Power Curves for Different Ambient Conditions

GE's perspective on extreme inflow conditions

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Extreme inflow conditions

Important to differentiate between:

- PC and AEP impact
- Instantaneous / diurnal / seasonal / stochastic
- Ambient / terrain influences / wind farm induced
- Measured performance vs. model predictions
- Aero design robustness to performance variation

Proper data filtering entails:

- Due consideration of site-specific conditions and correlations is required to define data filtering procedure.

Recommendation

Create a shared industry recommended practice on how extreme inflow conditions affect wind turbine performance.

This may be used as a basis for best practices on PC validity and measurement data filtering by individual organizations and OEM's (voluntarily).

Three very complex terrains

Photo courtesy Peter Gregg, GE

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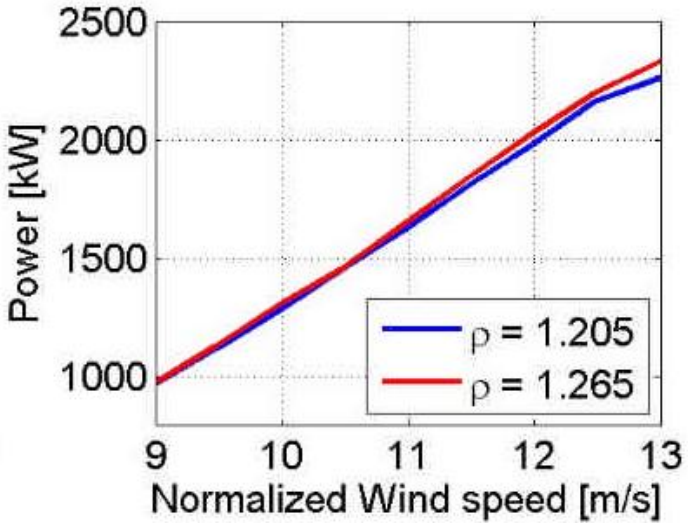
PC effect from air density

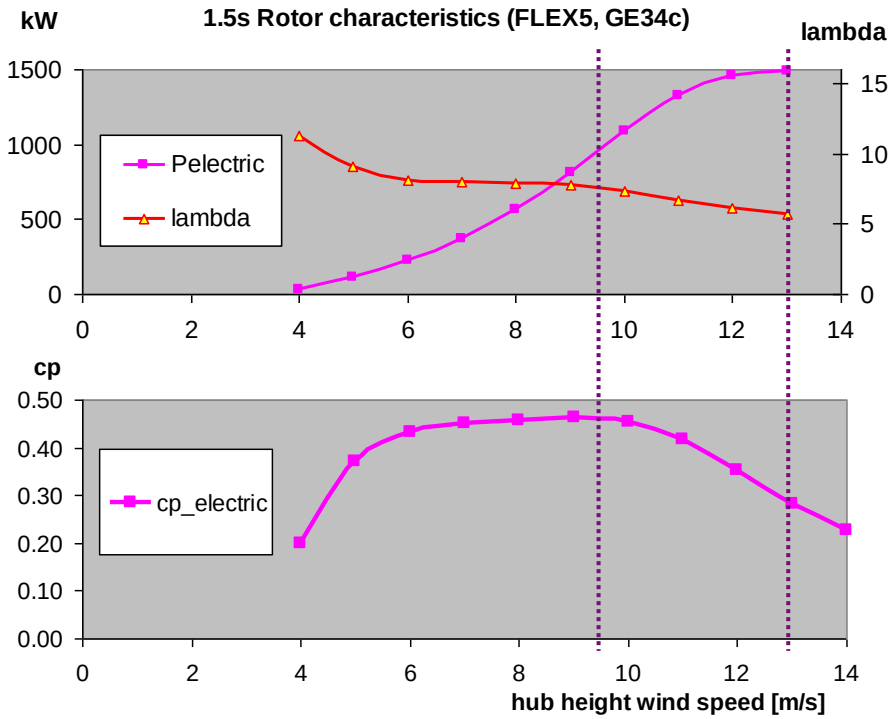
The PC correction for air density in IEC 61400-12* is inaccurate for VSP turbines with a constant speed region because it neglects the change in minimum TSR and in aerodynamic efficiency.

