



Power Curves: Influence of Turbine Design Choices

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Wind conditions are highly variable on all sites

Good aerodynamic blade design can handle highly variable conditions

Power curve measurement show stable results for a wide variety of conditions



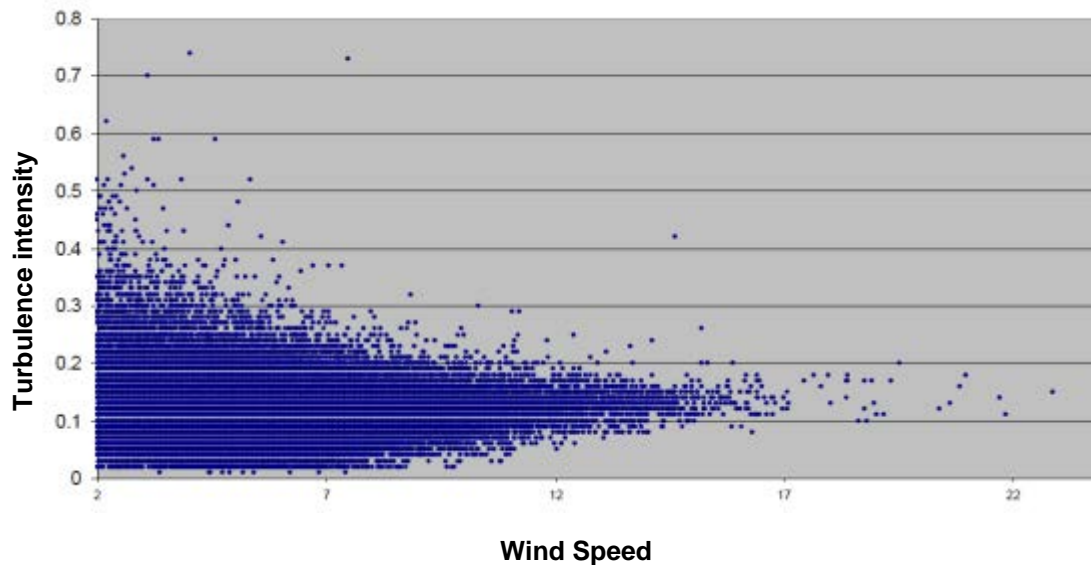
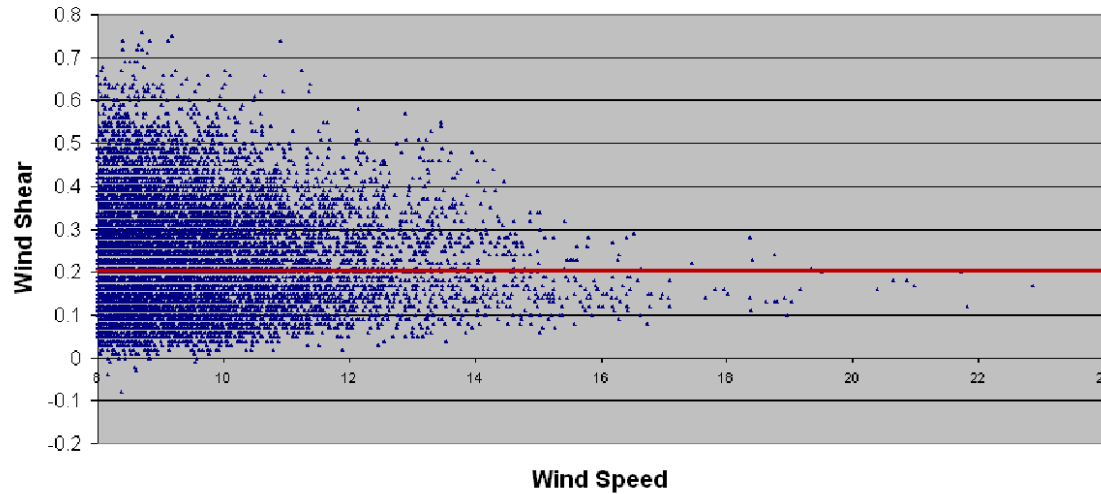
Rotor Aerodynamics



