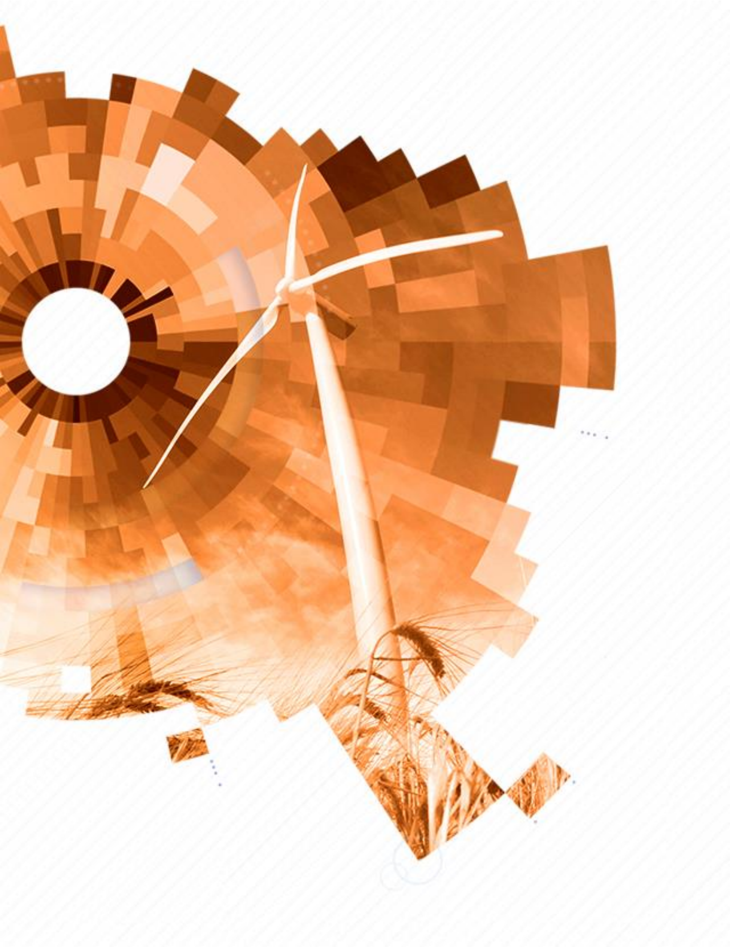
Steps towards comparison of turbine performance across varying turbine geometries

Matthew Colls, April 2014

Summary



- Introduction to Prevailing
- Effect of shear
- Shear equivalence
- An example

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Introduction to Prevailing

Who:

- 16 staff across four offices in the UK, Germany and the USA.

What:

- Wind farm design and analysis, for developers, lenders and financiers.
- Pre-construction and operational

Where:

- We have analysed over 500 wind farms in 18 countries.
- Europe, Americas, Africa, Australasia

