SOLUTION TOWARDS ENERGY AUTONOMY : DEVELOPMENT OF RENEWABLE ENERGIES, SMARTGRID APPROACH AND STORAGE IN SMALL ISLANDS EXAMPLES.

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27 Novembre 2014

GORONA DEL VIENTO (EL HIERRO) PROJECT

With the courtesy of ENDESA (Spain)

EL HIERRO EXAMPLE

Volcanic island with high relief
Good wind resources
10700 Habitants , 278 km^2
Annual demand : 43,6 GWh
Peak Demand : 7,5 MW

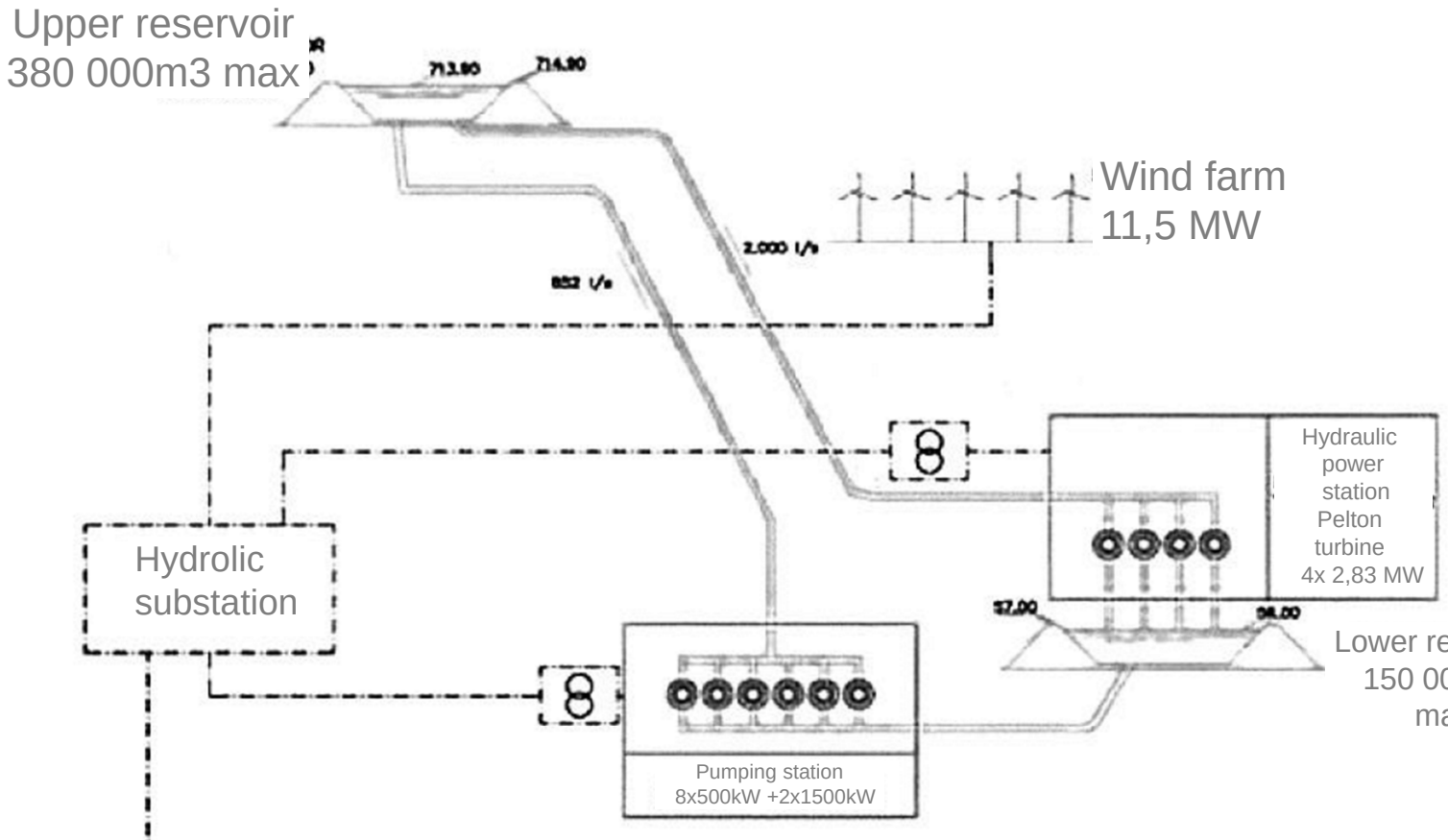
The idea of the Project is to associate wind energy with an hydraulic power plant and a pumping station.

