WC 03049 (bisher NC 01072)

Site efficiency maximization (SEM)

Wind Turbine Specialists

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For more information see Load Level Comparison Variable Speed Wind Turbine

As permitting wind parks is becoming more and more costly we have to evaluate and intensify wind Turbine energy collection as much as possible. This specially concerns our Windwin - **onshore** wind parks where wind speeds are below 7,5 m/sec or even only around 6 m/sec with high timewise variation. These are the programs and methods we need to consider:

1. Bigger rotor diameter

Standard 1,5 MW machines have rotors with ca 2,5 qm/kw.
With GE - 1,5sl - 1,5 MW machines bigger 77m rotors are recommended and often necessary (3,01 qm/kw) – in future for 1,5 MW nominal power WT with even 80m rotors and more (NEG Micon) will be available. Here we have ca. 3 square m/nominal kw or even more.
Enercon with E 70/20 – 2 MW it is only 1,92 qm/kw
With the new Gamesa G 90 – 2 MW this value is 3,01 square m/kW when using their standard 80 m or new 87 m rotors with extenders to 90m and still 2 MW nominal power, meaning about same specific ca. 3 qm/kw as the 1,5sl

2. Peak shaver and load reduction

Peak shaver etc. should be installed.
(WiCo 02039 and Wipro 0503-6, DEWEK 2002 "Load level comparison variable speed wind turbine", see link at the top of this document) Here the pitching program is adapted to reduce structural load peaks around nominal wind speed and allow to get safety for the "oversized" rotors and reduce negative influences to the machine fatigue profile.

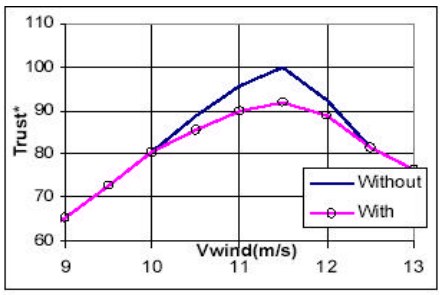

Fig. 2. Trust for Peak Shaving at Pitch Control

Further Pitch-Back-Signals (PBS) can also be added
From **load sensors** at the tower and other structural elements, esp. to ensure long gearbox life and avoid torque peaks under turbulences when above nominal wind speed due to the usual retarded pitching.

Machine must **not be stopped** beyond i.e. 25 m/sec winds, but via pitching only reduce speed and output gradually down to 20 % and still be connected with the grid at 25 – 40 m/s; then automatically speed up quickly again with weakening winds.

3. Park average maximization (PAM)

PAM should allow to produce short term up to 30 % more el. Energy, which lifts the average annual result and optimizes financial return (ROI).

3.1 Overrate WT Performance

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Here we install turbines which i.e. declare nominal 1,5 MW which can temporarily exceed their nominal power when operating above nominal windspeed via stronger adapted pitching by ca. 20-30% to collect the energy of short time strong micro – local winds. (i.e. the MD 77 makes up to 1,8 MW short term, same for the E 70/ 1,5 MW.) Preferably this is done with gearless machines. In gears this might create micropitting and reduced life below 20 years (see gearbox damages in Uckermark after 30 months use as documented in our Website http://www.windwin.de/de/unternehmen/publikationen.asp
This is also based on the experience that onshore mostly medium winds prevail and winds beyond nominal are seldom. Further this concept is based on the experience that in big parks the winds can be very different from one park end to the other base on shadowing.
Here we utilize in accordance with the grid owner the temporary **actual full grid overland capacity** to its limits independent of the normal or permitted single park average load in case the grid will accept short-term more energy during such strong wind situations above what is normally rated for the certified standard park condition.

Also technically the individual temporary WT higher output must be limited via sensors to the maximal permitting temperatures in various parts of the turbines and power electronics to avoid overload. Gearless machines may therefore be more suitable for PAM.

3.2 Area Multi Park Group Management

If several neighbor parks feed into one overland evacuation high voltage line, there may be even a **macro PAM.** Here the macro park area - management allows certain parks with stronger winds to short term produce ca. 30% above nominal to fill the gap which neighbor parks leave – and to use the full capacity of the outgoing evacuation line in case it's voltage drops due to high need elsewhere.

3.3 Park Over Nominal Investment (PONI)

Example El Guijo Windproject of LURIA: Here we may install i.e. for 40 MW grid limitation not only a WT capacity with nominal 40 MW (i.e. 27 units with 1,5 MW or 20 units with 2 MW nominal) but 10 – 20% more capacity. This can be up to 27 stronger units with each nominal 2 MW and limit the total output with grid management to i.e. 40 MW (or temporality more or less depending on the makro park management). Alternatively we might analyze Enercon with each 2 MW and install not 20 but 23 or more units to optimize 20 years rentability under specific known wind conditions.

Optimizing the investment for best rentability of the site (ROI over 20 years) the WT manufacturer can decide in first approach which configuration meets this objective. Gamesa i.e. may use the G 80 and select various tower heights 78 or 100 m hub height and rotors from 80 to 90 m based on the given wind values to find the optimum. We must however encounter that WT manufacturers tent to build more machines on lower towers as they make money with the Machines – not so with towers. Therefore the total cost including tower and fundament and ground cost or rental must be integrated in the PONI analysis.

On a site like El Guijo we have to take the MWH/Yr. per WT in i.e. 65 m hub height (close to the test – windmast anemometer height) as calculated by WT manufacturers (i.e. 4000 MWh/yr.) . To calculate performance on higher towers we then - other than standard programs - add 1 % per meter height. For 100 m towers this transforms 4000 MWh into 1,35 x 4000 = 5400 MWh/yr. Respecting the park efficiency we would have to deduct as usual ca. 10 – 12 % from this figure.

3.4 Nominal ROI + 10 %

Possible additional higher investment cost for **PAM** / PONI differentiation **should payback within 10 years** and PAM should **increase results (ROI)** by estimated **ca 10 %** or more over the 20 year lifetime. Calculation method see **OWIRA** (Optimized Windpark Rentability Analysis) Wipro 0583

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