PC Measurements

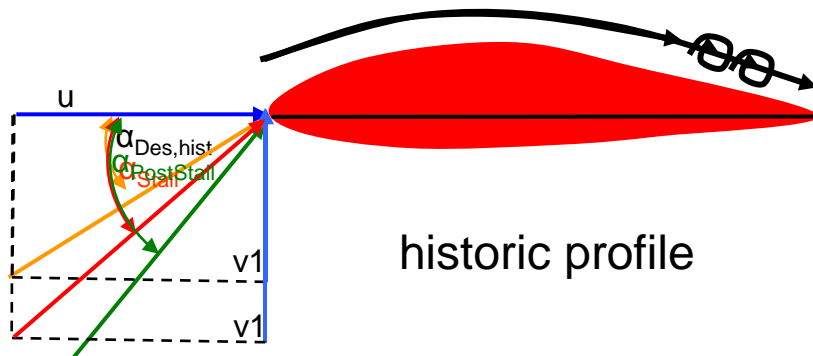


Summary

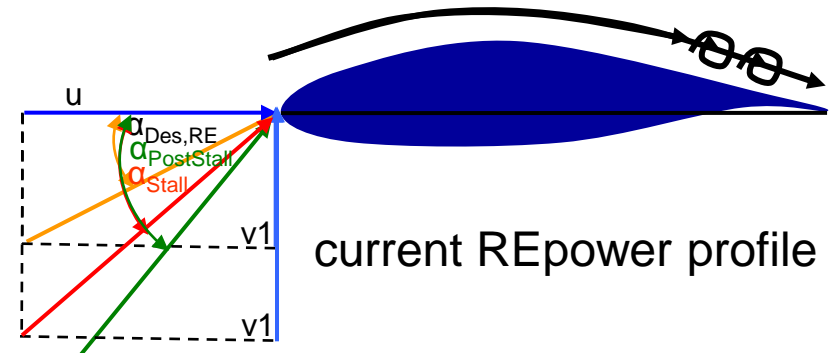


All sites show varying wind conditions

Turbine design needs to account for this.

