

# Power Curve Working Group

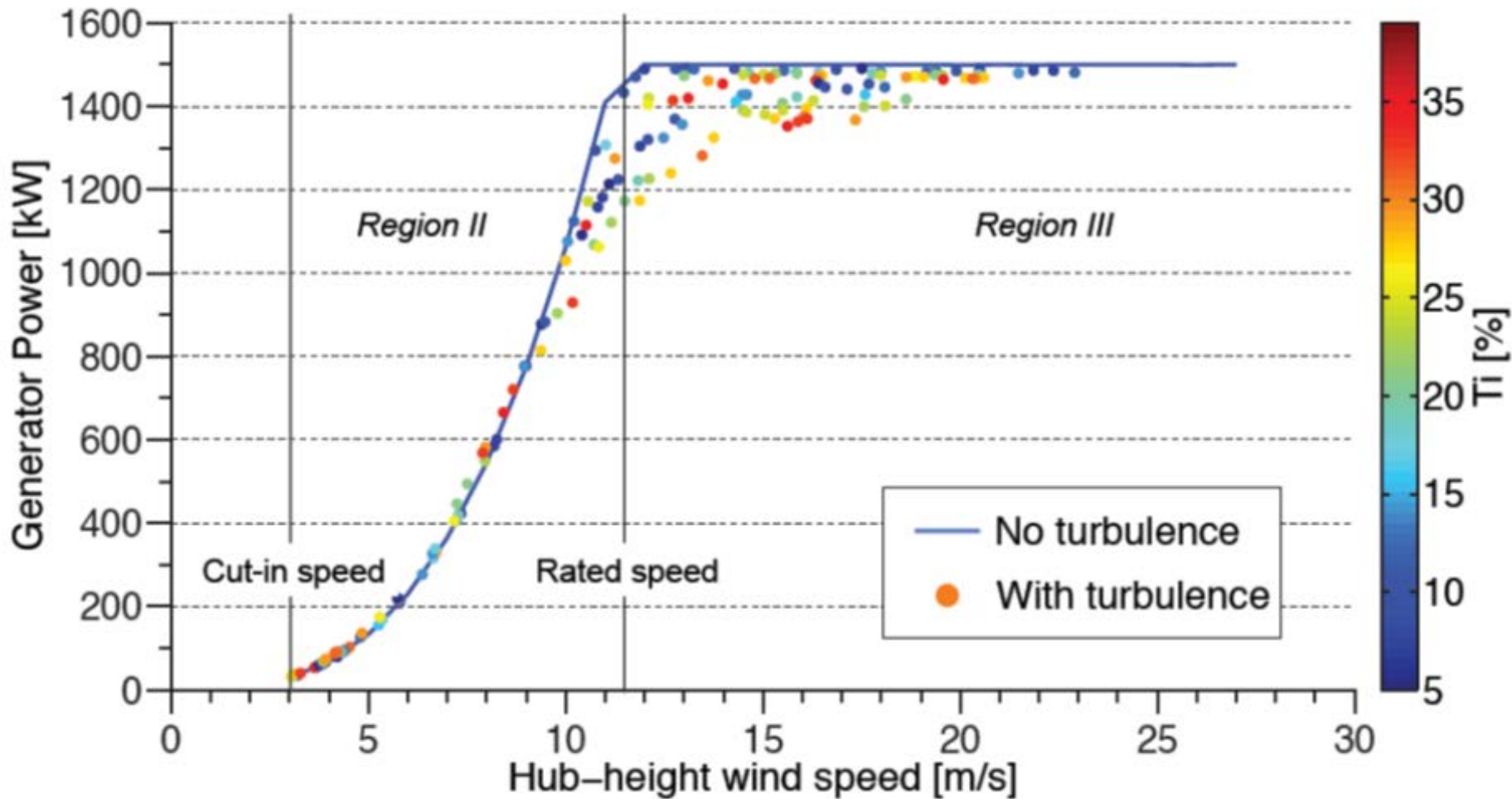


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# Impact of Turbulence and Shear

