption

Consumers — producers





Diagnosis — Self-healing — intervention

- Secure access to information to monitor and understand consumption
- Integration of new usage (EV, RES)
- Capacity to manage domestic appliances (up to 8 signals)
- Contribute to peak load management

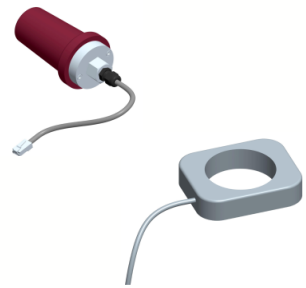
Faster interventions
On the network

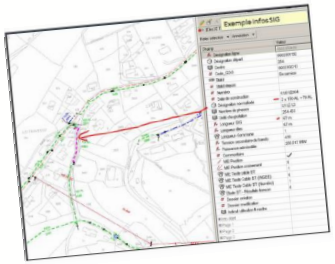
Contribute to the energy transition
Information and management

In addition to Linky, advanced Smart Grids technologies are necessary

Smart Grids : a combination of power network technologies with ICT technologies

- **Sensors and Smart meters to** get detailled information on the state of the network as well as consumption / generation profiles
- **Devices to exchange information** with generation sites
- **forecasting tools** to predict consumption and generation **at local level**, combined with **simulation tools** to anticipate potential constraints on the network
- **Digital technologies** implemented in the primary and secondary substations (control/command, monitoring, dynamic OLTC, …)
- **Advanced softwares for network operation and dispatching** (LV and MV default **localization**, MV network **self-healing**, **Volt / Var regulation** …)
- Solutions contributing to an **active management of consumption and generation** (peak period management, electricty storage, etc.)





Experiment the potential of smart grids for the integration of large wind energy capacities in a rural network

VENTEEA PROJECT
Location : Vendeuvre-sur-Barse (Aube)
Nber customers concerned: 3 000
Period : from 2012 to 2016

OBJECTIVES

Experimenting with new functions to manage the generation of renewable energy on the medium voltage grid

Study the impact of renewable energies on the quality of the electric wave, protection plans, safety of people and property

Adapt information systems for planning to handle renewable energies and their intermittent nature

Study the contributions of solutions for storing electricity generated by RES as a mean of stabilizing the power grid

ACHIEVEMENTS

EQUIPMENTS AND SOLUTIONS

- Installation of a digital control/command solution in the HV/MV substation
- Installation of a MV/LV substation with an “on load tap changer”
- Installation of default detectors on overhead lines, self-powered, with two-way communication capabilities
- Implementaiton of a state estimator (estimation of the voltage profile of the MV feeders, based on voltage measures)
- Implementation of a generation forecast tool based on the local wind conditions
- Intallation of an electricity storage system (Li-Ion battery of 2MW and 1,3 MWh), shared between the TSO, the DSO and the producer

STUDIES

-study to evaluate the impact of wind generation intégration on the durability of power network equipments
- technical and economical study of electricty storage solution
- study of the social impact

Contribution of smartgrids to the electric system in urban areas equipped with Linky

GREENLYS PROJECT
Location: Lyon et Grenoble
Nber customers concerned : 1 000 residential customers et 40 tertiary sites
Period : from 2012 to 2016

OBJECTIVES

- Testing, in real condition, interruption of consumption in peak periods(heating and/or domestic hot water)
- Optimising operation and dispatching for medium and low voltage networks
- Optimising power flows in areas comprising photovoltaic generation and electric vehicule charging stations
- Encouraging consumers to manage their power demand and to participate to energy saving actions
- Testing solutions to forecast local consumption and distributed generation
- Identifier la création de valeur des expérimentations

ACHIEVEMENTS

CUSTOMERS
- recruitment of customers participating to experiments (390 residential customers et 3 tertiary sites)

EQUIPMENTS AND SOLUTIONS
- Installation of equipments in the MV/LV substations : voltage measures and fault detections
- Installation of equipments in the photovoltaic generation sites to manage voltage variations
- Experimentation of a tool to localize losses in the low voltage network
- Implementation of a tool to forecast distributed generation and consumption

TESTING CAMPAIGNS
- peak shaving : 40 000 orders for consumption reduction were realized in coordination with Engie, GEG and Schneider Electric between 2013 et 2015 (2 winter seasons)

NICE GRID
A SMART SOLAR DISTRICT

Contribution of a smart solar-powered district and of storage to handle demand peaks

NICEGRID PROJECT
Location : Carros (near Nice)
Nber customers concerned : 1 500 residential customers for peak shaving, 100 residential customers for PV generation and storage
Period : from 2012 to 2016

OBJECTIVES

- Optimizing operation of a medium and low voltage network incorporating massive PV generation
- Testing, in real condition, a 3,5 MW load management in winter
- Encouraging consumers to manage their power demand and to participate to energy saving actions
- Study technical interest of electricity storage (battery at primary and secondary substations, at customers' home)
- Testing temporary islanding in case of an emergency (technical issues and assessment of the costs)
- Testing solutions to forecast local consumption and distributed generation

ACHIEVEMENTS

CUSTOMERS	- recruitment of customers participating to experiments – peak shaving and demand management (200 residential customers for winter period and 70 for summer period, and 11 tertiary sites)
EQUIPMENTS AND SOLUTIONS	- Installation of a "solar" MV/LV substation (local regulation OLTC based on solar condition and estimation of PV generation) - Installation of 2 500 Linky smart meters, of which 550 in the area comprising PV generation - Installation of a 1 MW battery in a primary substation, of a 250 kW battery in the LV network for islanding, of 20 residential batteries of 4 kW each - Implementation a Network Energy Manager (NEM), software platform contributing to the coordination between entre RTE (TSO), ERDF (DSO) and flexibility aggregators
TESTING CAMPAIGNS	-Test of Solar Bonus offers during summer (Solar hour = Off-peak hour tariff between 12 AM and 4 PM ; SMS warning) -Test islanding on a low voltage district (at ConceptGrid and then at Carros)

Optimise energy consumption and generation over a region

SMARTGRID VENDÉE PROJECT
Location: Vendée
Nber sites concerned: 100 tertiary buildings, 10 000 public lightings ; dispatched over 6 primary substations (HV/MV) et 2 700 secondary substations (MV/LV)
Period : from 2013 to 2017

OBJECTIVES

- Optimizing operation of the distribution network
- Testing the acceptance and efficiency of an active energy demand management of public buildings
- Enabling the integration to the distritbution network of renewable energy sources
- Developing a Smart Grids skills center at CNAM
- Testing solutions to forecast local consumption and distributed generation

ACHIEVEMENTS

EQUIPMENTS AND SOLUTIONS

- Installation of a digital control/command solution within 3 primary substation (HV/MV)
- Installation of measuring devices (voltage, current) for each feader of the primary substations
- Installation of 150 smart meters Linky (and several concentrators) in the public buildings and public lighting sites
-Installation of two Weather Stations to contribute to generation forecast
- Implementation of a tool to forecast generation and consumption within the area of a primary substation
-Implementation of a web platform, contributing to the coordination between ERDF and the RES generators connected to the MV network