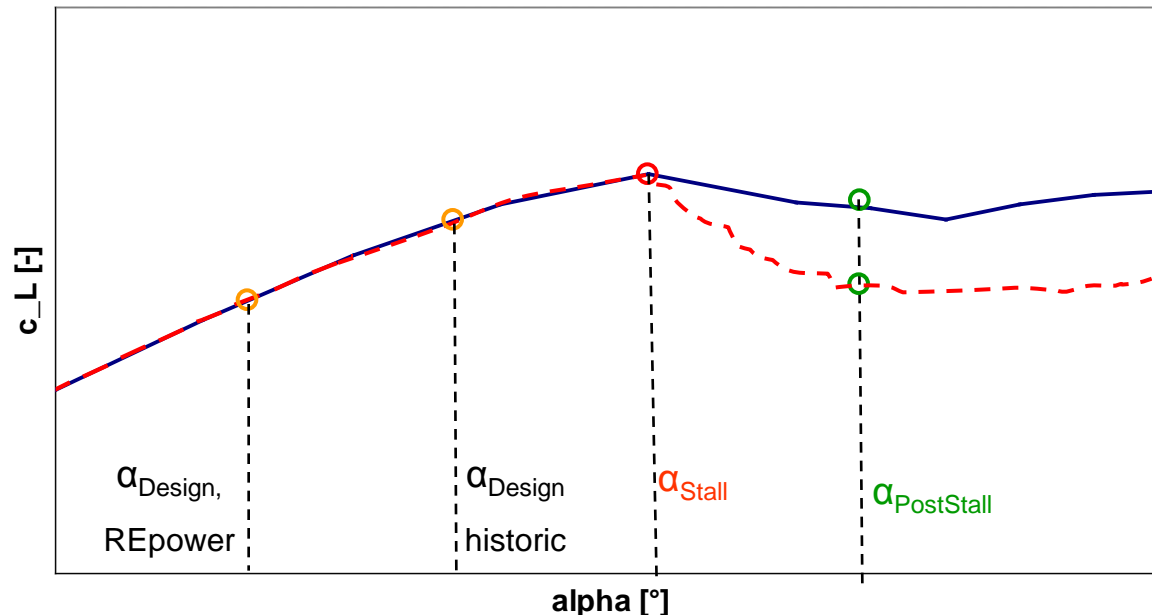


historic profile



current REpower profile

lift coefficient over angle of attack



— current REpower profile — historic wind power profile

