



Réseau de transport d'électricité

Wind power forecasting from the System's Operator point of view

Requirements & experiences

SafeWind End-user Workshop
Fredericia 2012

AGENDA

- 01. Overview of wind power in France
- 02. Missions of RTE
- 03. Impact of wind power on RTE's activities
- 04. Developments in dealing with wind power

01



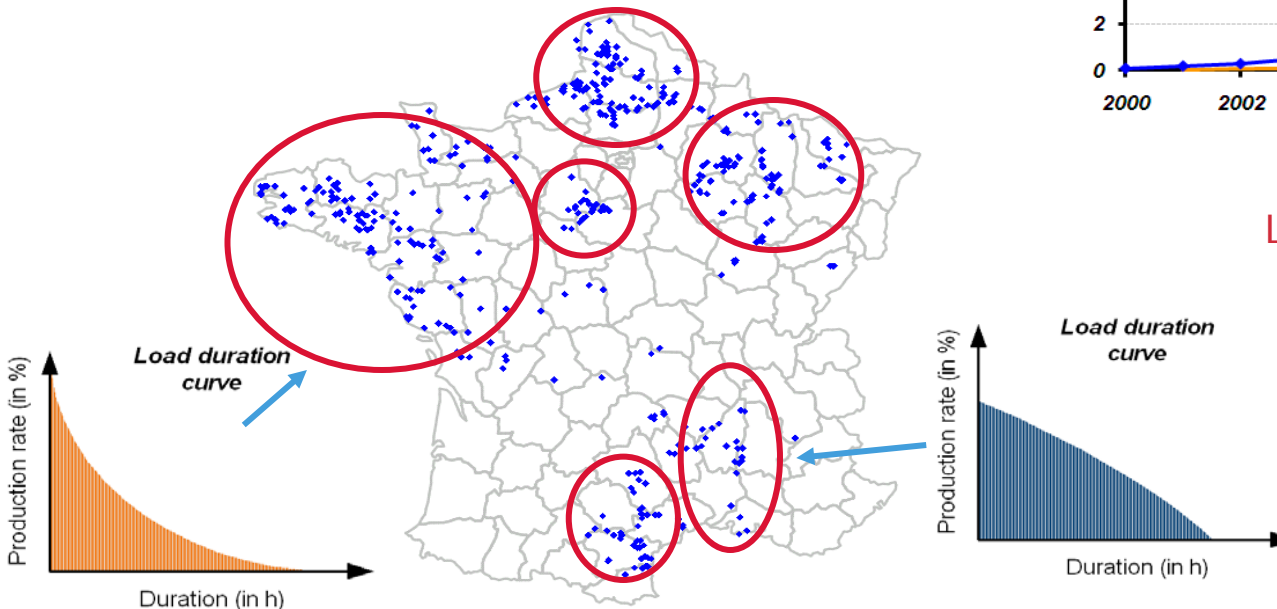
Wind power in France

About wind power in France

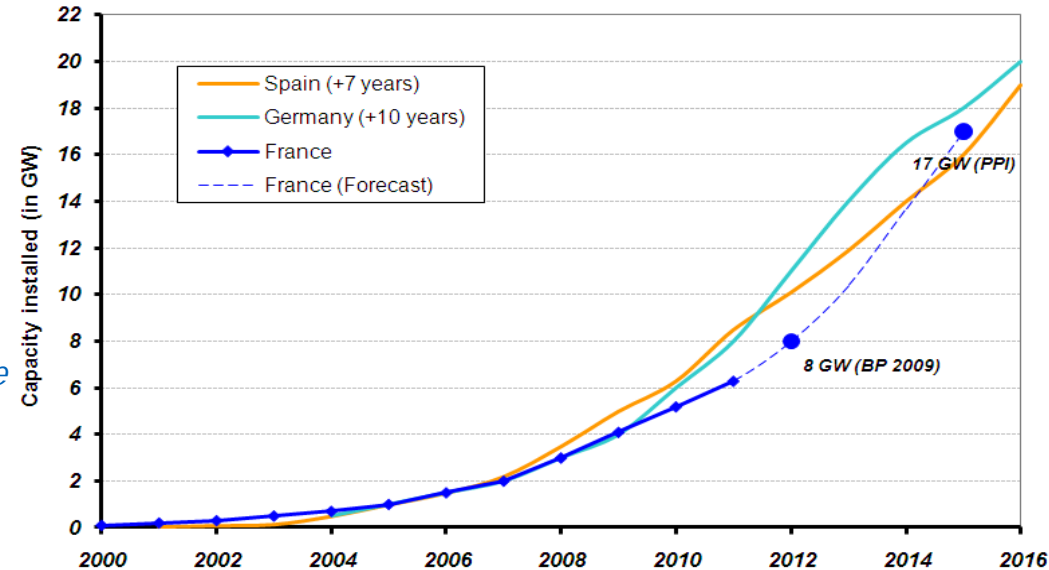
A high rate of growth

- Total wind power capacity installed in december 2011 : about 6 640 MW
- Target expected : growth similar to neighboring countries
- Target 2020 : about 25 GW
- More than 650 wind farms, mostly connected to the distribution grid

... compared to 110 GW of total capacity installed in France and the highest peak load of 101 700 MW



Growth of wind capacity installed
Germany, Spain and France



Location of this production:

- Variable production ...
- ... but "well" distributed, which allows "smoother" variations.