Overestimation per IEC for ρ = 1.0 kg/m^3 is ~2% AEP

* $$WS_{corr} = WS_{meas}\left(\frac{\rho_{meas}}{\rho_{std}}\right)^{1/3}$$



Source: Wagenaar, J.W. ECN / EWEA 2011



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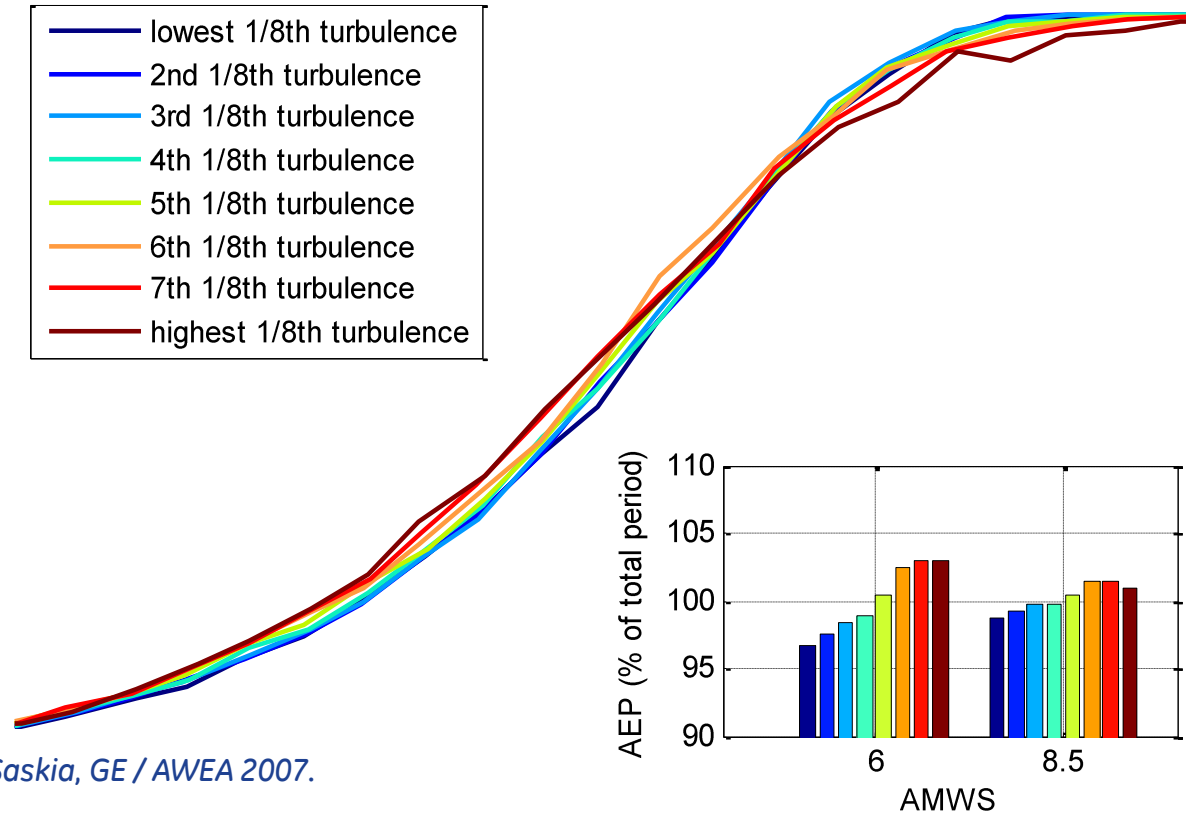
