ABSTRACT

The characteristics of decentralised wind farm power generation and the difficulties associated in predicting output require the network managers to benefit from the best data for real-time management, to allow for forward-looking studies and to ensure the safety of the French electrical system. RTE and ERDF have worked together to find a solution that makes the information from the various sites available to the experimental platform. In a second step, the solution consists of substituting the experimental platform for a SCADA industrial product, offering a great interoperability with RTE’s controlling and management tools and the environments such as the producers’ control centres.

A NEW CONTEXT

In France, the development of renewable energy sources is supported by the purchase obligation process whilst maintaining the option of resorting to invitations to tender. By these means, the French government has published a number of calls to tender with regard to renewable energy, particularly in mid-2004 with respect to off-shore wind farm production and the beginning of 2005 for on-shore wind farm production. The objectives were established by the POPE1 programme law of July 2005 and the PPI2 decree of July 2006 providing for 13,500 MW of wind turbines by 2010, of which 1,000 MW will be off-shore, and 17,000 MW of turbines by 2015 of which 4,000 MW will be off-shore.

These objectives mark a serious and sustainable development of wind turbines in France. Off-shore installations will be directly connected to the transmission network. However, it is probable that the wind turbine installations will continue in the main to be connected to the distribution network as there is better financial return on the connecting operation and the running costs with this kind of connection.

Within this framework, following the model of its German and Spanish neighbours but a few years behind, France has seen its wind farm production potential attracting increasing interest from investors. Thus French wind turbine output has grown from a few hundred MW at the beginning of 2005 to almost 2,300 MW at the start of 2008. Taking into account the number of projects currently being prepared, the threshold of 10,000 MW could be reached by 2010.

Because the time taken to organise the transmission system is often longer than that required for setting up a site, there will be more and more constraints on the electricity system.

France has three uncorrelated wind farm zones: the Atlantic, the Mediterranean and the Continental. Turbine output measurements over the years 2005 to 2007 and the analysis of wind speeds over the last fifty years would indicate that French wind farms will be relatively efficient: overall, the average annual load factor of French wind turbine production is 24% over the last three years.

Wind turbine output is characterised by its variability and uncertain forecasting linked to atmospheric phenomena. Furthermore, when there are irregular electricity or weather flows, the behaviour of the machines varies according to the technology used, particularly with respect to the risk of stalling.
All these features typical of wind turbine production, with the incident of 4th November 2006 providing a good example, show how important it is for network managers to receive the best possible information regarding its operation, in order to guarantee the safety of the French electricity system in accordance with the UCTE4 recommendations.

Steps taken towards dispatching the wind turbine telemetry output, good knowledge of the machine performances and use of efficient production forecasting models using weather reports, particularly regarding wind, thus become major challenges for the network managers.

OBSERVABILITY OF WIND TURbine PRODUCTION: A MAJOR CHALLENGE FOR NETWORK MANAGERS

For the network managers, wind turbine production presents a new set of problems linked with its own specific features:

- Variability and uncertain forecasting of production linked to local weather conditions with sudden production variations during particular weather condition (strong wind exceeding 90km/h).
- A large number of sites (more than 300 by mid-2008) with an average power of less than 10 MW, spread over the whole of France with more than 95% connected to the distribution network;
- A large number of players involved (producers, manufacturers and distributors);
- A diversity of technologies (construction and control technologies).

Analyses carried out by RTE have shown the need to adapt its practices regarding the balance of supply / demand, management of day-ahead margins and the control of transits as soon as wind farm production reaches 3,000 MW.

For example, by adding an extra unforeseen variable to the Electricity System, wind turbine output can increase the requirement for production supplies to be available quickly and at any time in order to guarantee the Supply / Demand balance. The volume of these extra supplies caused by wind turbine production will therefore depend on the ability of RTE to recognize it and provide for it. The same applies to the management of flows on the transmission network in dimensioning safety margins so as not to exceed the current carrying capacity in the case of unforeseen variables.

Because the tools currently in place for observing other production methods are not adapted to the specifics of wind turbine production, RTE decided in May 2007 to create a structure purely for the integration of wind turbine production in the French electricity system: the IPES Project, with one of its main lines of interest being the observability of wind turbine production.

1 To reach an adequate observability level at the end of 2008, the first phase of the IPES project consisted in the implementation at the beginning of 2008 of an experimental platform to enable operators to visualise real-time running patterns and future management of the electricity system. Fed by all available production data, a forecast model developed by RTE (PREOLE) and a data base describing the technical characteristics of wind farms, this platform, similar to control tools5, offers a good view of wind turbine production injected into the network on D and D+1. Today, it enables data to be accessed from more than 300 wind farms, spread over 160 electricity stations, including around 1,500 wind turbines of 52 different types. A visual example is presented in appendix 1.