02



RTE's Missions

Missions of RTE as Transmission System Operator

The main missions, defined by law*, are:

- **Managing network infrastructures**
 - ✓ RTE must, at the fairest cost to the local administration, maintain, strengthen and develop the network to meet demand, whilst striving to reduce its impact on the environment.
- **Managing electricity flows on the grid**
 - ✓ Operational responsibility to maintain load-generation balance and system security by calling for the reserves submitted by the market participants on the BM
 - ✓ Managing exchanges capacities with others European TSO
 - ✓ Congestions management (redispatch on BM, change network topology ...)
- **Contributing to the proper running of the electricity market**
 - ✓ To guarantee that all users of the electricity transmission system are treated in a non-discriminatory manner
 - ✓ To develop interconnection capacities with other TSO
- **Contributing to the integration of expanding renewable electricity generation**

*: laws n°2000-108 and n°2004-803 .
More information on <http://www.rte-france.com/>

03

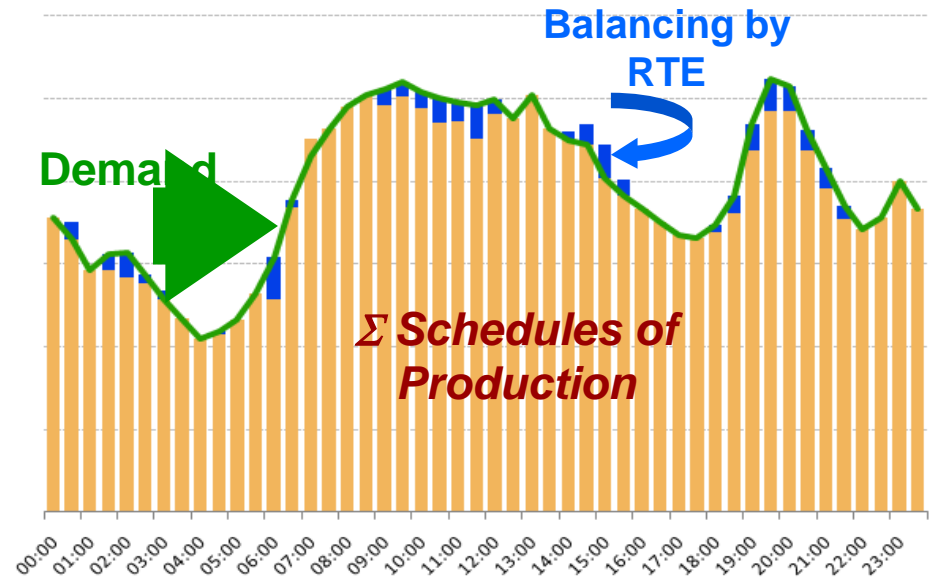
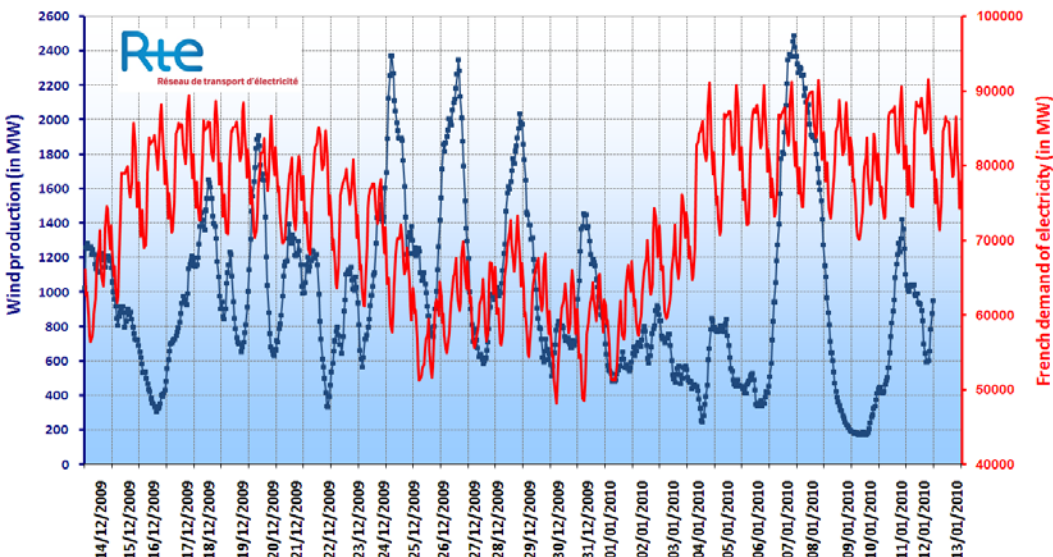
Impact of wind production on RTE's activities

Balancing production and demand (1)

A balance at any time...

- Between demand and production injected into the grid
- On behalf of users of the electricity transmission system
- Imbalances due to outages of power plants, error of forecast of consumption...

Example of wind production and french demand of electricity



... including also

- Variation of generation from renewable sources
- Forecast needed to ensure this balance in short-term

