From innovation to industrialization : Enedis approach to unleash new business models

7th of July – Alexis Phélizon

Power Distribution is undergoing a significant change in its model

The target is the Energy Transition which is a major concern of public and local authorities, and of the citizens

A further development of **renewable energies** (notably solar and wind generation)

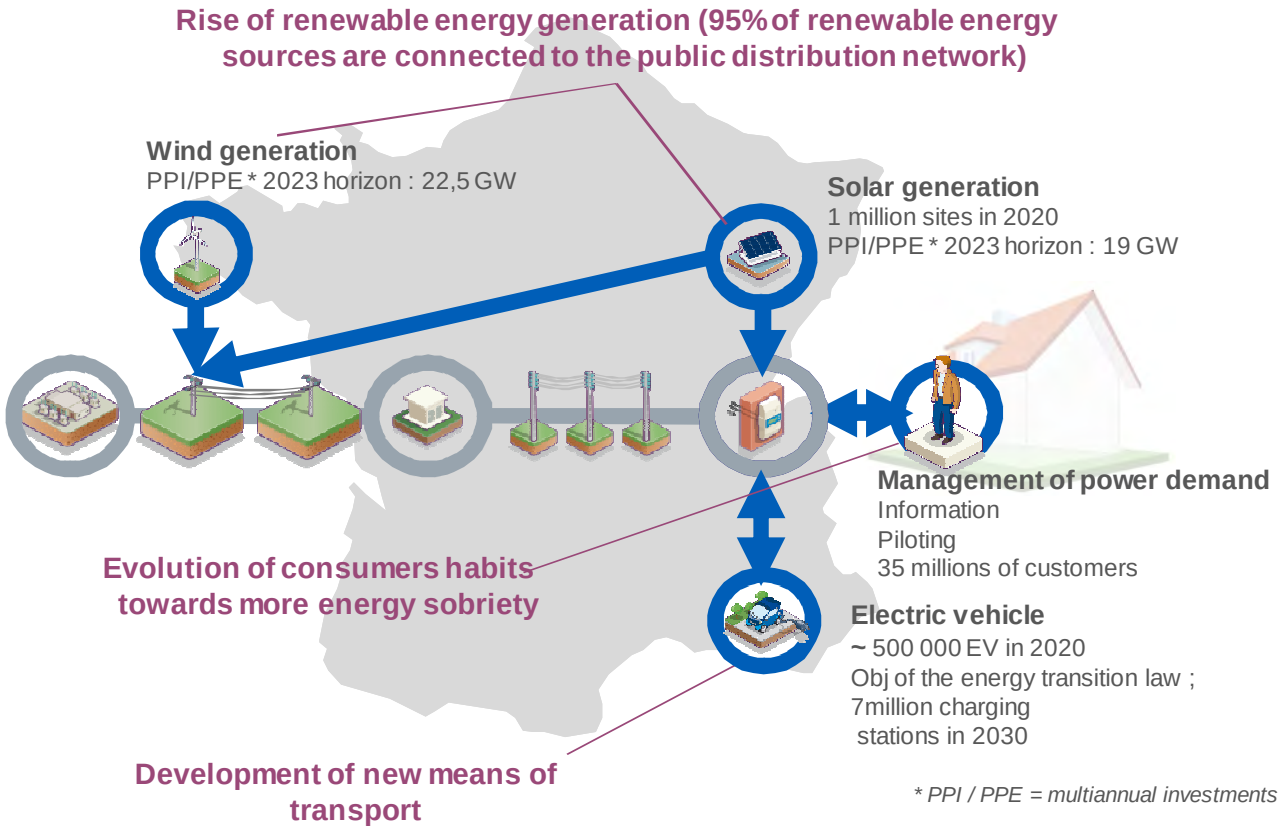
The progressive arrival of **electric mobility** and **recharging infrastructures**

A willingness of more **efficiency** and **management of power demand**

The development of **electricity usages** allowing the consumer to **manage** more actively **their consumption**

The public distribution network is at the core of this dynamic

In France, the distribution network irrigates territories with 1,3 million km of medium and low voltage networks and is directly linked to the energy transition.