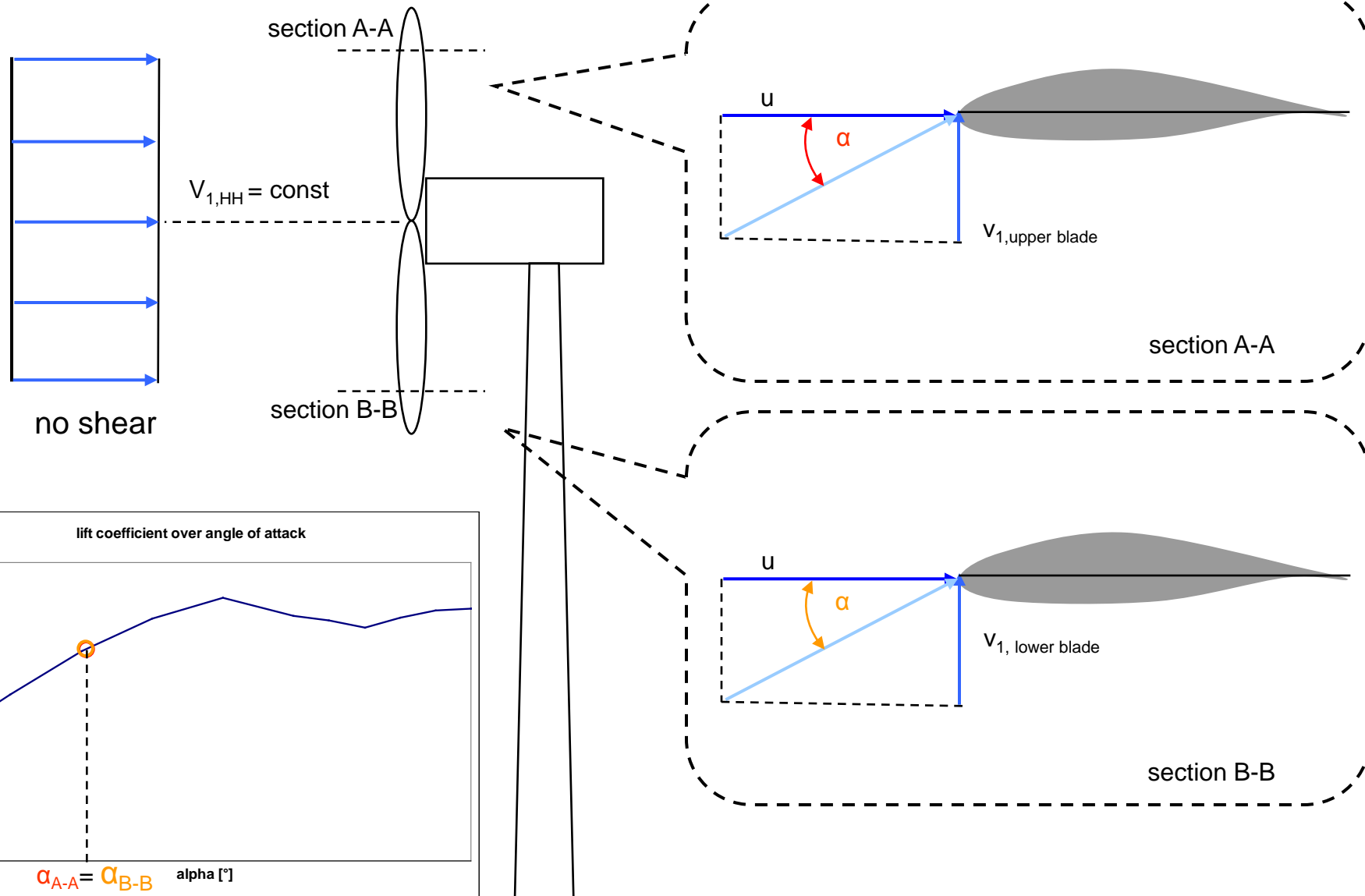
$$\text{Lift} = \rho/2 A c_L v_r^2$$

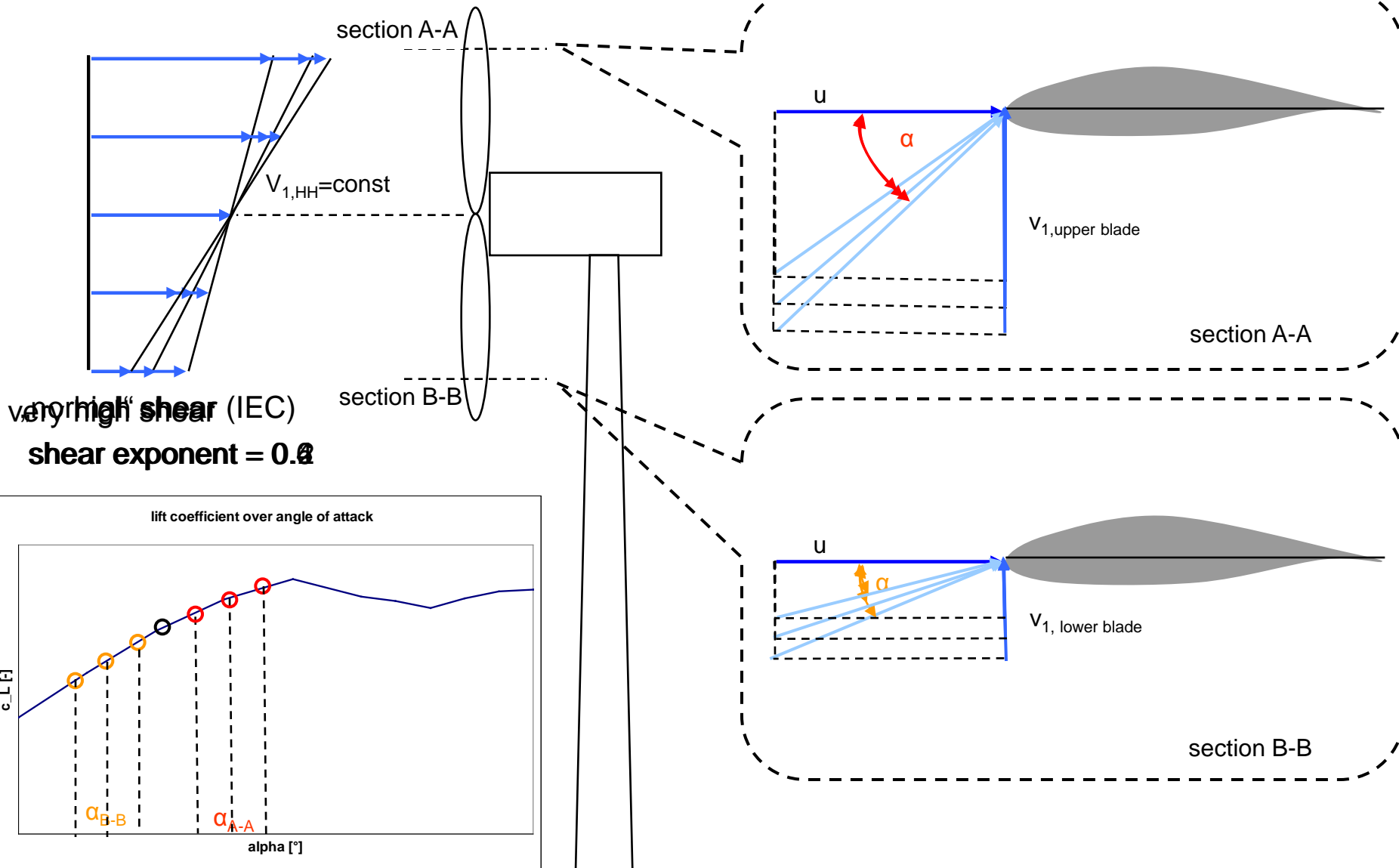
REpowers philosophy is to have a sufficient angle margin to stall.