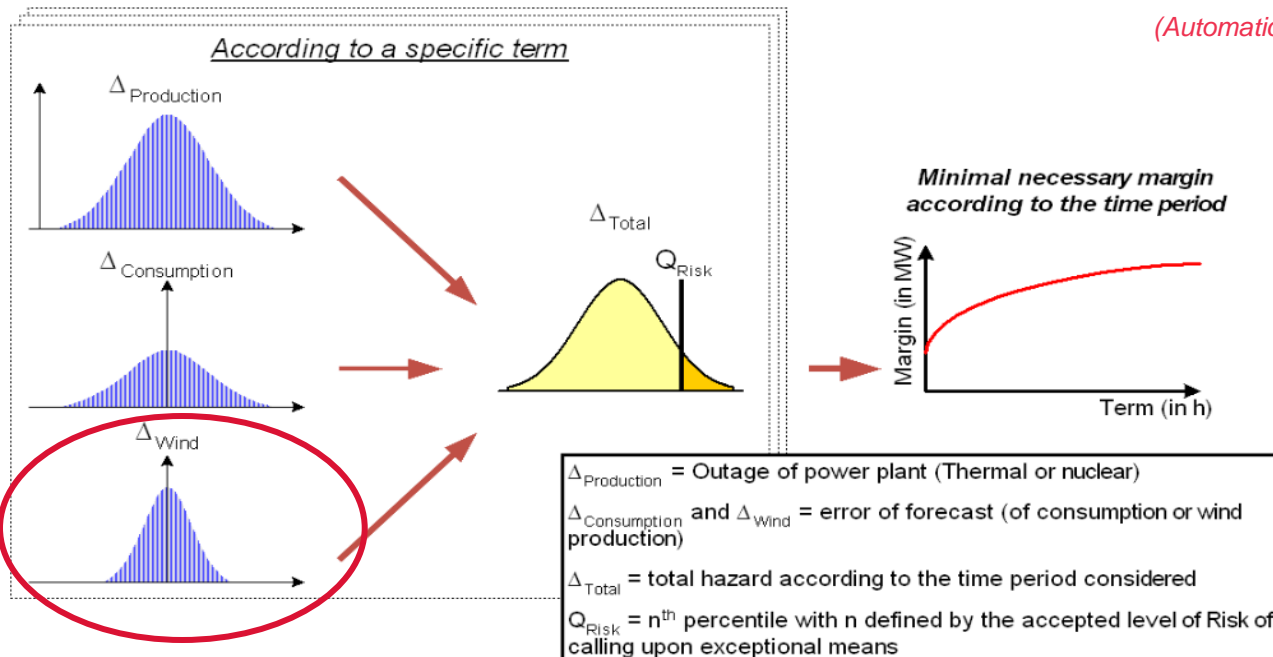
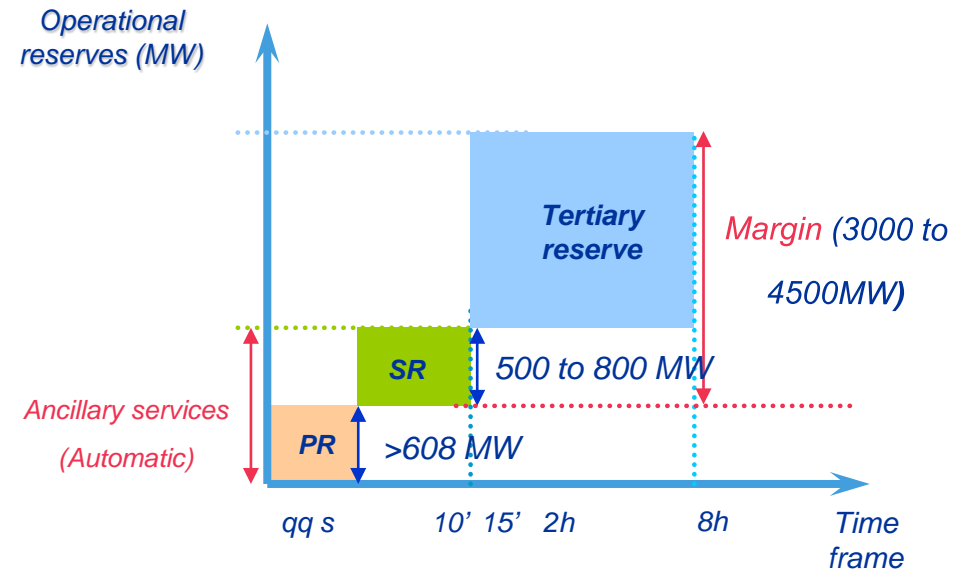
Balancing production and demand (2)

Reserves have to be available

- To ensure this balance and the security of the system

Wind generation and size of tertiary reserves

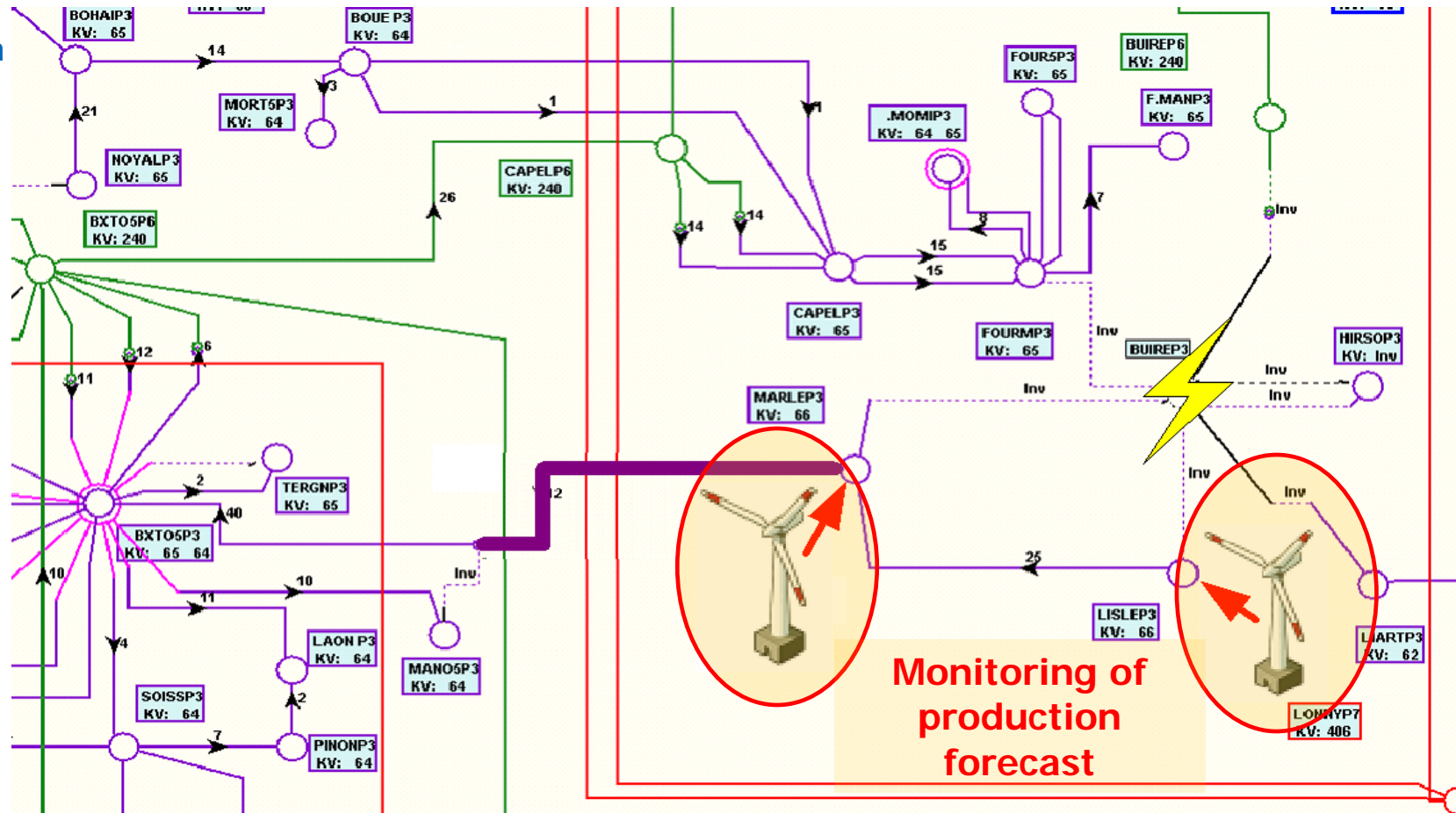
- Error of forecast of wind production taken into account in dimensioning total hazard RTE should to cope with.