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Introduction to Prevailing

The effect of shear

High wind shear

Angle of attack variations around rotor

Blade performance changes

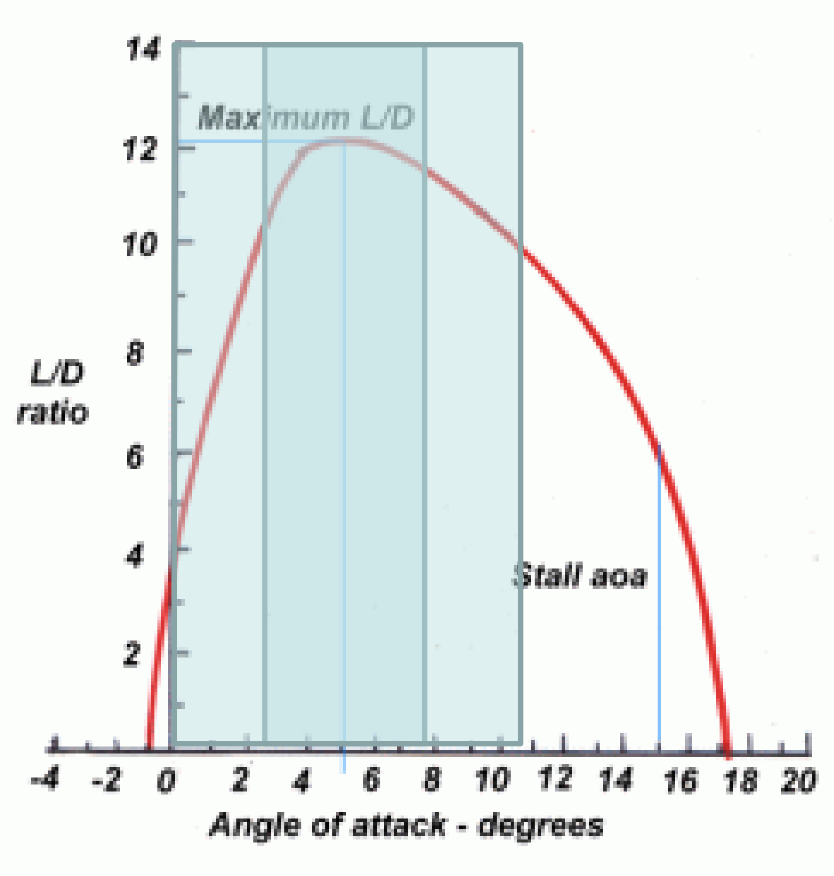
Power curve changes

Angle of attack

- Vector sum of wind vector and blade rotation

Effect of Shear (2)

- Angle of attack variation is linked to performance variation.
- Wind speed ratio across the rotor, not shear
- Ratio = U_{top}/U_{bottom}
- Ground location doesn't matter



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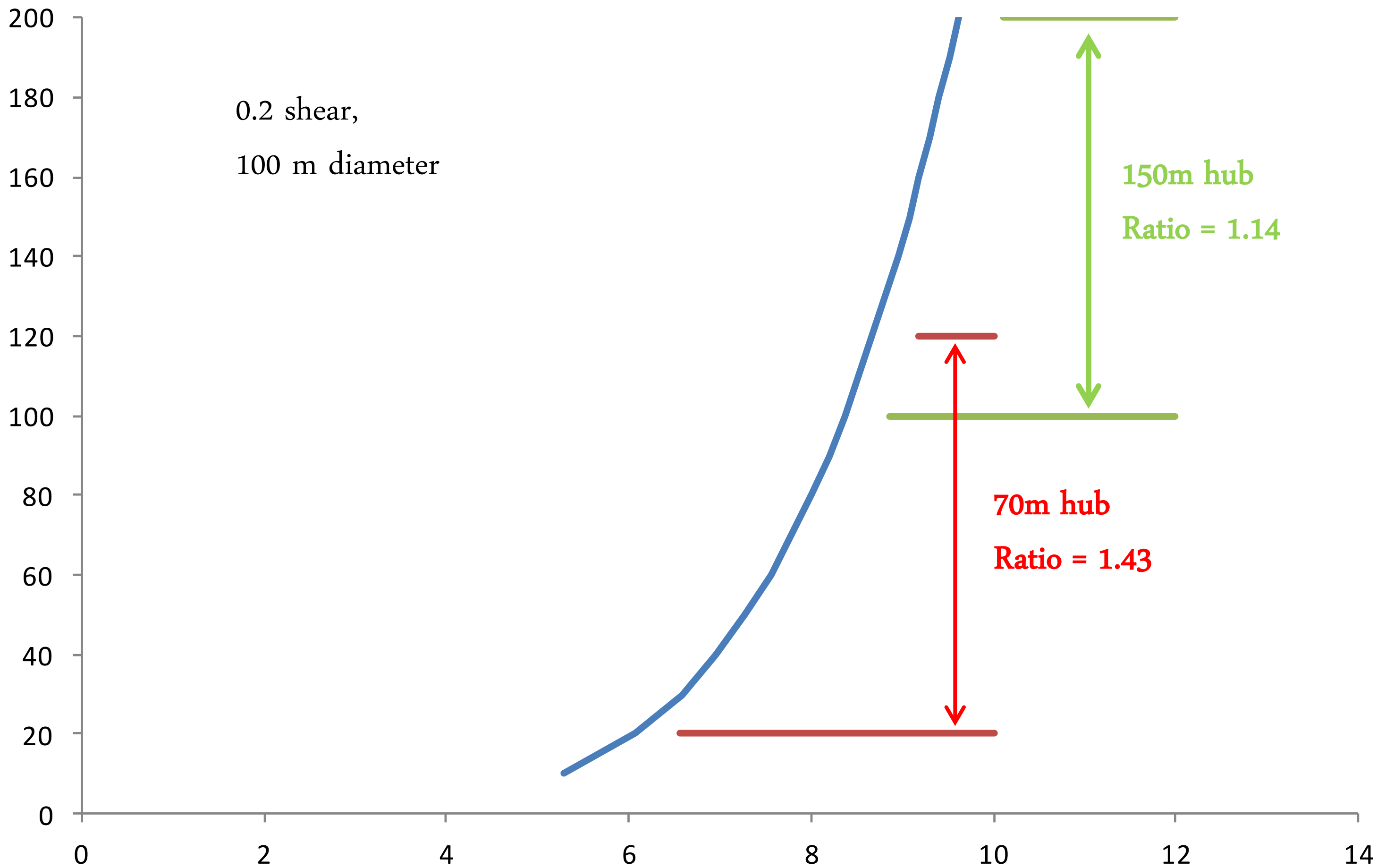
Effect of Shear (3)