Gorona del viento

(60%) El Hierro council
(30%) Endesa
(10%) Canarian technology Institut.

When wind is producing more energy than needed ,water is pumped and stored in the upper reservoir. When wind is not sufficient , water is turbinated to the lower reservoir to produce the complementary energy needed.
The target is to cover all the needs of the island by renewable energy and to avoid the use of the diesel plant already existing

GORONA DEL VIENTO GENERAL SCHEME



65 Million € of investment with 35 million funded by Spanish Government

Expected performance :

- 1,8 millions € saved /year
- 18.700 tons of avoided CO2 /year
- 6.000 avoided tons of fuel

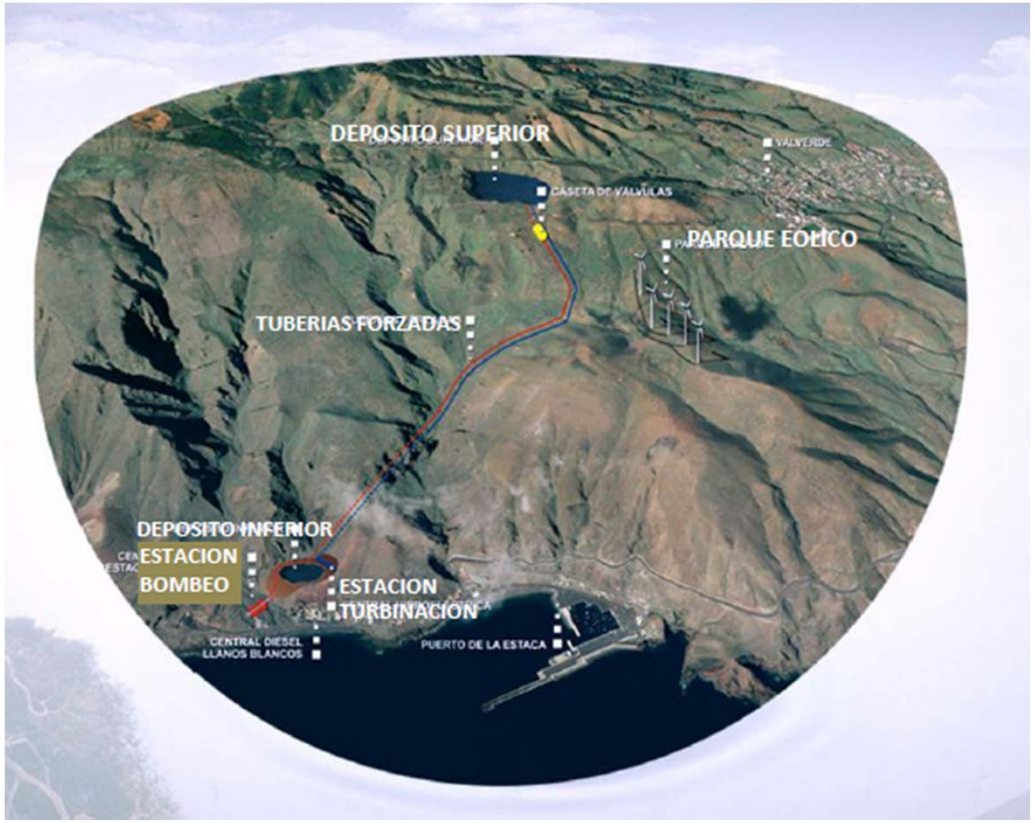
GORONA DEL VIENTO BUILDING PICTURES

Wind farm

Upper and
Lower Reservoir

Water pipe

EL HIERRO GENERAL SITUATION



- Civil work is completed and mechanical assembly is finished :
- Wind farm , presently limited to 2 MW is connected to the grid and in operation.
- Hydro plant was inaugurated in june 2014
- Hydro-pumping system project is nearly finished (electrical engineering, power electronics and control system of the plant not yet achieved).
- During initial implementation phase , 50 to 80% of total demand will be met with RES