smooth stall behaviour.

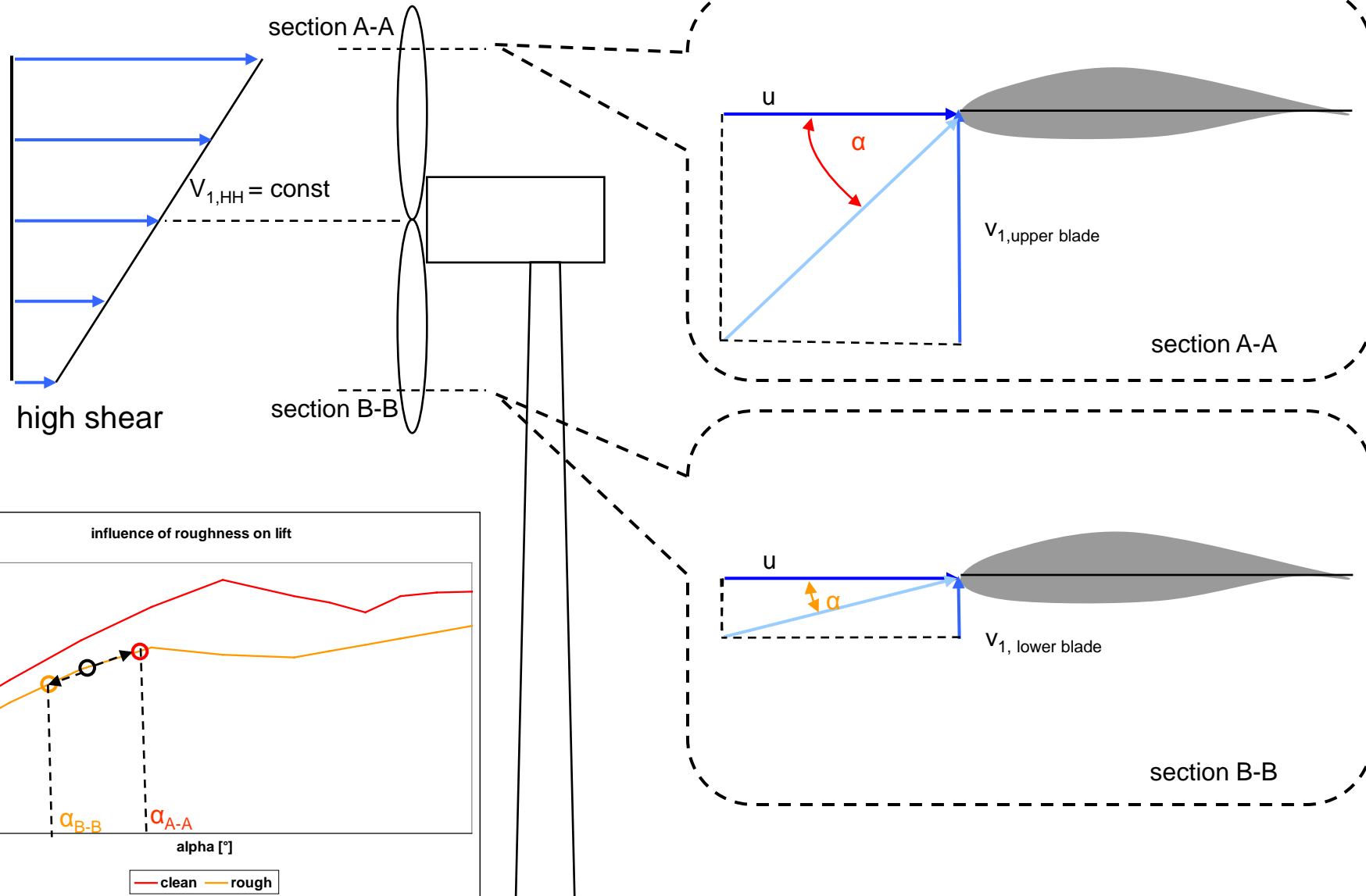
Rotor Aerodynamics

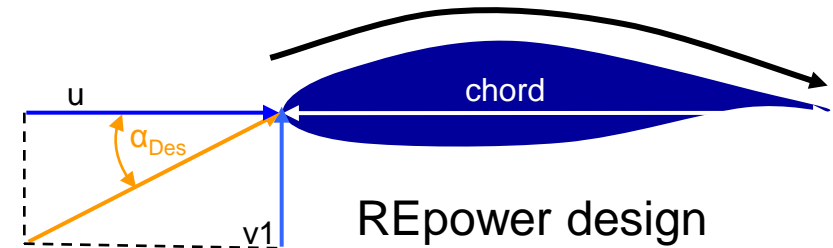
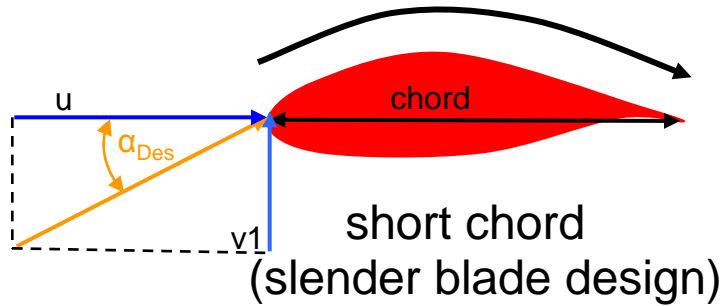
Airfoil characteristics