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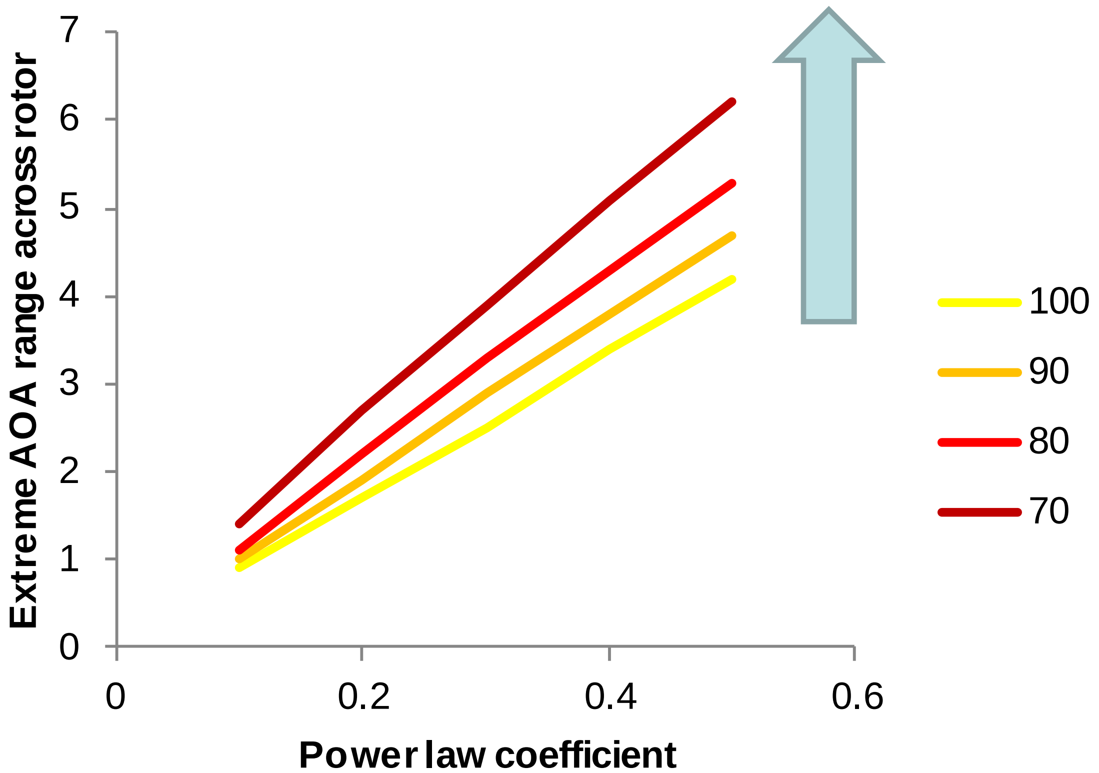
Hub height change effect

- Lower hubs and higher diameters cause greater AOA variation.