Operating the network with wind generation

An example* of network management:

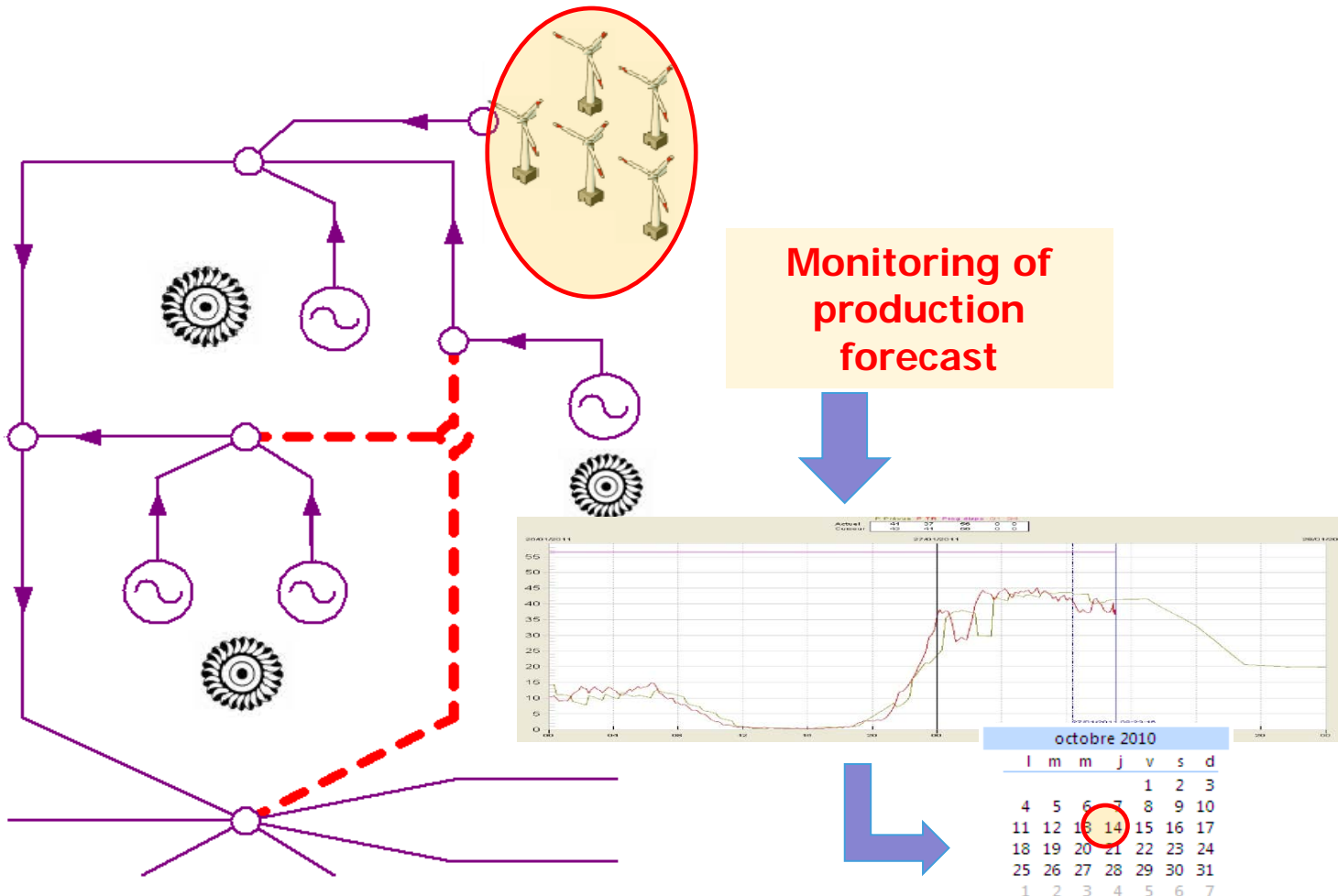
1. Illustration of grid with wind generation and low consumption
2. If constraint occurs in a power sub-station (N-1), injections from wind farms into the grid could bring flow over admissible limits (overload).
3. Forecasts of wind production are monitored (alarms configured) to anticipate overload situations.



*: systems could also be inserted into the network to limit automatically production from wind farm in case of constraints

Wind generation and maintenance of the grid

How forecasts could be used to optimize schedule of maintenance on the network (preventive maintenance on devices and facilities)...



1. Part of network with mix production (hydraulic and wind)
2. Operation of preventive maintenance have to be scheduled on equipment (1 day operation)
3. Monitoring of wind forecast to optimize maintenance (available with low production from wind farms)