Key figures

404 000 new customers connected

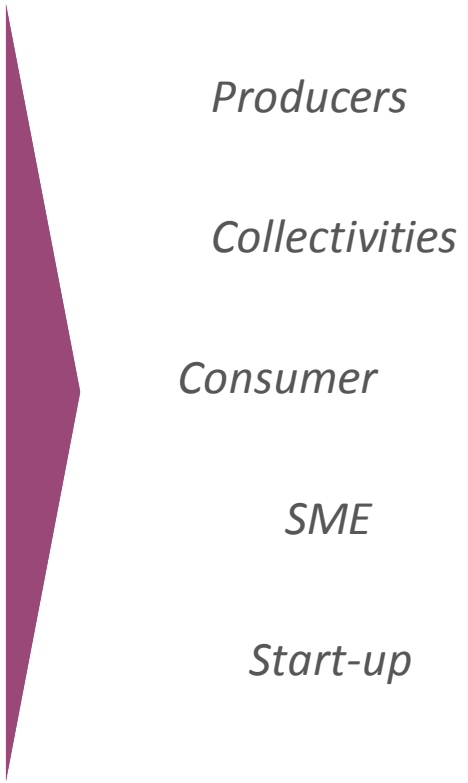
11 million field operations

21 GW of RES connected to distribution network (end dec 2016, 356 000 sites)

** PPI / PPE = multiannual investments program / energy program*

Enedis has to answer the expectations of the different actors of the territories

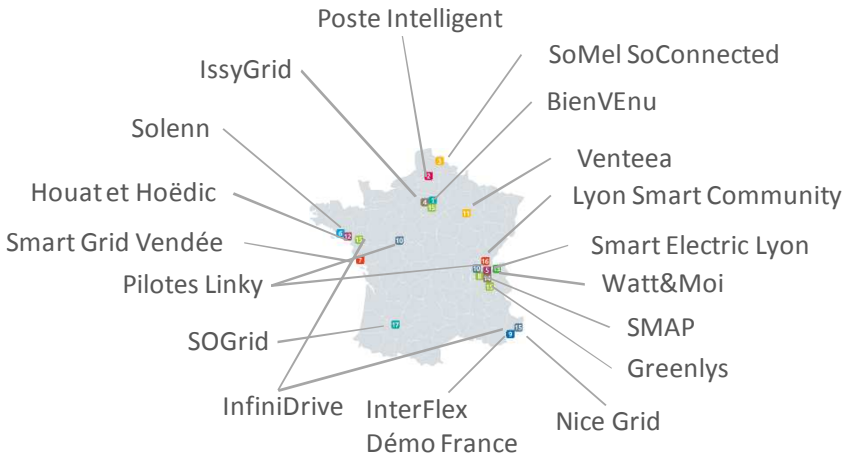
- The integration of a larger amount of intermittent renewable energy generation at interesting costs and delays for producers
- The access to more informations on consumptions to increase the awareness on managing the power demand
- The conservation of a high quality of furniture to make the territories more attractive and to facilitate their socio-economical development
- The exploitation of the local energy resources and the development of more flexible usages
- The stimulation of the ecosystem to encourage the innovation of SME/start-up (in particular through an open data approach)



To do so, Enedis is innovating with a program of 26 Smart Grids projects in France and in Europe

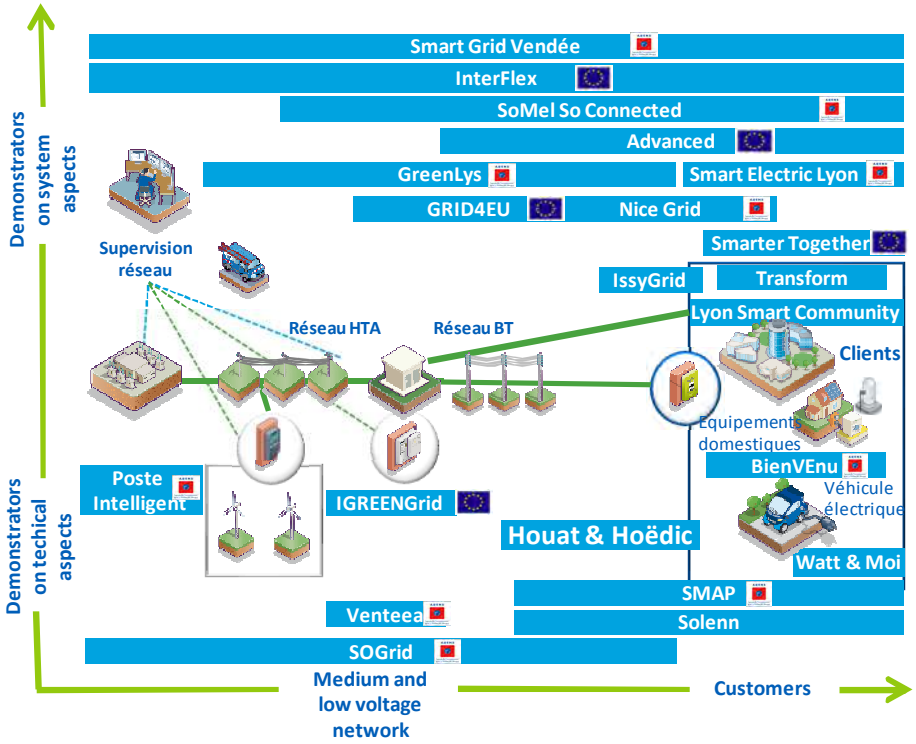
A set of pilot projects at the service of a new industrial dynamic which rallies a hundred partners.