5 Système National de Conduite – National Control System (based in the Paris region) and SRC (Système Régional de Conduite – Regional Control System, based in the seven regional centres)
RTE and ERDF have worked together to define and put in place an adapted communication mechanism that enables them to use the experimental platform to visualise in real-time the measurement of power produced by the wind farms connected to HTA. Since the start of October 2008, power measurements from 75% of this production have been redirected towards the ERDF (ACR) control centres and the IPES experimental platform. This is added to by measurements from all wind farms connected to HTB.

The second phase of the IPES project intends to acquire and set up a SCADA industrial product by the end of 2009, a model already used by other network managers and which, in a standardised communication environment, will offer great interoperability with the control systems of distributors and producers.

**REAL-TIME TRANSMISSION OF WIND TURBINE PRODUCTION DATA: A NEW CHALLENGE FOR NETWORK MANAGERS**

To make use of this data relating to one wind farm of which 95% of the turbine production is connected to the ERDF network, a joint meeting was held at the end of 2007 between the two managers of the RTE and ERDF networks to decide on a solution that would maintain the following criteria:

- regenerate active power every minute and link it to an HTB / HTA station, (following principles similar to those implemented for the other installations directly connected to the transmission network);
- offer data representing the wind farms in France, which have the feature of being spread out over three wind zones with local phenomena;
- make use of it within a reduced period of 6 to 9 months taking into account the rapid growth of the French wind farm industry which should have reached 3,000 MW by the end of 2008;
- limit the cost of development of such an operation for the two network managers.

This discussion led initially to the definition of a provisional solution helping to satisfy the RTE observability requirements in the short term. This solution consisted in:

- only using the wind farms connected by direct links to the HTB/HTA station, links that are not connected to any other user. This measure enables 75% of wind farms connected to the ERDF to be observed, even though there are some regional disparities (only 40% in Brittany);
- measuring the active powers using telemetry data available from these connections on the control system of the ERDF control centres;
- setting up this exchange of information between ERDF and RTE according to the standardised protocol CEI 60870-5-104, with the establishment of a national identification code system for producers, HTA connections and their link to the transmission network HTB/HTA station.

In December 2007, a service contract was signed between RTE and ERDF committing both parties to the implementation conditions of the agreed solution:
- January 2008: definitions of exchange specifications between ERDF and RTE and of a long-term transmission structure for server access.

- May 2008: test on the ERDF control centre with respect to the RTE experimental platform.

- June 2008: carrying out the procedures in all ERDF control centres concerned, thus helping to make available to RTE control centres an active power in real-time over more than 75% of French wind farms.

This first stage solution enables information to be made available from installations connected to the direct link points. However, this solution has some disadvantages:

- It does not enable all wind farms to be dealt with, in particular, any installations connected to the network using links serving other users such as consumers

- It relies on direct links which may not remain as such in the future and may be used for connections to, for example, consumers;

- The accuracy of the power measurement using telemetry is low.

It will only be effective until 2010 when wind turbine production will have reached a substantial level. To improve the current mechanism, a second stage is underway to explore two other possible solutions:

1. **Exchanging information with the producer supervision centres**

RTE and ERDF have approached a number of producers who have a supervision centre in order to examine the nature of data that could be made available to them and to carry out a few experiments to define the technical and contractual procedures of a protocol for the exchange of information with the wind farm producer supervision centres.

A diagram of the arrangement is presented in appendix 4

2. **Knowledge of unavailability factors**

Whichever solution is used for the transmission of data between the producers and the network managers, this solution must include information on unforeseen or scheduled unavailability factors on the production sites. The power measurement per installation at one minute intervals of the forecasts established based on weather data enables the forecasting model for each site to be fine-tuned, as long as the forecast and unforeseen unavailability factors are known. A method of transmitting these unavailability factors between producers and managers should therefore be defined and put in place. This may be done globally from the producer control centres when the installations are operated by a control centre, or if this is not the case, installation by installation using adapted internet site solutions with input from the producers, for example.

Apart from the supply of data relating to the wind turbine installations connected to its network, ERDF has a vested interest in this wind turbine observability procedure complemented by forecasts based on weather data. Indeed, as wind farm production grows, this data could prove to be more and more useful for the operation of the distribution network.

In this “win-win” situation, the two network managers have therefore decided to continue to collaborate by exchanging data and encouraging pooling between the two partners providing transmission and information processing.

RTE will also approach the ELD to take on the same procedure.

In conclusion, this “System” set up for the observability of wind farm production is likely to be able to provide equivalent services for other types of decentralised production being developed currently or in the future on the
distribution management networks, such as production from the substantial photovoltaic industry.

In addition to the observability function of decentralised production, ERDF and RTE are continuing their collaboration in 2009 in order to build in a controllability function of production installations so as to be able to act on them either in a preventive or corrective way, when evacuation capacity restrictions appear on the transmission or distribution power networks.