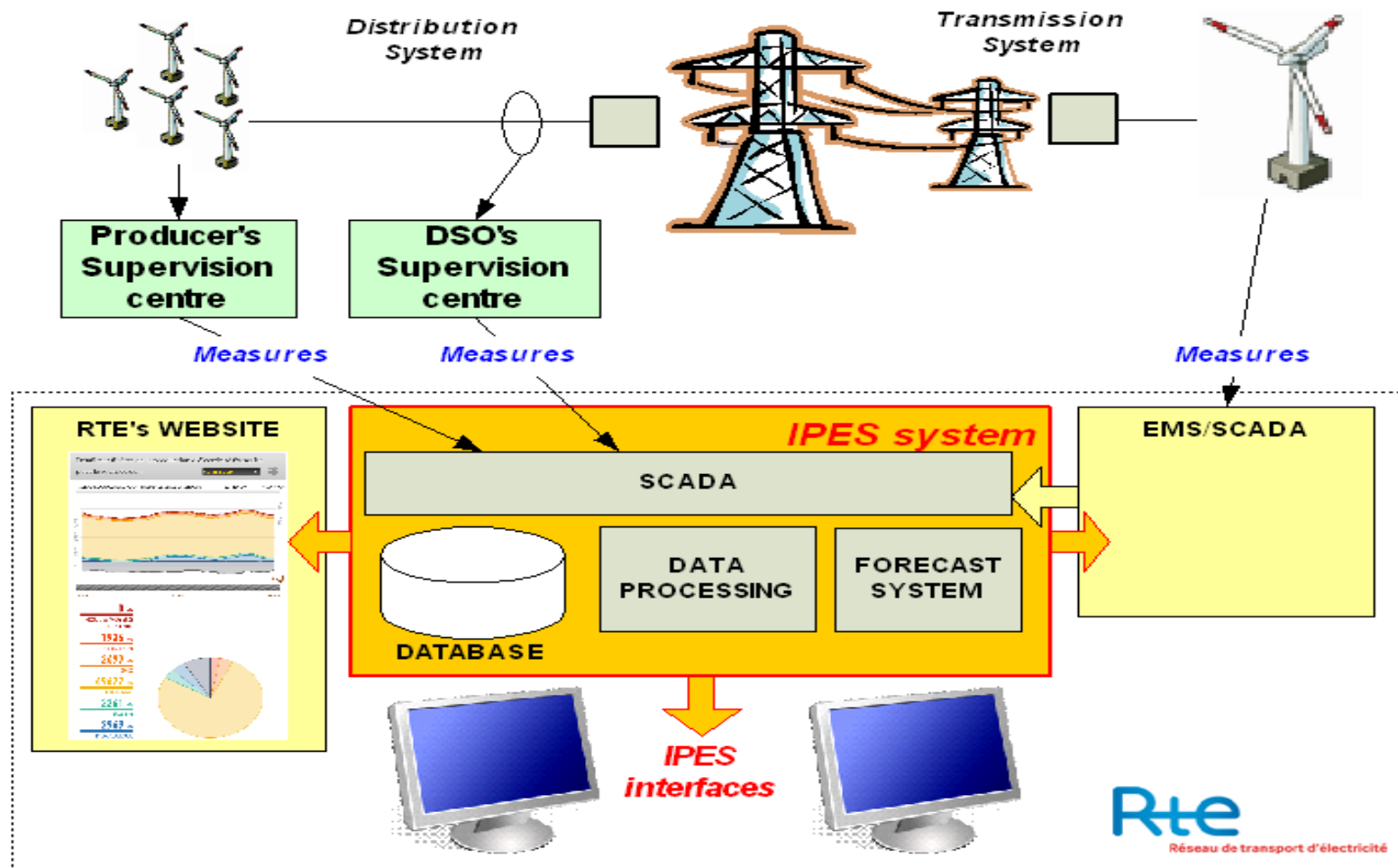
04



Tools dedicated to Wind power

IPES: a system dedicated to wind power*

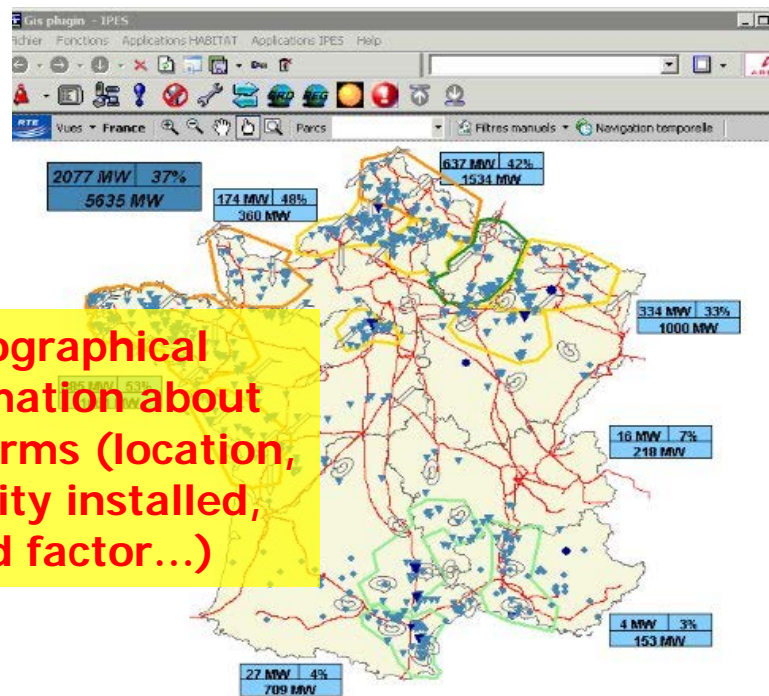
A tool to collect data relative to wind farms and to provide information to end-users in charge of managing the grid.



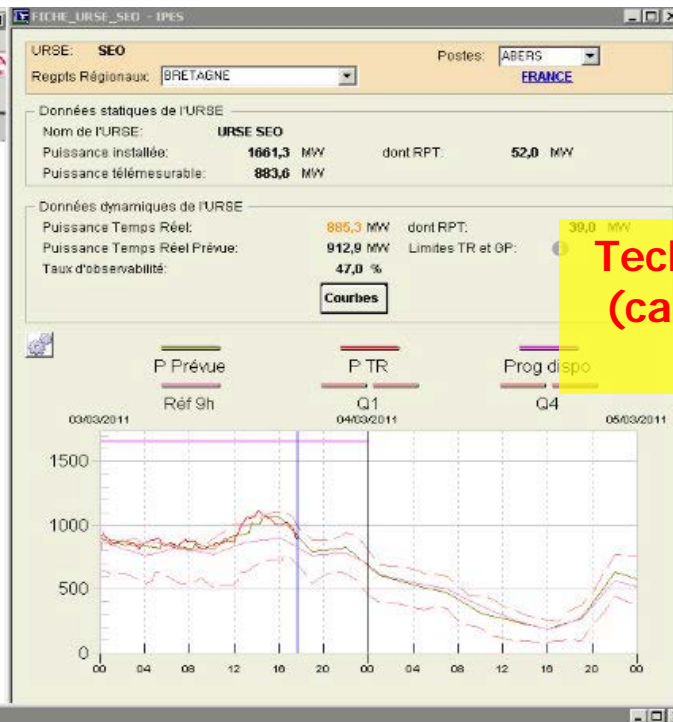
*: PV production will be also monitored by IPES