Airfoil characteristics – roughness influence

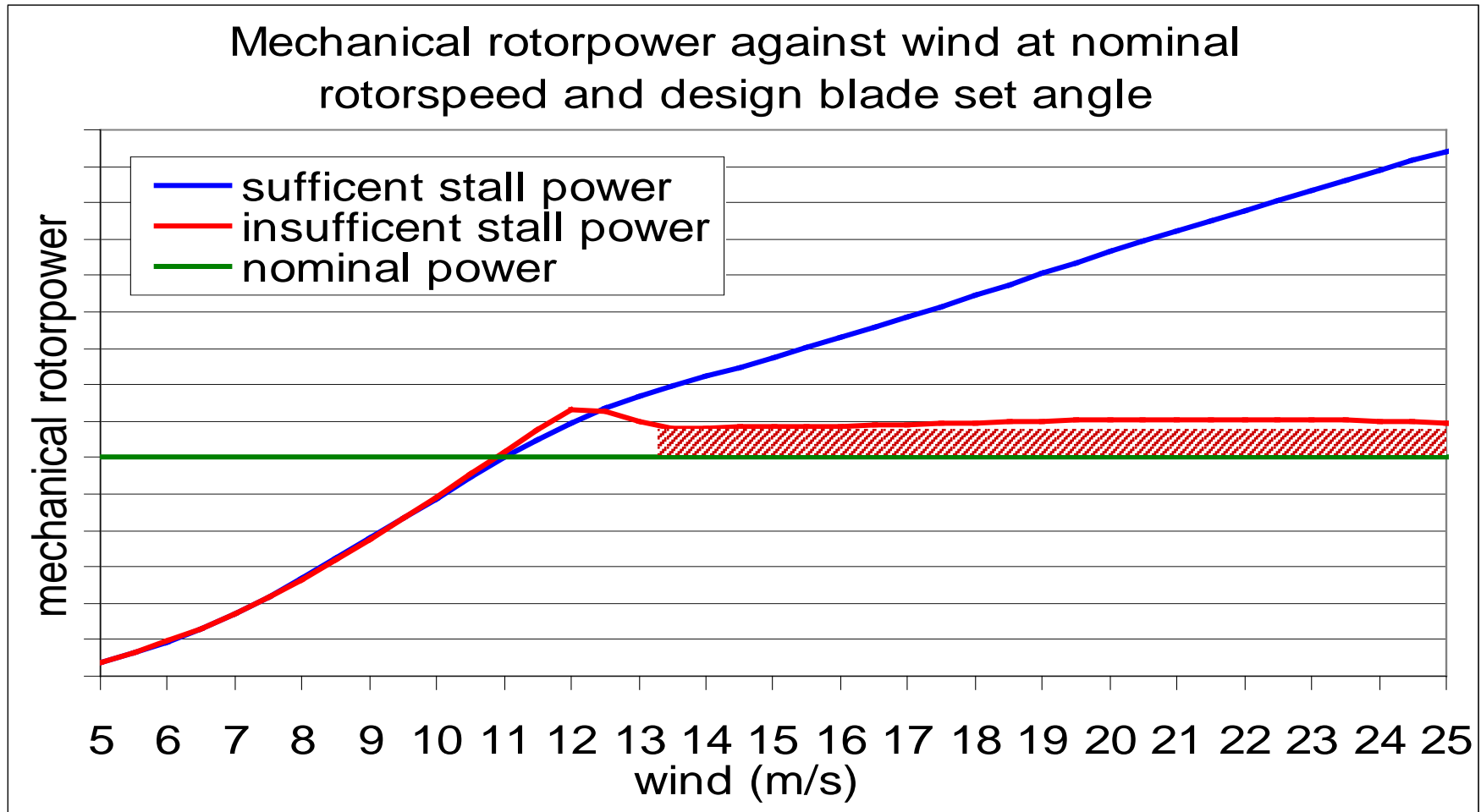




$$\text{Lift} = \rho/2 A c_L v_r^2$$

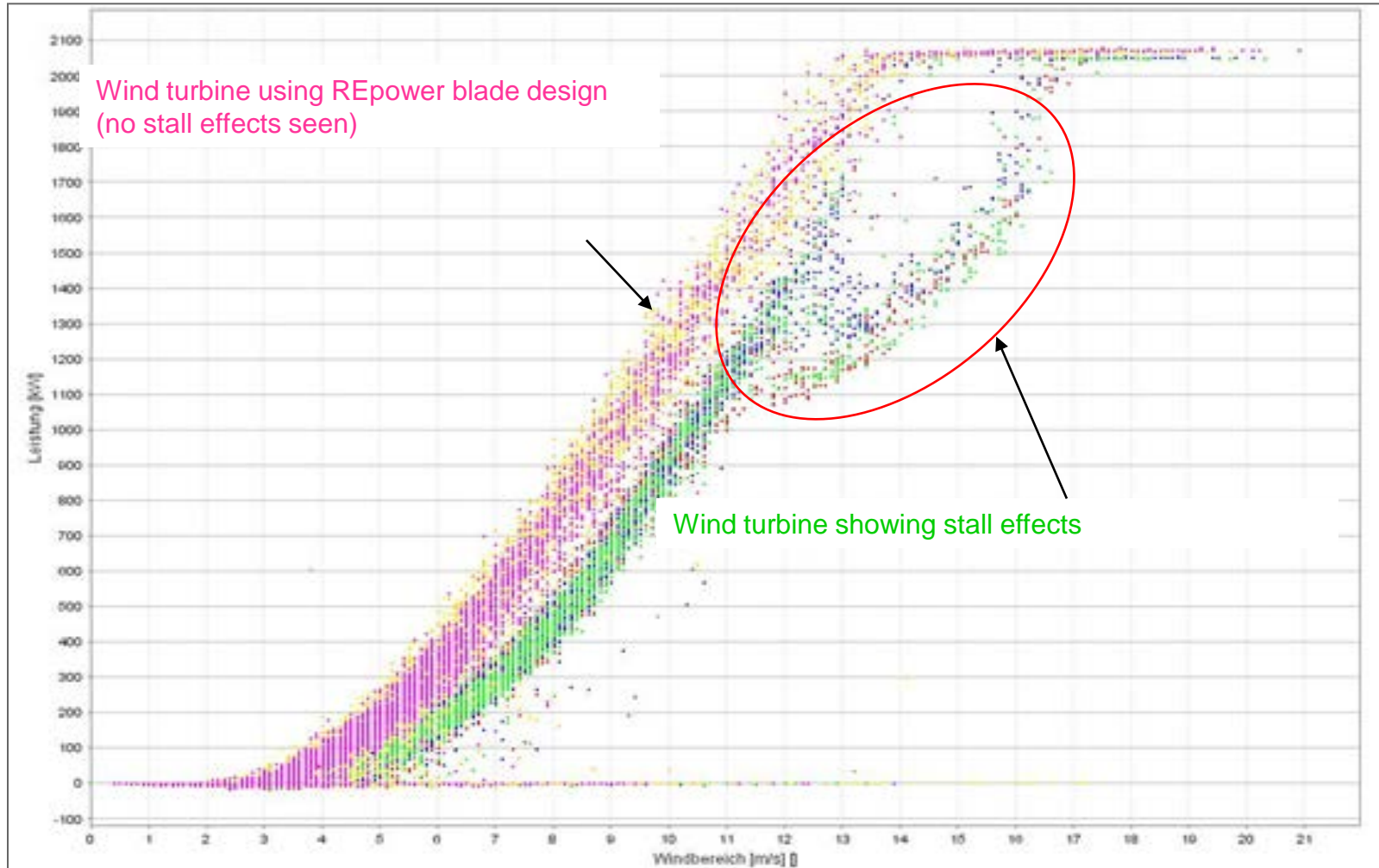
$$A = f(\dots, \text{chord})$$

Chord	↓
Profile Thickness	↑
Contamination Sensitivity	↑
Stall Power	↓
Loads	↓



For high performance under varying conditions

REpower blades are designed with high Aerodynamic Safety Factors





Rotor Aerodynamics



PC Measurements



Summary

Power Curve Measurements

Power curve verification reference list



MD₇₀

MD₇₇

MM₇₀

MM₈₂

MM₉₂

3.4M₁₀₄

5M

6M

MD₇₀ MD₇₇ MM₇₀ 5M 6M
MM₈₂ MM₉₂ 3.4M₁₀₄

Model

Number
of
measurements

Number
of
measured
turbines

Ratio
EMAEP/GAEP
[%]