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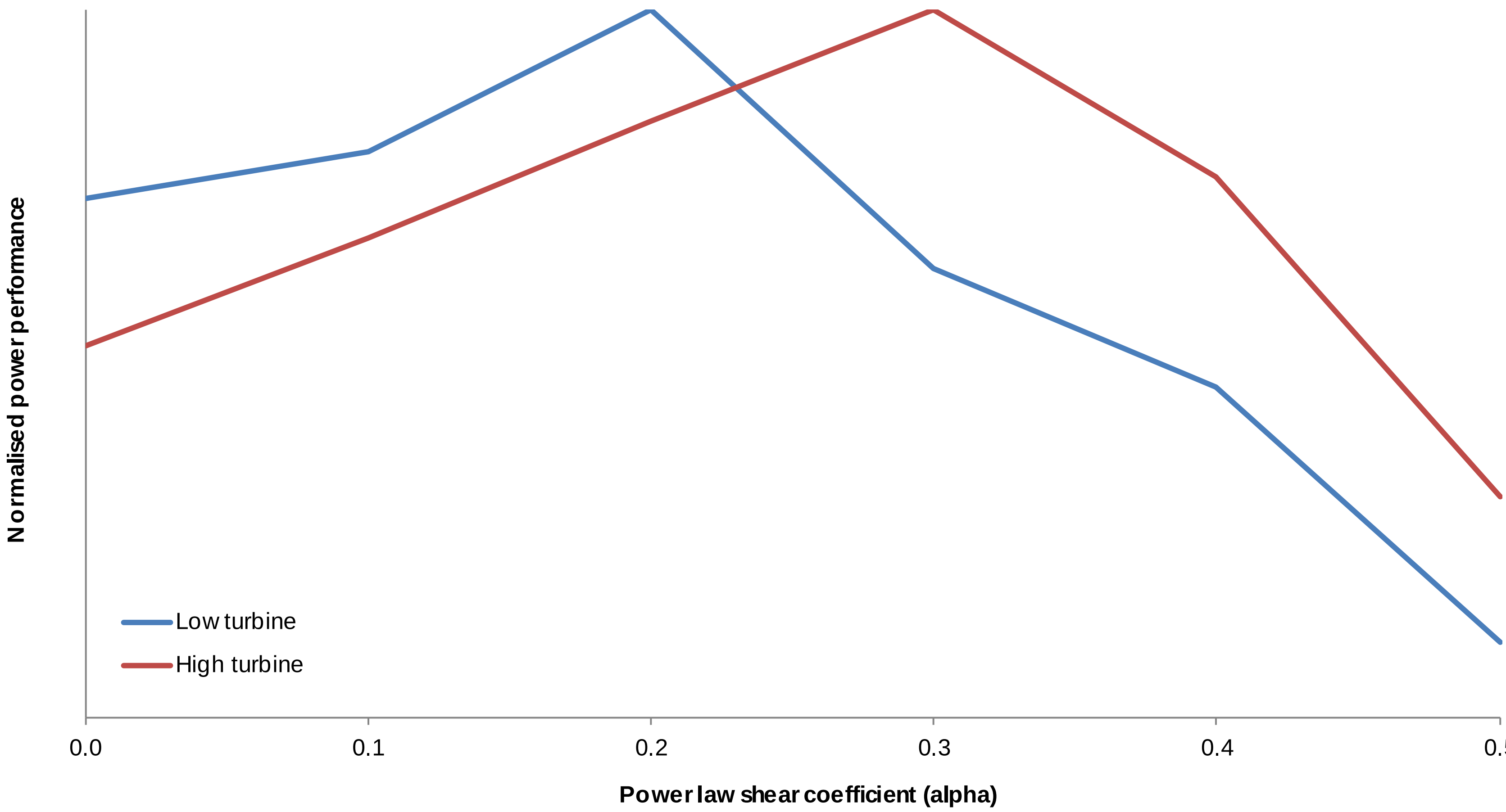
Proposed parameter

- "Equivalent Alpha"
- The same **cross-rotor wind speed ratio** at two different turbines.
- (¾ rotor size used for ratio comparison to match main power producing band)