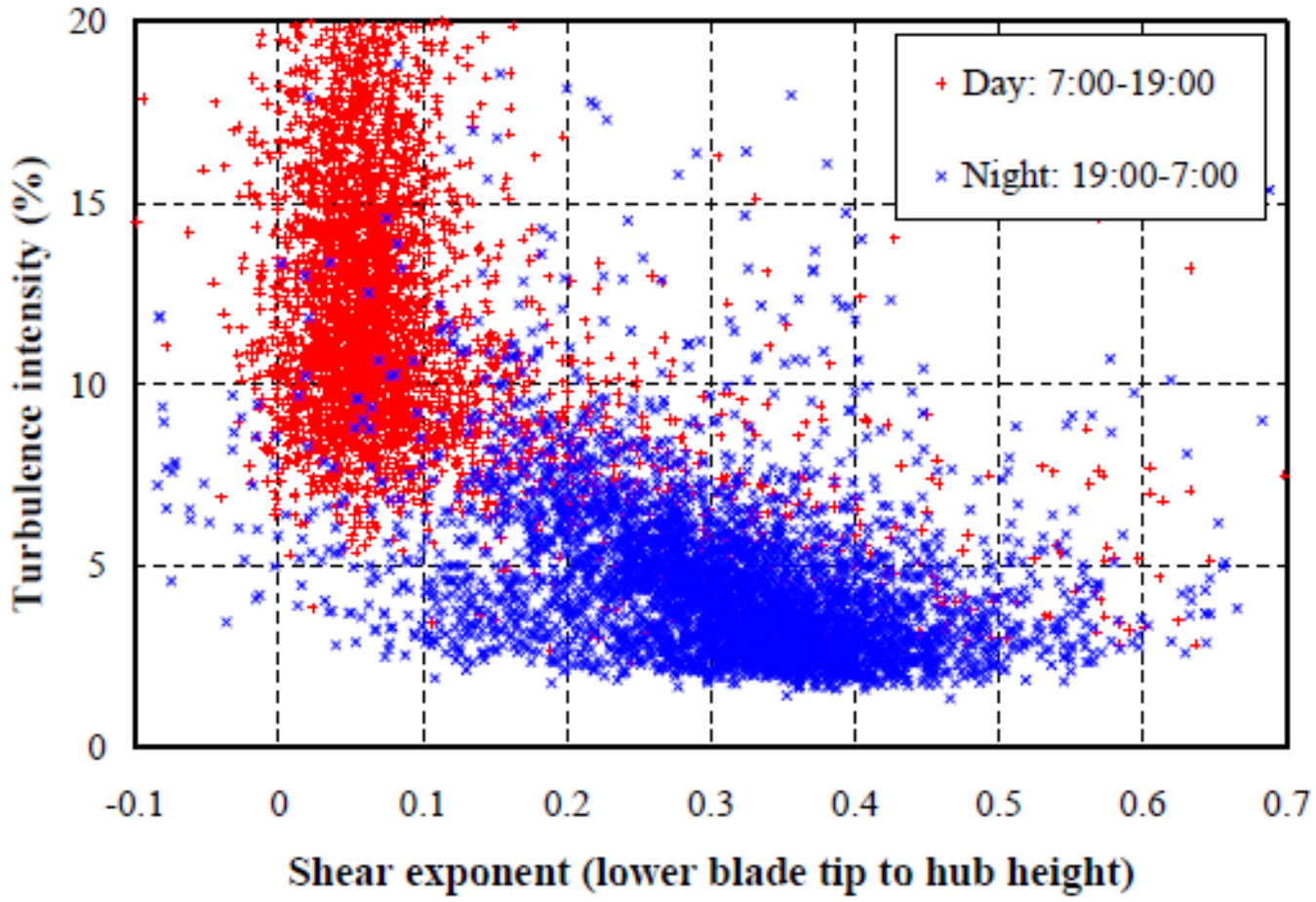
PC effect from turbulence

Turbulence creates opposite effects on power capture in the tail and the knee of the PC



Source: Honhoff, Saskia, GE / AWEA 2007.