- Projects led in France



- Projects led at a European scale

This innovative program covers a wide range of Smart Grids issues (technical and/or systemic).



Projects supported by the ADEME

Projects supported by the European Commission

Some of the projects are achieved and have provided results

Focus on 3 dimensions that have a link with expectactions of the different actors (producers, collectivities, consumers, new entrants, …)

Renewable energy sources integration and storage

Successfull experimentation of solutions **enhancing the capacity of the distribution grid** to integrate renewable energy sources

Flexibility and economic models

Experimentation in real condition of several kind of flexibilities (ToU tariffs, peak shaving programs) demonstrating **a potential and the necessity to proceed to further experiments**

Data management

Successfull experimentation of solutions to **share data from smart meters with consumers and/or third parties**, raising their awarness to contribute to energy conservation

Focus on main results

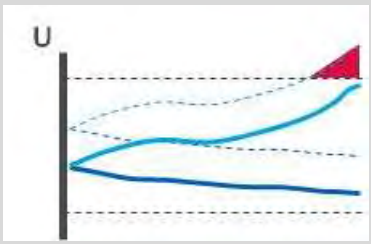
Renewable energy sources integration and storage

- Development of promising forecasting tools of renewable generation and power demand
- **Experimentation of dynamic voltage control on MV and LV networks**
- Effective implementation of MV and LV real time network state estimator (ex : tracking of the variations of LV voltage plan)
- **Study of a smart connection of RES on MV network (modulation of power)**
- Successful integration of electricity storage based on Lithium-ion technology at different levels of the network
- **Optimization of the use of electricity storage by a multi-actor/multi-service approach**

Illustrations

Experimentation of dynamic voltage control on the MV network, based on :

- Voltage sensors installed on the network
- Transmission of data from sensors and from generation sites (based on a permanent communication) to the regional control center
- Pre-industrial implementation of a digital control/command solution at the primary substation
- Real time state estimation of the network
- Action on the On load-tap changer of the primary substation



Connection, installation and operation of storage systems at différens level of the network (primary and secondary substation, LV network, customer)

Focus on main results

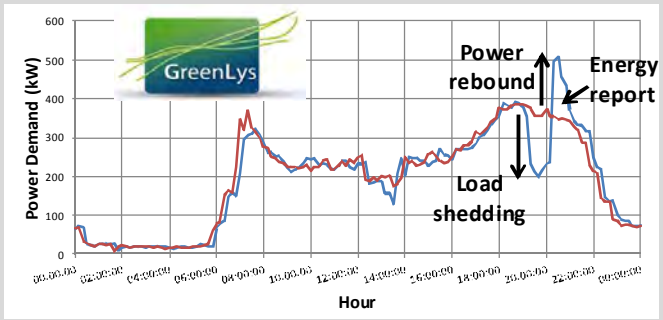
Flexibility and economic models

- **Observation of a power rebound of 25 to 50% of the curtailed power and an energy report of 95% of the curtailed power**
- Necessity of a coordination between DSO and aggregator
- **Ability to aggregate flexibilities in summer and winter in order to shift energy consumption or reduce consumption peak**
- In order to solve strains on LV network, requirement of a large number of flexibility consumers participating in flexibility programs
- **Demonstration of the local and temporary nature of the value from the point of view of the DSO**
- Need of an accurate vision of local situations and their medium-term evolution in order to target efficiently the deployment of smart grid solutions
- **Necessity to consider a multi-service and coordinated usage of the material in order to maximize the value**

Examples

Observation of a power rebound of 25 to 50% of the curtailed power and an energy report of 95% of the curtailed power

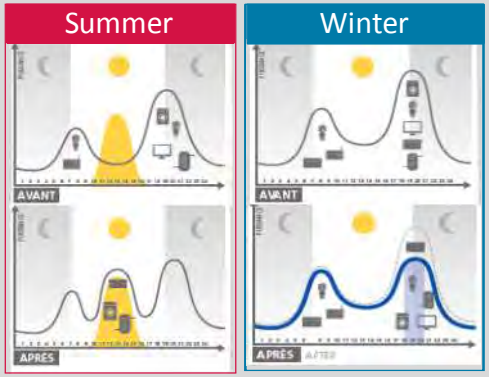
Individual curtailments of 300 LV customers