PROJET PEGASE

PROJECT Made by

Funded by

GENERAL CONTEXT

- **In France, intermittent RES has known very high growth rate. In most of insular territories operated by EDF IES division, the instantaneous share of these energies is regularly reaching 30% of the total production. Beyond this limit, the most recently connected plant can be disconnected to protect system security.**

- **This situation has led the French regulator (CRE) to launch several call for tenders for RES farm with storage capacity to overtake the 30% limit and solve problem related to intermittence and difficulty of forecasting production.**

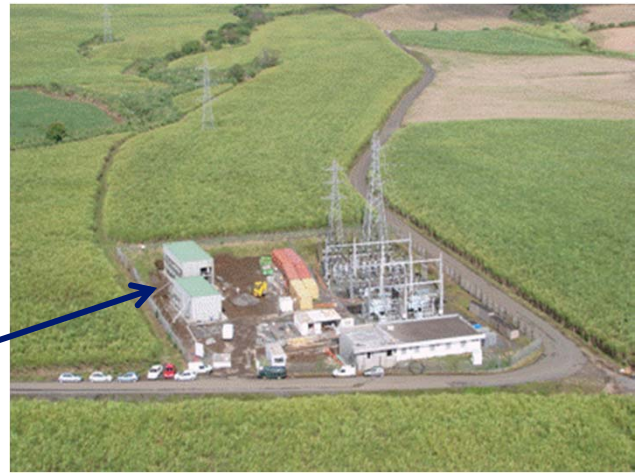
- **EDF R&D and EDF IES division invest in the experimental project PEGASE to develop forecasting tools for production of RES, information systems to collect and process data in order to optimize these productions thanks to an already existing 1MW storage on La Réunion island giving the opportunity of numerous experimentations.**

- **After more than 3 years of R&D work, spin-off EDF Store & Forecast society has been created to value the intellectual property and offer validated technological solutions to all actors developing intermittent RES project with storage.**

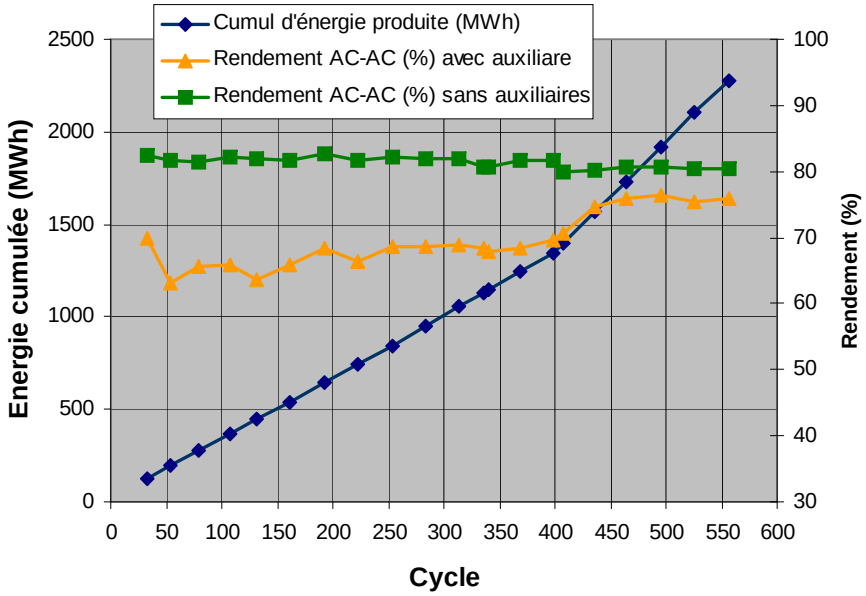
NaS Battery La Réunion

2007 : decision to invest in a battery initially to test peak shaving that started in 2009 :

- Charge Of the NaS Battery during the night when marginal cost of electricity is low.
- Discharge during peak time.



NaS Battery : 1MW – 7,2 MWh situated in 63kV/15kV Saint André substation.



Battery efficiency variation while cycling.

PEGASE SYSTEMS

2 MW photovoltaic plant (Albioma)

Development and test of optimizing algorithms to optimize operation of NaS storage La Perière wind farm (10 MW) and la Roseraye PV farm (10MWc) to cope with CRE requirements.