Monitoring wind generation with IPES (1)

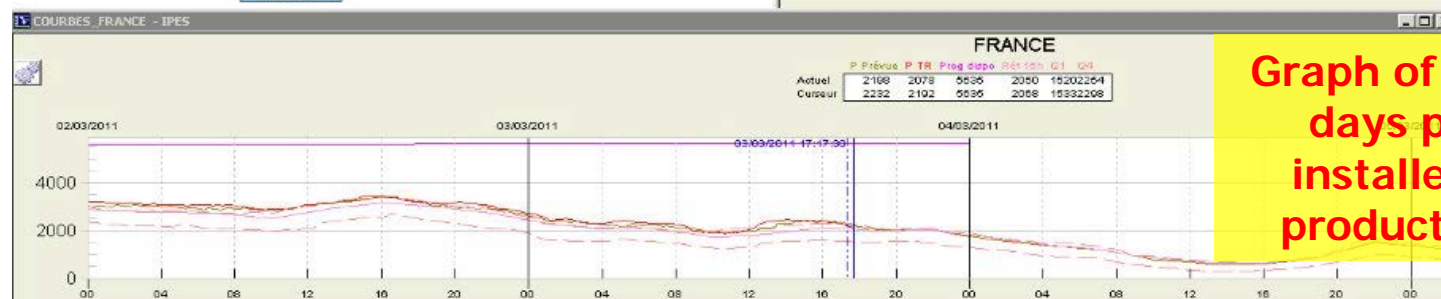
A complete interface to provide different types of data, from measures to forecasts and location of the wind production.



Geographical information about wind farms (location, capacity installed, load factor...)



Technical information (capacity, measures, forecasts...)

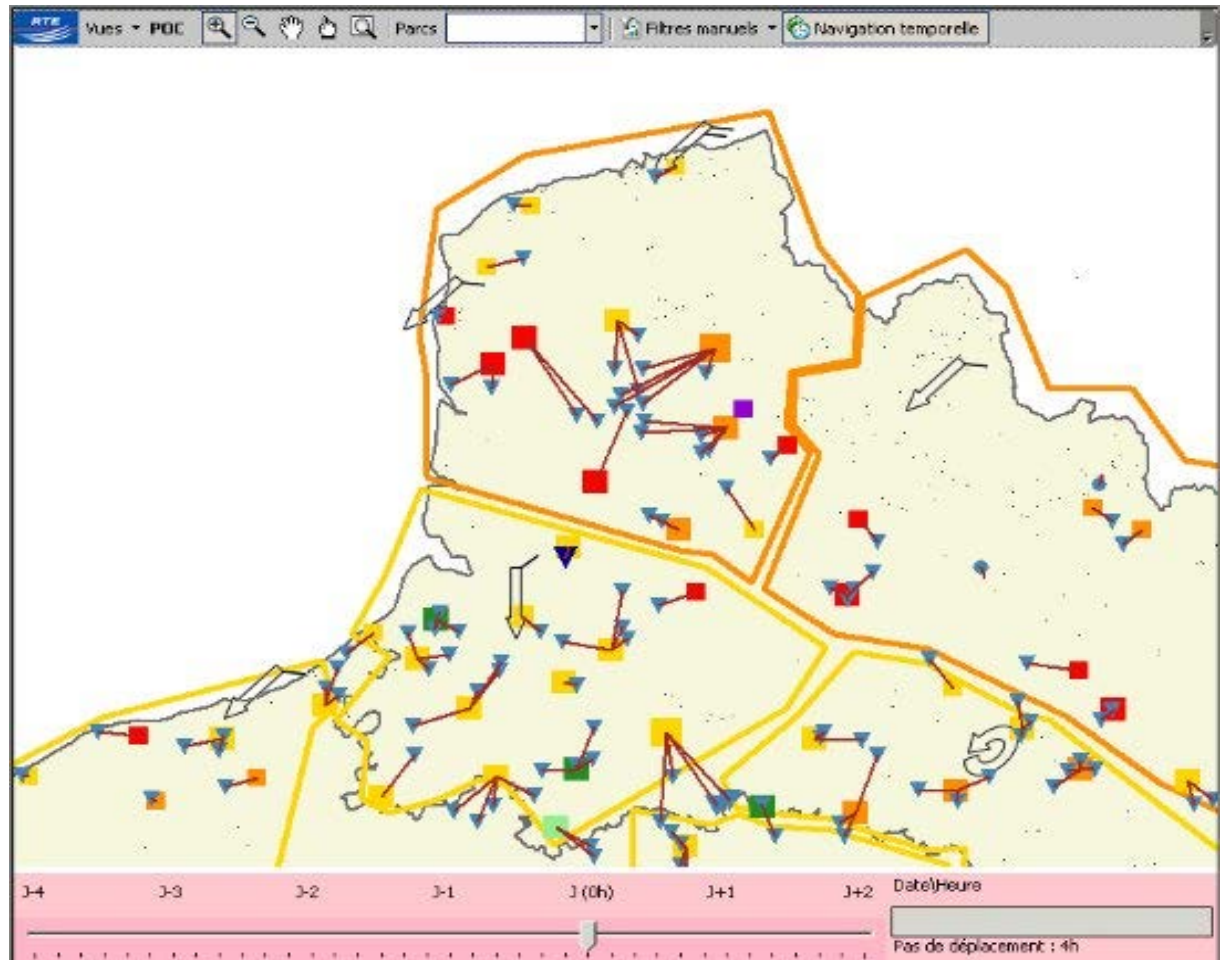


Graph of production on a 6 days period (capacity installed, estimation of production, forecasts...)