NICE GRID
A SMART SOLAR DISTRICT

In summer, shifting of consumption in solar period from 12 am to 4 pm (25%/client in average which represents 5% of extra consumption in the area)

In winter, reduction in consumption during the peak period from 6 pm to 8 pm (21%/client in average which represents 2% of HV/MV substation power)



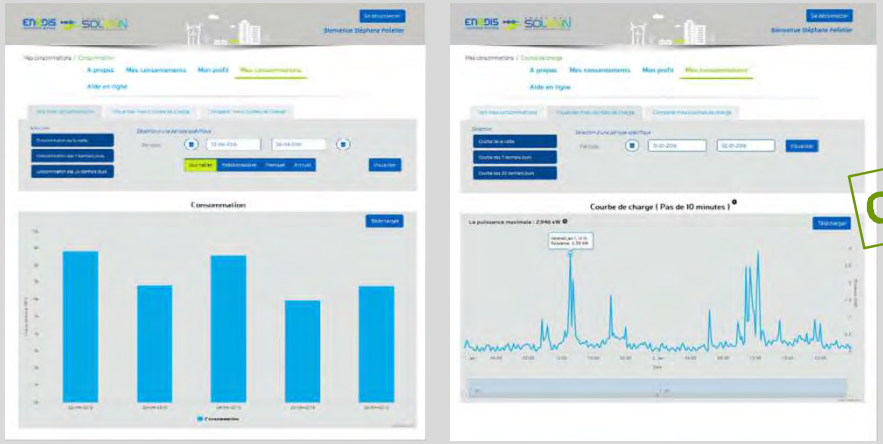
Focus on main results

Data management

- Experimentation of a system to management customer consent to share its personnal datas
- Automation of the chain from collection of raw data to publication of consumption data (load curves and daily consumption), in compliance with the regulatory framework and the security constraints
- **Implementation of a web portal to visualize individual consumption data**
- Implementation of a platform contributing to energy conservation through individual coaching and animation

example

SOLENN



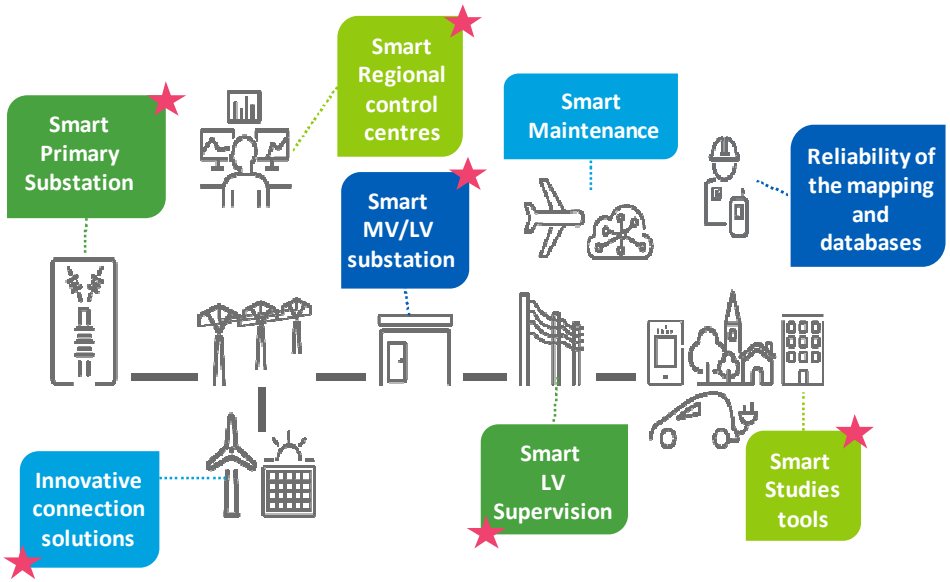
On Going

While the experiment are conducted, the obtained results are contributing to the industrialization of smart grids by Enedis

The collaborative innovation dynamic launched by Enedis in 2011 continues

- Enabling the **collaboration of partners in consortium** gathering all the **stakeholders** of the electric system (collectivities, local authorities, manufacturers, SMB, network operators, research laboratory, universities,…)
- **Mobilizing** and **combining investments** efforts
- Developing **robust technologies** to tackle the future challenges for the networks
- Enriching the reflexions on the **economic models** linked with smart grids and their viability for all the actors of the system