Standard

5

2

98.9%
min / max results
96.9 – 100.8

Standard

6

2

99.2%
min / max results
96.1 – 103.2

Standard

2

2

101.9%
min / max results
101.2 – 103.3

Standard

8

8

Plus Option

1

1

100.9%
min / max results
96.4 – 106.8

Evolution

6

5

Standard

1

1

Evolution

6

5

100.0%
min / max results
98.2 – 102.1

Standard

3

3

100.4%
min / max results
99.6 – 100.1

Standard

1

1

100.9%
min / max results
n/a – n/a

Standard

1

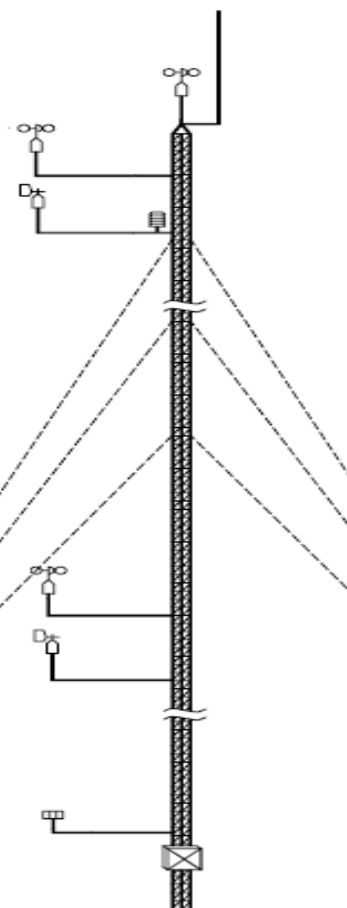
1

101.2%
min / max results
n/a – n/a

40

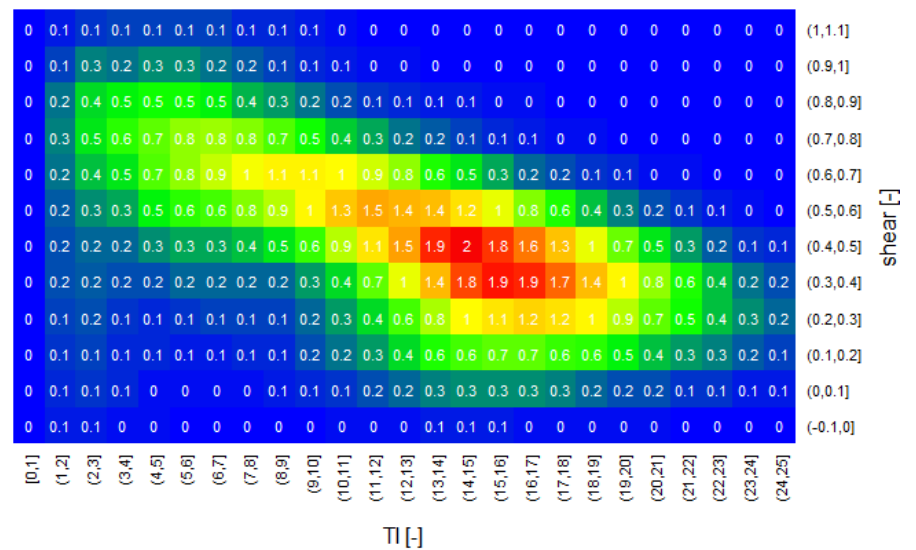
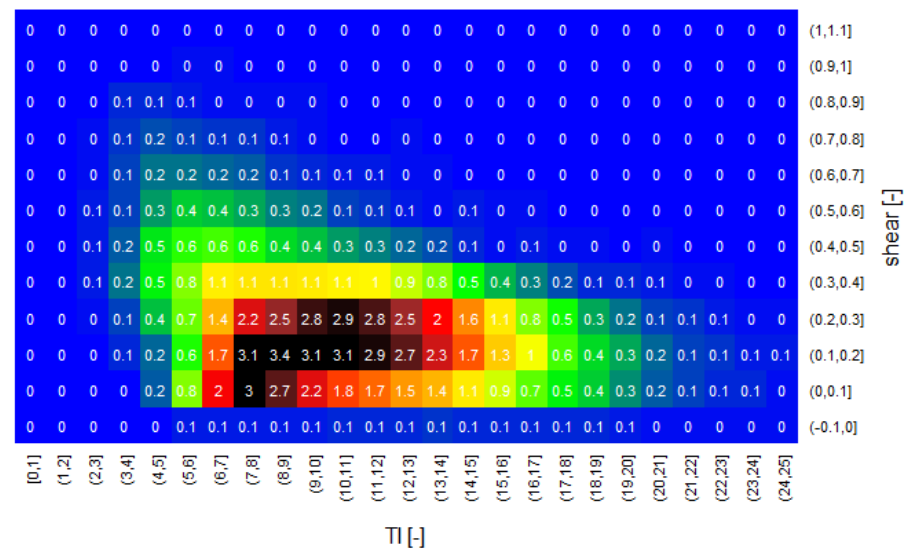
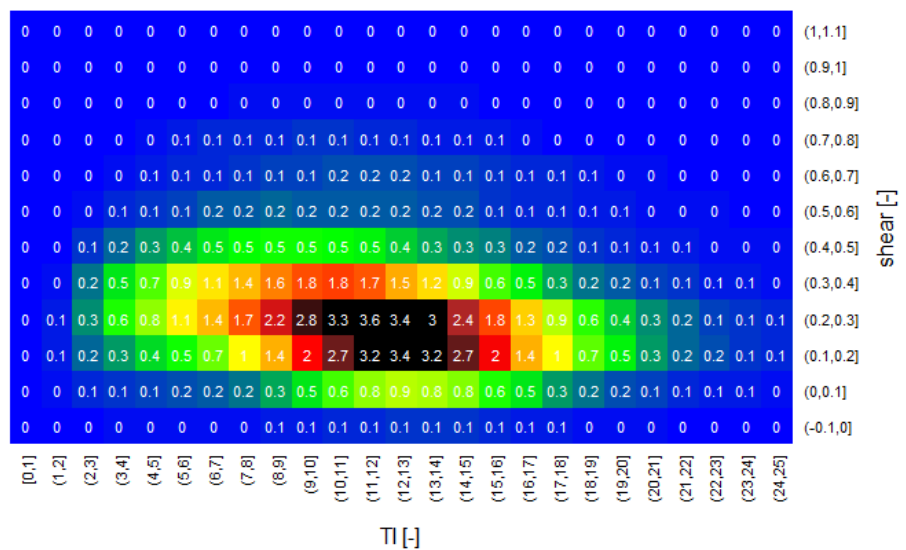
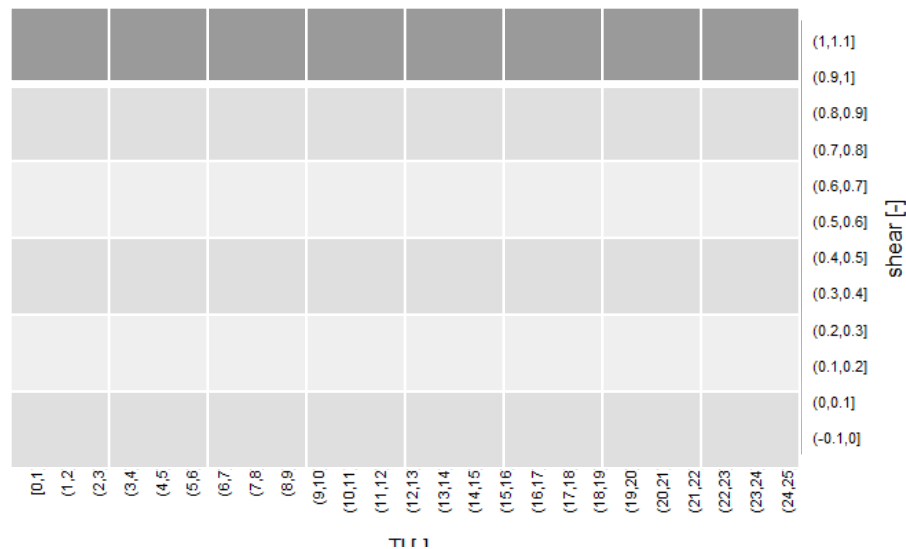
31

100.4%
min / max results
96.1 – 106.8



Power Curve Measurements

Varying site conditions





Rotor Aerodynamics



PC Measurements



Summary

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