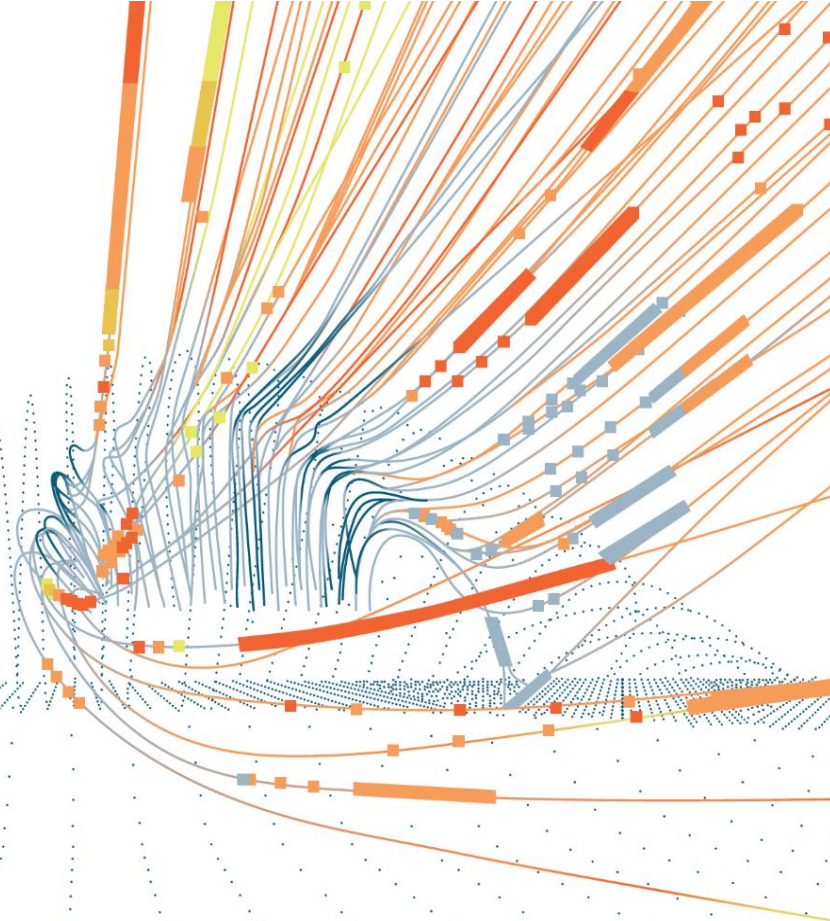


WIND KNOWLEDGE

IS WIND POWER



Workshop: Site Suitability

WindSim 12th User Meeting, Tønsberg 22-23 June 2017

PRESENTED BY: Di Li

windsim

Content

- IEC 61400 – 1
- Current method in WindSim
- Workshop purpose
- Workshop agenda
 - Objective
 - Parameters
 - Methodology
 - Important factors

IEC 61400 – 1

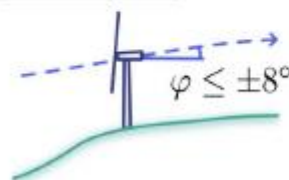
The conditions of the turbine at site shall be less severe than the criteria of the wind turbine design.

- Extreme wind
- Ambient turbulence
- Effective turbulence
- Flow inclination
- Wind shear
- Probability density function
- Air density

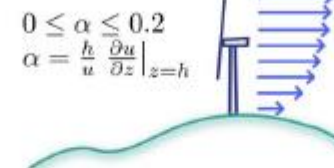
Extreme wind



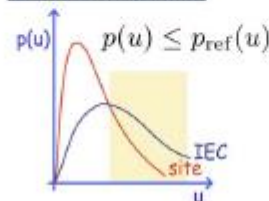
Flow inclination



Wind shear



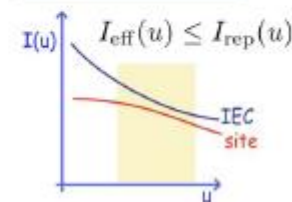
Wind distribution



Wake turbulence



Turbulence intensity



Current method in WindSim

Extreme wind

1. ST wind - MCP with MERRA - LT wind
2. Flow model - LT wind at turbine (hourly, over 30 yrs)
3. Annual peaks
4. Gumbel fitting, 50 return years – Extreme wind hourly
5. Gust factor, hourly - 10 min

TI:

1. ST wind – Representing ST wind
2. Flow model - wind at turbine
3. Irep by statistics
4. Ieff with Fransdsen model

Shear and flow inclination:

1. Flow model (verified with ST wind)

Probability density function:

1. ST wind - MCP with MERRA - LT wind
2. Flow model - LT wind at turbine (hourly, over 30 yrs)

Workshop purpose

We would like to help your work on site suitability to be

- Faster
- More accurate
- More efficient
- Easier to do analysis
- Easier to present the result

Workshop agenda

Introduction (10 min)

Your tools, procedures and experiences to solve the challenge related to site suitability?

Discussion (40 min)

- Objective (5 min)
- Parameters (15 min)
- Methodologies (10 min)
- Important factors (10 min)

Summary (10 min)

Purpose

- Site verification
- Layout design - GIS Layer for shear, flow inclination, TI, extreme wind
- Sector management – operation strategy
- Lifetime reduction – load response.

Parameters

Site verification Parameters

| | |
|-------------|----|
| IEC 61400-1 | 7 |
| OEM 1 | 41 |
| OEM 2 | 31 |
| OEM 3 | 27 |

| | | | | | | |
|---|-----------------|---|--|--|--------------|----------|
| Based on measurement data / air density corrected | | Global speed-up between reference mast and WEC at hub height used to extrapolate measured V_{ref} and V_{e50} | Scale and shape parameter of Weibull function. Based on long term correlated measurement data. | Wake affected scale and shape parameter of Weibull function. Based on long term correlated measurement data. | | |
| V_{ref} [m/s] | V_{e50} [m/s] | Speed-up | C (A) | k | C (A) -w- | k -w- |

| Normal wind conditions ⁽³⁾ (annual) | | | | | |
|--|--|-----------------|------------|-----------|-----|
| 1 | Height for conditions | m.a.g.l. | 540+45=585 | | m |
| 2 | Weibull scale parameter | A | 10.8 | 12.3 | m/s |
| 3 | Weibull shape parameter | k | 1.9 | 1.95 | - |
| 4 | Average wind speed | V_{ave} | 9.5 | 10.6 | m/s |
| 5 | Average turbulence intensity at 15m/s ⁽⁴⁾ | I_{ref} | 11.4 | 12.4 | % |
| 6 | Standard deviation of I_{ref} | σ_{Iref} | 3.0 | 2.8 | % |
| 7 | Wind shear power law exponent ⁽⁵⁾ | α | 0.13 | 0.04/0.26 | - |
| 8 | Maximum inflow angles | - | 3.1 | 6.5 | ° |

Methodology

Extreme wind:

1. Monthly peaks
2. Peak over threshold
3. EWTS II
4. National Code
5. Weather station

TI:

- Site complexity – Cct
- Irep by standard deviation linear model

Important factors

- Method ranking
- Uncertainty analysis
- Multiple met mast method
- Presenting the result

Thank you

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