Monitoring wind generation with IPES (2)

Different views and options according levels and needs for exploitation of the network

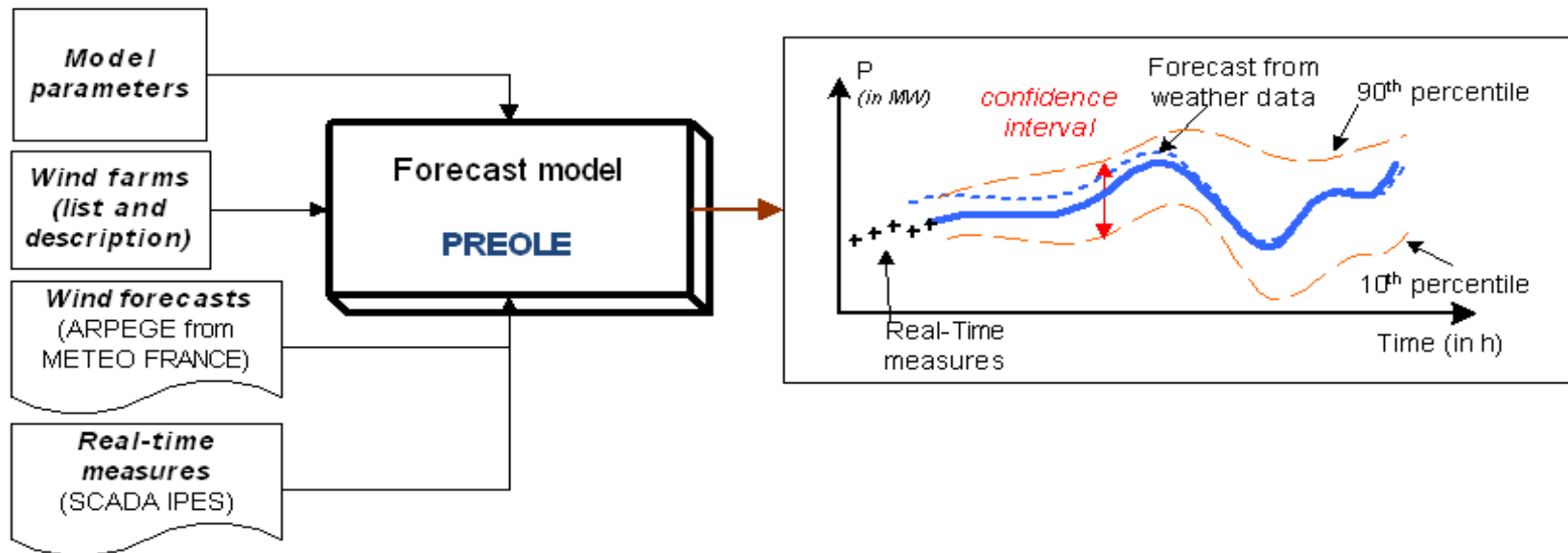
- Wind farms connected to power sub-stations
- Supervision of regional areas
- Set of alarms to monitor wind production according to potential constraints on the grid



Forecasting wind generation with PREOLE

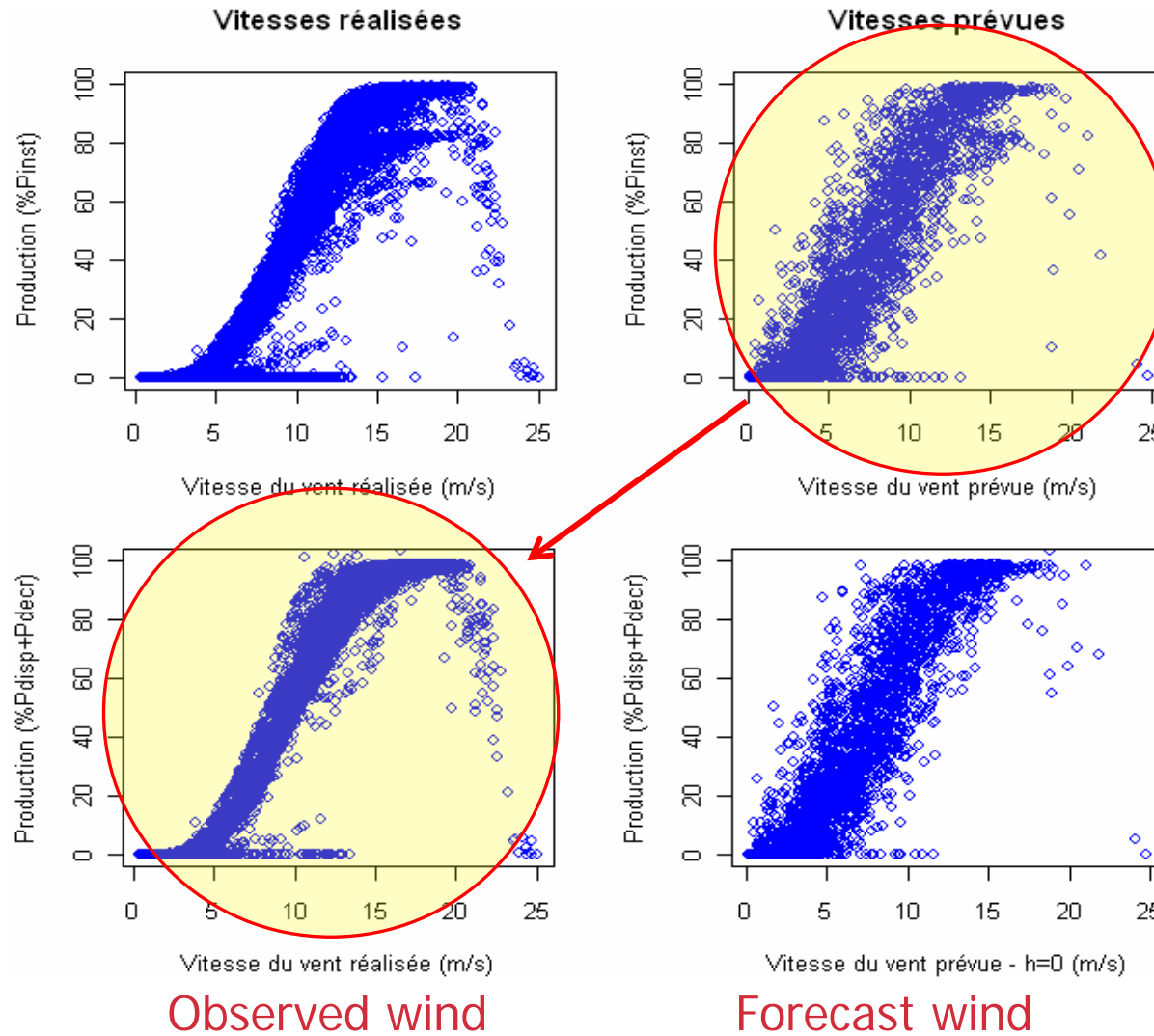
A forecasting model dedicated to wind generation