80m diameter
60m hub height
0.2 shear

80m diameter
100m hub height
0.35 shear

Turbine performance with alpha



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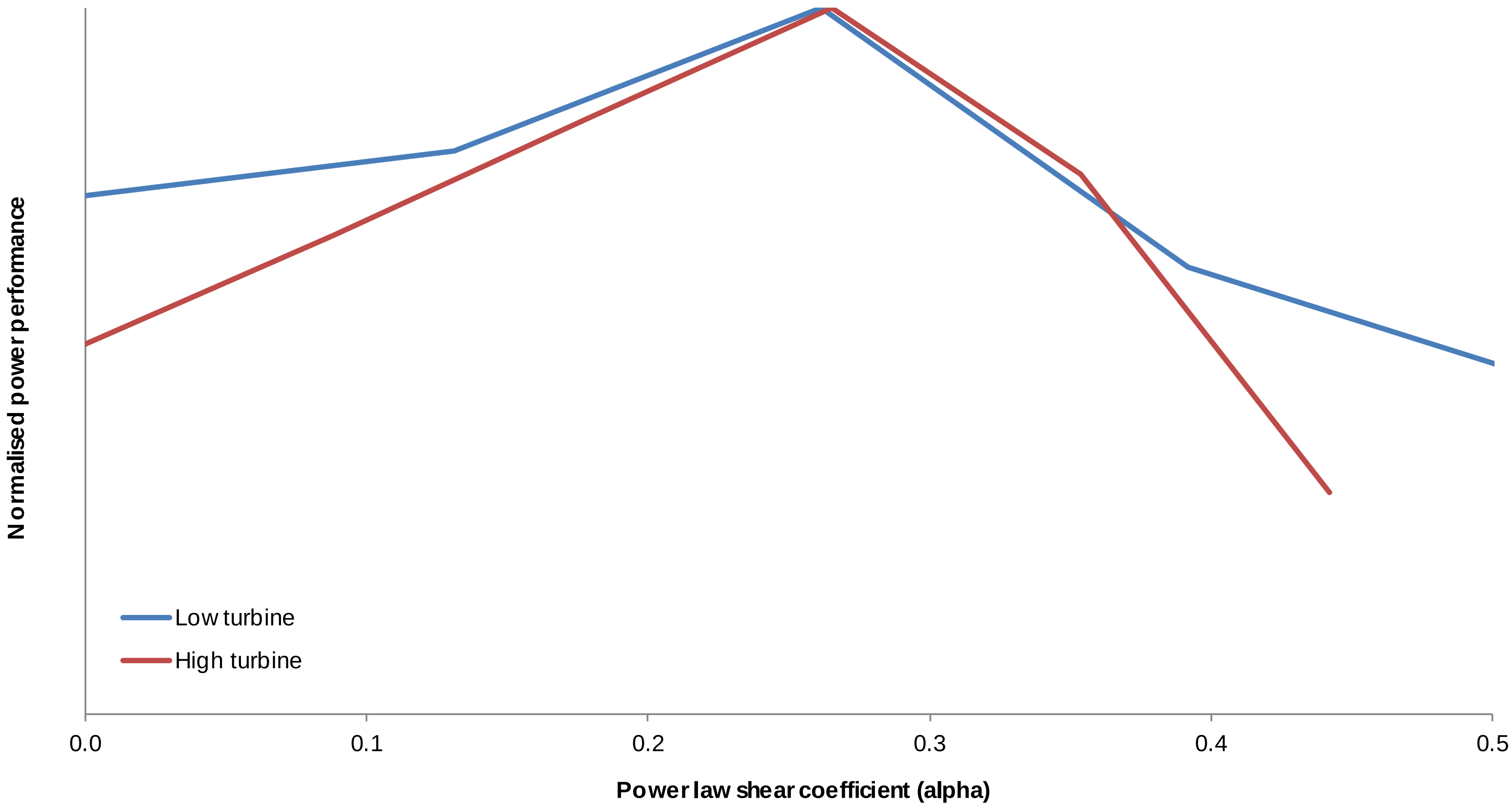
Turbine performance with “equivalent alpha”



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Conclusions

- “Equivalent Alpha” looks like a useful way to compare performance across geometries.
- Helpful in assessing the impact of lower hub heights on performance.

- More validation needed (to follow)
- BEM prediction of trends (also in progress)