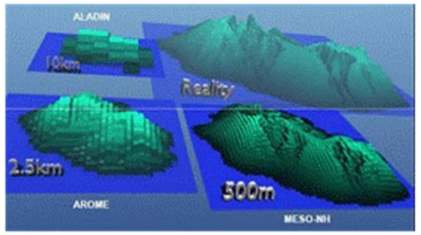
Wind farm 10 MW (Quadran)

1 MW NaS Battery Energy storage (EDF SEI)

Photovoltaic plant 10 MW (EDF EN)

Ground-based Weather observations (EDF R&D)

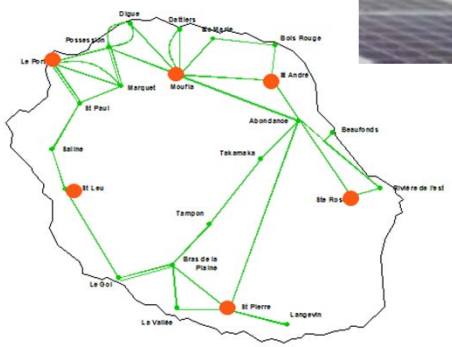
PEGASE RESULT HIGHLIGHTS



METEO FRANCE

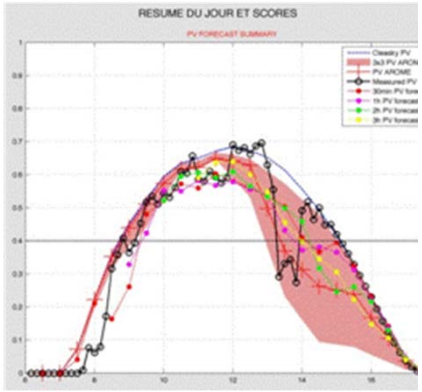
High resolution weather forecast

LMD



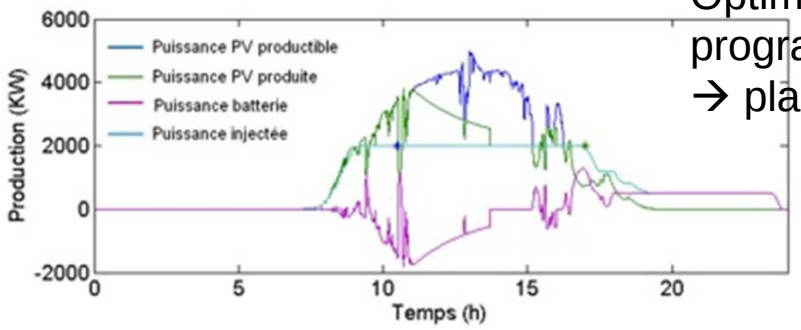
Realtime network of weather sensors

Predict, plan and ensure production intermittent Renewable Energy



Production forecast
→ Prediction

Battery Energy Storage
→ Ensure production



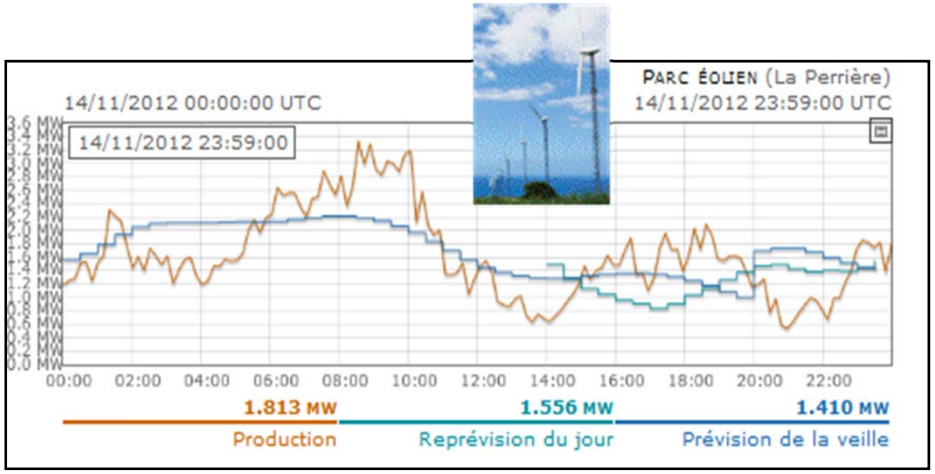
Optimization programs
→ planning

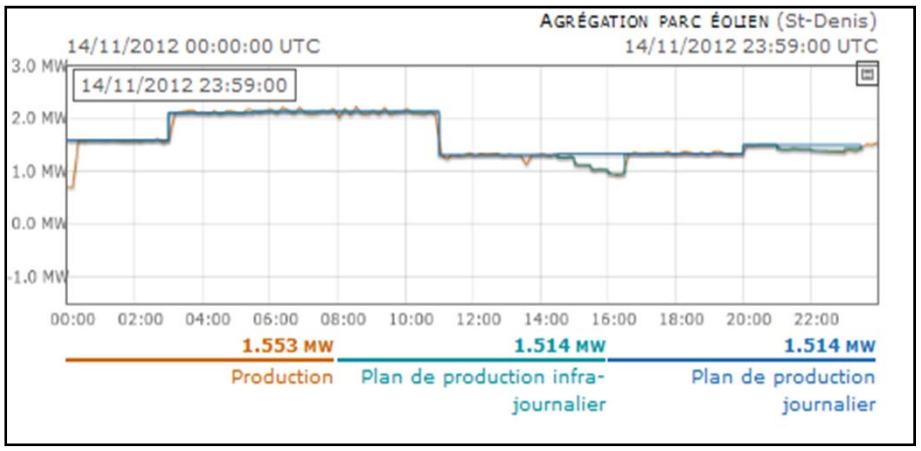
More results…

Test of PEGASE tool to cope with rules of purchase tarif for wind /storage plant on existing NaS (1MW-7MWh) storage copled with La Perriere Wind farm (10 MW)

Daily wind forecast (given by Quadran)