- Since the end of 2007, use of a forecasting model named PREOLE
- Forecast provided at different scales: from wind farms to France (and regional areas, power substations)
- Parameters estimation is based on the past wind generation behavior (measures)
- Real-time measures taken into account to improve very short-term forecasts
- Forecast up to 72h term (according to weather forecasts)
- Accuracy of global forecast (France): RMSE about 5% of capacity installed



Link function and data

Power

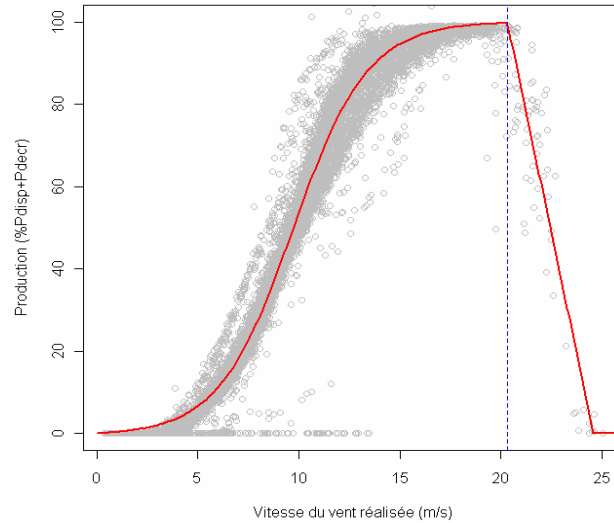


Corrected
power

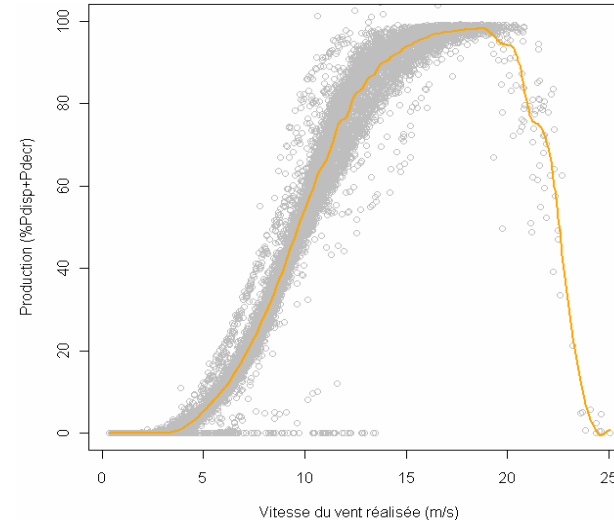
Link function works

RMSE
from 15-17%
to 5-6%

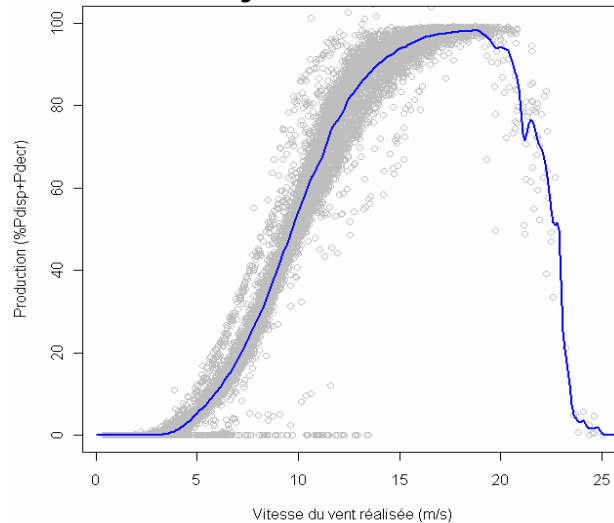
Parametric method



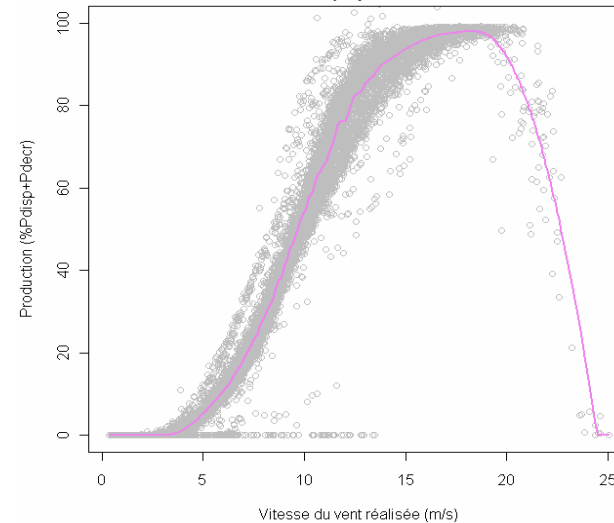
Spline regression



Nadaraya-Watson method



LOESS (2) method



Conclusions

Massive integration of wind (and renewable) production into the grid is technically and economically possible with ...

- *Dedicated tools and accurate forecasts,*
- *Coordination between Distribution and Transmission System Operators (DSO and TSO),*
- *Adapted rules for connection, more flexibility and services from wind farms*

... and coordination between European TSO to integrate these productions at a large scale.

Thank you for your attention