Smoothing of the Wind Power Production by a geographical Spreading of the Wind Farm : Application to Asynchronous Doubly-fed Wind Generators.

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General background :

Wind power is highly dependent on the wind resources at the considered site

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In a wind park, as the distance between the wind generators is increased, the correlation between wind gusts goes down

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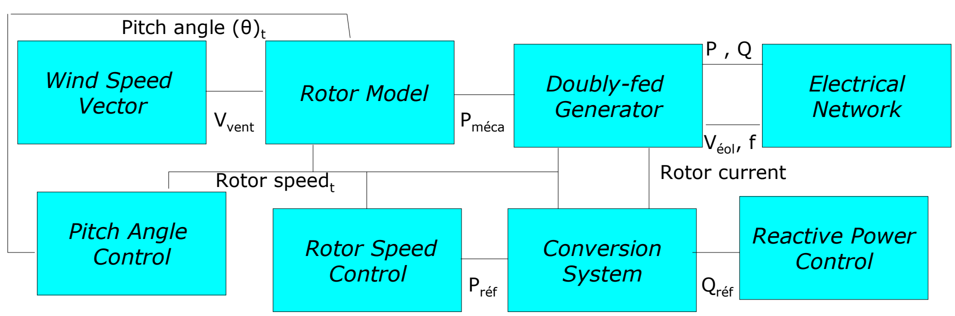
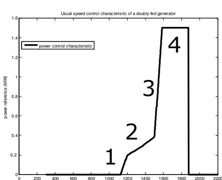
Large-scale geographical spreading of wind generators can reduce the active power variability of a wind farm

The doubly-fed wind generator model :



The rotor speed control characteristic :

The output of this block is a new active power reference based on the following speed control characteristic :



area 1 : starting area
area 2 : maximal power extraction area
area 3 : constant speed area
area 4 : power limitation

Typical characteristic used in Schelle to control a 1.5 MW doubly-fed wind turbine.

Note : The proposed simulations have been realized for a wind turbine operating at unit power factor => Qref = 0

The conversion system :

The converter = ideal current source at the electrical rotor frequency ;
This block receives as inputs : P_{ref} and Q_{ref}
and gives as outputs : i_{qrref} and i_{drref} :

$$i_{qr} = \frac{-P_{ref}\cdot(L_s+L_m)}{(1-g)\cdot L_m\cdot v_{qs}}$$

$$i_{dr} = \frac{v_{qs}}{\omega_s\cdot(L_s+L_m)} + \frac{Q_{ref}\cdot(L_s+L_m)}{L_m\cdot v_{qs}}$$

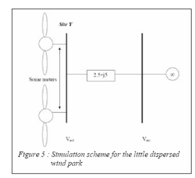
Two simulation cases are considered :

Case 1 *: Large spread wind park = two wind generators distant from a few **kilometers** ;*

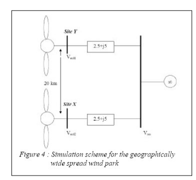
Case 2 *: Usual case with two wind generators distant from a few **meters** (approximately two times the wind turbine blade length) ;*

The simulation schemes:

The 'little dispersed' wind park:

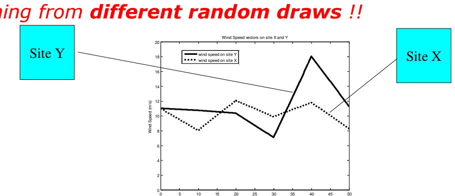


The 'wide-spread' wind park :



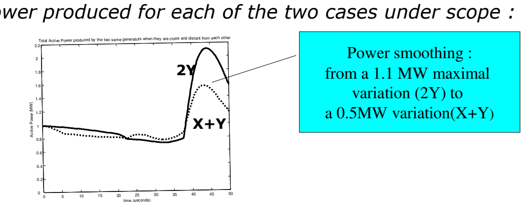
Wind speed sequences :

*⇒Wind turbines **distant** from a **few kilometers** will be subject to **two 50 s wind speed sequences** having the **same Weibull parameters** (as the hourly behaviour is approximately the same) **but** coming from **different random draws** !!*



Simulation result and conclusion

Active power produced for each of the two cases under scope :



This study has shown the active power smoothing by geographical spreading of the wind turbines and could be completed by :
=>Testing the proposed cases in real networks ;
=>Impact of the proposed geographical spreading on the network frequency