Optimization and planning of the total production (wind + storage) 24h ahead.
Optimisation of battery .



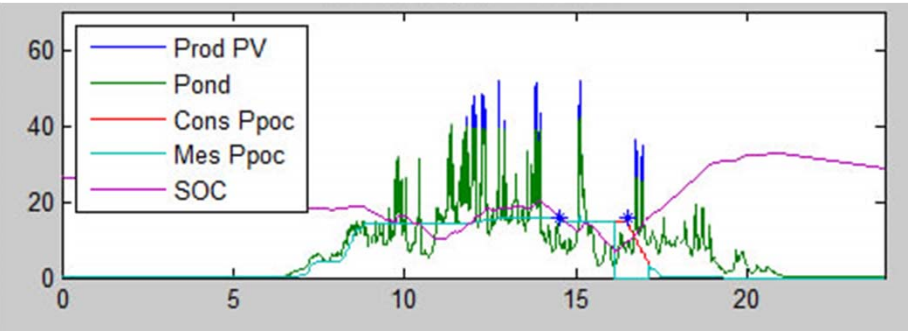


Application to Toucan Project (French Guyana)

5MWc PV farm with Zebra storage Monsinery, Guyane

- Automatic operation of PV farm

Day with Intermittent production



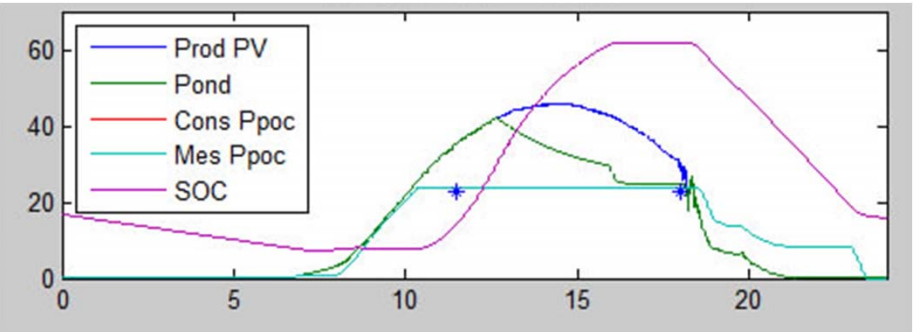
Ppoc = Power at point of connection

Prod PV = productible PV Power

Pond = Puissance convertisseur PV

SOC = State of Charge (battery)

Day with Clear sky



Conclusion

- Technical solutions exist to increase the share of intermittent renewable energy in the production mix but with possible consequences on the cost of the final energy.
- All systems do not have the same ability to accept a important share of intermittent energy
- Most of the present work is oriented to reduce the over costs of RES insertion as much as possible by using smarter solutions.

Thank you