Correlation between TI and shear



Source: E. Rareshide, Garrad Hassan / AWEA May 2009

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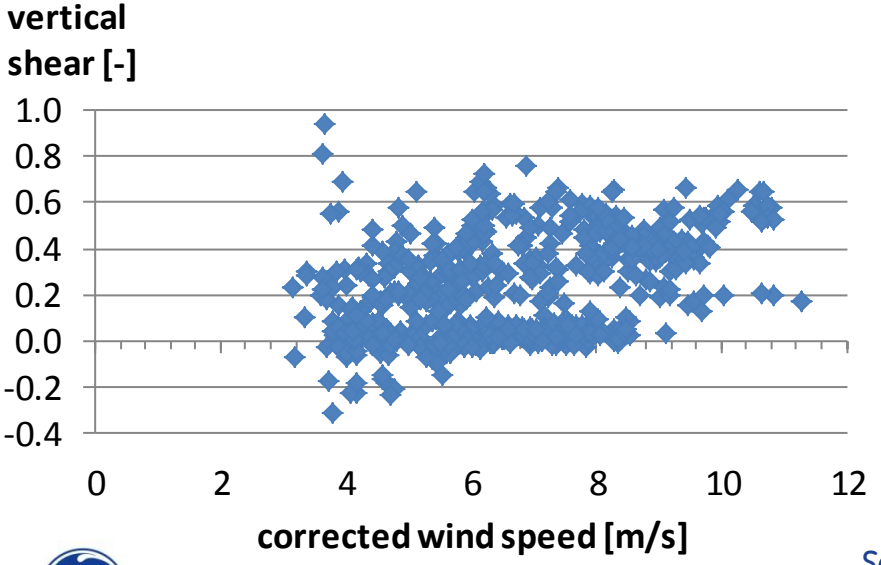
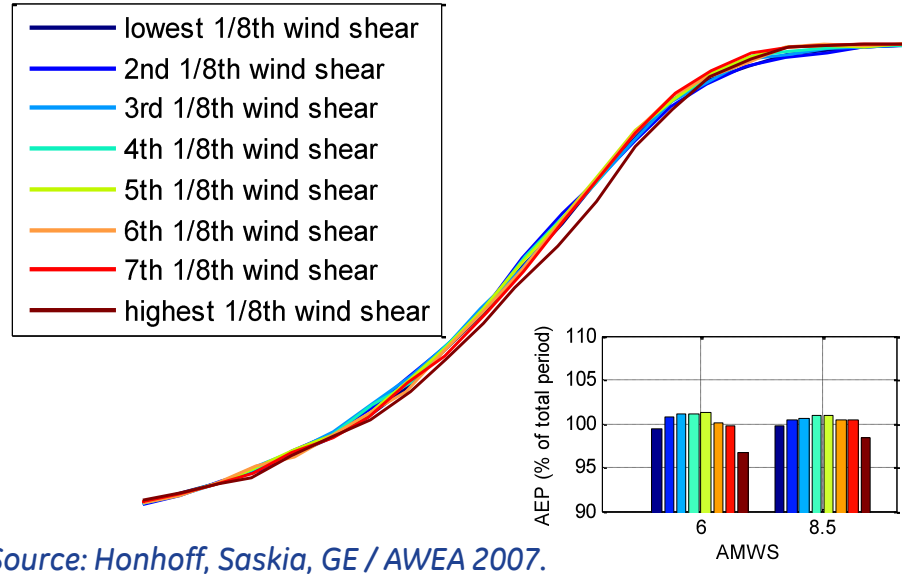
PC effect from wind shear

Wind shear and turbulence are correlated but their effect on aerodynamic efficiency is twofold.

- Lower turbulence improves PC knee (+)
- Shear increases affects rotor average mean wind speed (±) and yields larger 1P-variations in inflow angle (-)





Source: Honhoff, Saskia, GE / AWEA 2007.

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Selected literature

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