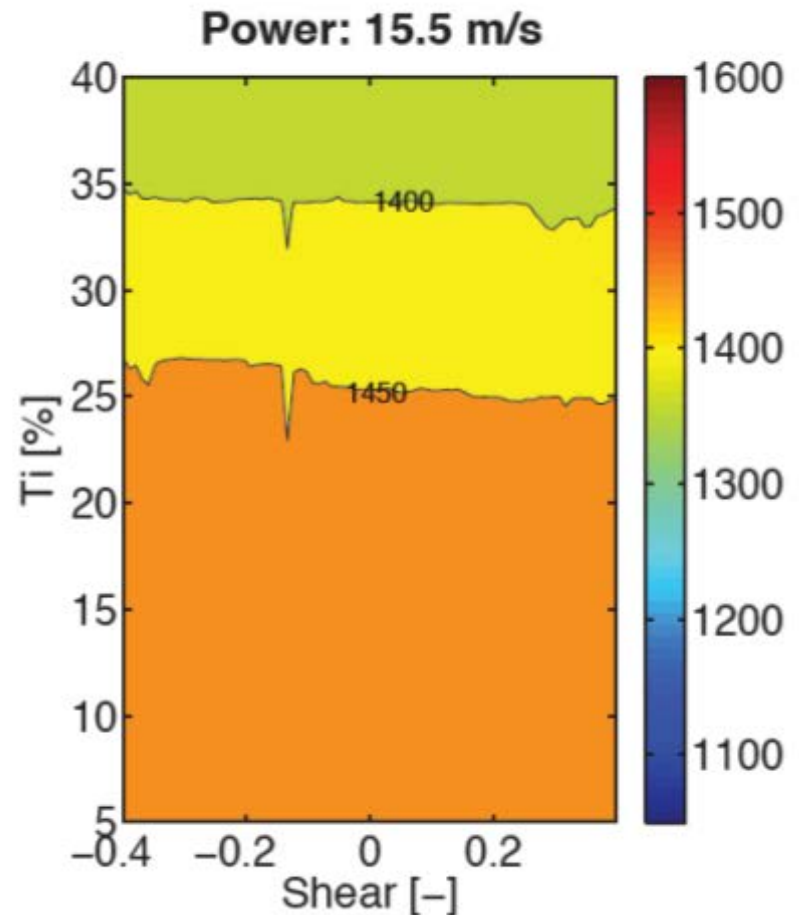
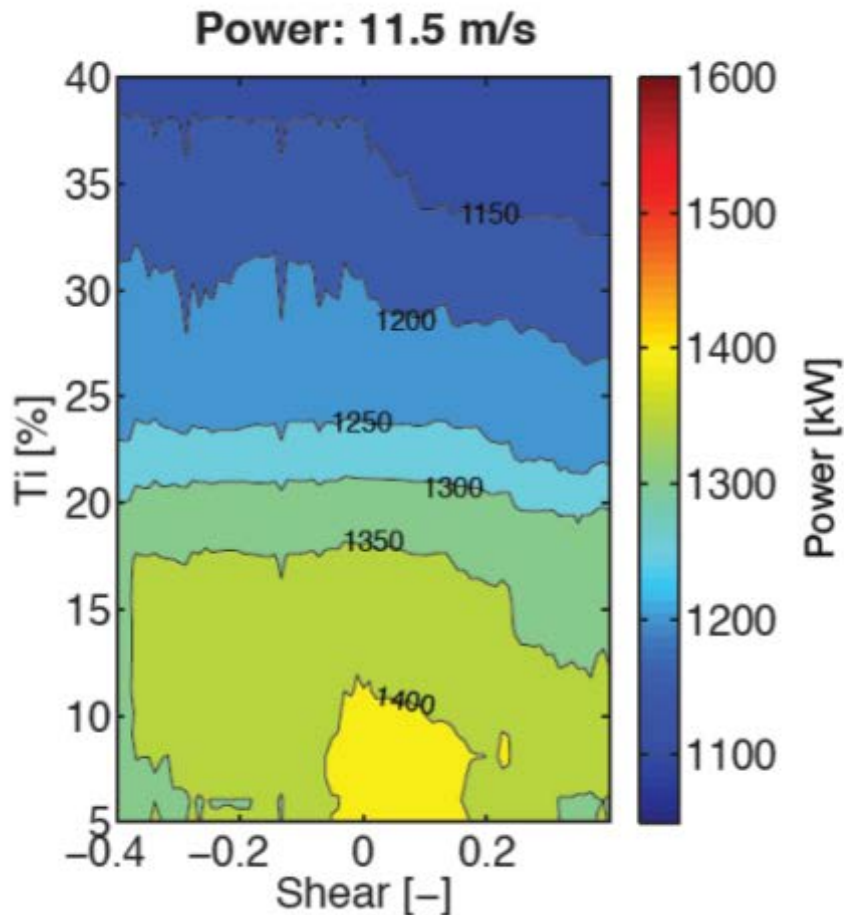
- 1.5 MW Turbine -  $5\% < TI < 40\%$ ,  $0.15 < \alpha < 0.25$



Clifton et al. 2012

# Impact of Turbulence and Shear

- Turbulence dominates above rated, more complex below



Clifton et al. 2012

# Discussion Points

- **How can the industry make progress on this issue?**
  - Further analysis of highly instrumented test sites
    - e.g. DTU Høvsøre, ECN, NWTC, TTU
    - What data can be made available to community?
  - Identify critical variables that influence power losses (and loads)
    - TKE, Coherent TKE, momentum flux, veer?
    - What can be obtained from existing measurements and what requires new instruments?
    - What is uncertainty for different fidelities of measurement
  - Comparison of existing power curve corrections
    - Disk averaged vs. turbulence corrected
    - Weigh ease of implementation vs. improvement
  - Suggest public training and testing dataset(s) be created for validation of power curve correction methods

# Discussion Points

- **What site specific measurements can be used to improve yields?**
  - Turbulence intensity and shear important
  - May be other important/encompassing variables – engineering analysis and cost benefit analysis required
  - Minimum of hub height towers will multiple vertical stations
  - Possibly augment with remote sensing up to rotor tip for shear
- **What extra information can be supplied by turbine manufacturers to improve yields?**
  - Data from highly instrumented sites to community
    - Faster time resolution is “free”
    - Some limited knowledge of control operation is required
  - Corrected power curves (possibly unwarranted) – will influence what measurements are needed at site
  - Power performance tests at more diverse set of sites