The results are contributing to the 2018 horizon roadmap of Enedis to modernize the distribution network management and to support the actors of the electric system and the territories



★ *Solutions of the roadmap based on the demonstrators results*

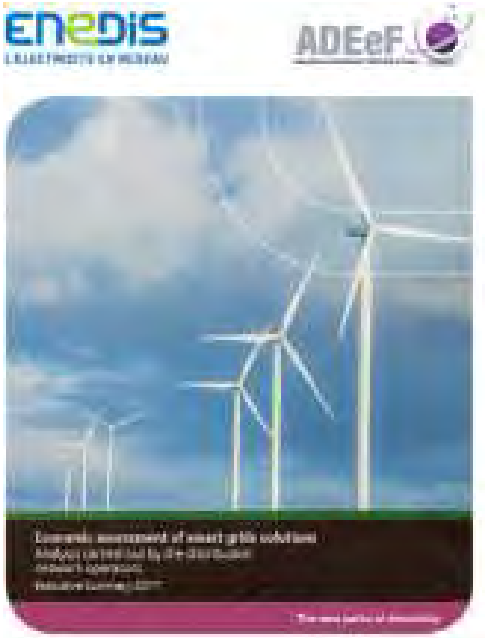
In addition, an economic assessment of smart grids for distribution network has been realised

Clarify, in the French Context, the debate regarding economic potential and deployment methods with the government and the industry

A key step in the industrialisation of initial smart grid solutions

- Economic rationale to set deployment strategies
- Gains to accelerate the energy transition

A work produced in collaboration with ADEeF, ADEME and RTE that responds to the request of two ministries and integrates within the industrial DSO strategy of Enedis



Full report (in French) and executive summary(in English) available at the following urls
http://www.enedis.fr/sites/default/files/Rapport_evaluation_eco_des_Smart_Grids.pdf
http://www.enedis.fr/sites/default/files/Synthese_Smart_Grids_version_anglaise.pdf

A methodology that guarantees relevant and useful results

Cost benefit approach of the collective value advocated by the JRC and the EPRI

Assessment of each solution based on Enedis actual decision tools to ensure the coherence of the results

6 advanced functions were studied based on their relevance, maturity and role in the system

Two different deployment plans depending on the function

National deployment

Enable **the evolution of the infrastructure**
Information services or automated mechanisms that can be integrated **in a generalised industrialisation process**

Local deployment

Respond to local constraints and **support the energy transition**

Each of the function offers a positive gain for the whole grid

Benefits and costs of the solutions studied up to 2030

National deployment	Operational planning systems Self-healing extension	Costs and benefits for the distribution network -24 / +93 / +€69m -0.6 / +35 / +€34,4m
Local deployment	Centralised voltage control Self-adaptive reactive power control of DG Active power curtailment of DG	Average costs and benefits per transmission substation -215 / +340 / +€125k -60 / +560 / +€500k -150 / +770 / +€620k
Local deployment	Flexibility to alleviate demand constraints Implementation costs Investment postponement gain Network operation gain	Average costs and benefits per transmission substation variable — depending on the local flexibility service between €0 and €24k/MW/year — depending on the local situation between €0 and €20k/MWh — depending on the local situation

- *Costs: assets, development, curtailed energy …*
- *Benefits: diminution of lost load/curtailement, postponed investments*

Direct meaningful effects for the benefit of local energy transition

Improved insertion of DG thanks to an optimised use of the existing network

National deployment	**Operational planning systems**	Between **80 and 200 GWh of additional renewable energy produced** per year by existing installations at the same cost
Local deployment	**Self-adaptive reactive power control of DG** **Active power curtailment of DG**	**Savings of between €90k and 100k/MW on connection costs** thanks to self-adaptive reactive power control and active power curtailment **Connection of an additional 720 MW of MV production** in the existing network by 2030 thanks to MV curtailment

Improved resilience of the electricity grid

National deployment	**Self-healing extension**	**Reconnection of customers as much as 25 minutes faster** than before in the event of an incident in a substation

Enedis, distribution system operator, is committed alongside local collectivities and electric system actors

Helping in **consuming better** by saving energy and by reducing **consumption peaks** thanks to data provision

Facilitating the development of **electric mobility**

Supporting the development of the **renewable energy generation**

Developing the network at the **best price** to tackle the **energy transition challenges**

Contributing to the **economic growth** and to the **attractiveness of territories**

Ensuring a **quality public service**

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@enedis

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Enedis - Tour Enedis, 34 place des Corolles - 92079 Paris La Défense - enedis.fr
SA à directoire et à conseil de surveillance au capital de 270 037 000 euros - R.C.S. Nanterre 444 608 442