EWEA CREYAP benchmark exercises: summary for offshore wind farm cases

Mortensen, Niels Gylling; Nielsen, Morten; Ejsing Jørgensen, Hans

Publication date:
2015

Document Version
Peer reviewed version

Citation (APA):
EWEA CREYAP benchmark exercises: summary for offshore wind farm cases

Niels G Mortensen, Morten Nielsen & Hans E Jørgensen

Wind Energy Denmark 2015
Acknowledgements

• RES Ltd. for Gwynt y Môr data pack
• DONG Energy Wind Power A/S for Barrow data
• Dong Energy, Iberdrola and Crown Estate for Shell Flats wind data and other information.
• 60 teams from 13 countries; thanks for making the comparison and presentations possible!
• EWEA for arranging Offshore CREYAP Part 1+2, thanks to Tim Robinson and his team.
Comparison of Resource and Energy Yield Assessment Procedures

EWEA CREYAP concept
• Industry benchmarking
• In-house training and R&D
• Identification of R&D issues

Three issues today
• Wakes and wake modelling
• Yield assessment uncertainties
• Modelled vs observed yields

CREYAP history
• Onshore Part 1, Bruxelles 2011
  – Scotland W, 14 × 2 MW (28 MW)
• Onshore Part 2, Dublin 2013
  – Scotland E, 22 × 1.3 MW (29 MW)
• Offshore Part 1, Frankfurt 2013
  – Gwynt y Môr, 160 × 3.6 (576 MW)
• Offshore Part 2, Helsinki 2015
  – Barrow, 30 × 3 MW (90 MW)

Summary
• 157 submissions from 27 countries
  – 97 for onshore
  – 60 for offshore
Barrow estimated turbine yields and wake effects
Barrow estimated turbine yields and spread of results
Barrow wind farm (only) – which wake model is best?
# Wake modelling uncertainty

(CREYAP 1-4, Nygaard 2015)

<table>
<thead>
<tr>
<th>Wind farm</th>
<th>Size</th>
<th>Layout</th>
<th>Wake loss</th>
<th>Uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onshore 1 Hilly</td>
<td>28 MW 14 WTG</td>
<td>Irregular 3.7-4.8 (D)</td>
<td>6.1%</td>
<td>13%</td>
</tr>
<tr>
<td>Onshore 2 Complex</td>
<td>29 MW 22 WTG</td>
<td>Irregular 4-5 (D)</td>
<td>10.3%</td>
<td>18%</td>
</tr>
<tr>
<td>Offshore 1† Gwynt y Môr</td>
<td>576 MW 160 WTG</td>
<td>Regular 6-7 (D)</td>
<td>14.3%</td>
<td>22%</td>
</tr>
<tr>
<td>Offshore 2 Barrow</td>
<td>90 MW 30 WTG</td>
<td>4 staggered 5.5 × 8.5 (D)</td>
<td>7.9%</td>
<td>16%</td>
</tr>
<tr>
<td>10 offshore‡ DONG 2015</td>
<td>90-630 MW 30-175 WTG</td>
<td>10 layouts</td>
<td>one model</td>
<td>16%</td>
</tr>
</tbody>
</table>

† Without two rather unusual outliers
‡ N.G. Nygaard, EWEA Offshore 2015
Uncertainty for offshore wind farm predictions

Offshore CREYAP exercises Part II+I
- Barrow, 30 WTG, 90 MW (2015)
Barrow predicted vs observed $P_{50}$ (1 year)

Data points used = 20 (of 22)

Mean predicted $P_{50} = 324$ GWh$^{-1}$
Standard deviation = 9.6 GWh$^{-1}$
Coefficient of variation = 3.0% 
Range = 300 to 343 GWh$^{-1}$

Prediction bias = +4%
(cf. Cox, EWEA Offshore 2015)
Summary and conclusions – offshore wind farms

• Important issues offshore
  – Yield calculations
  – Wake modelling
  – Technical losses
  – Uncertainty estimation

• Wake modelling
  – Represent a significant loss
  – Uncertainty $\propto$ WTG wake loss
  – Models and spec’s important
  – Configuration essential too!
  – Classic models seem to provide realistic results for Barrow
  – Many more farms necessary...

• Yield assessment uncertainties
  – About 5-9% (minimum)
  – Consistent self-evaluation

• Modelled vs observed yields
  – Data for Barrow only
  – Estimated = 104% of obs. AEP
  – Spread (uncertainty) = 3%

• Standards and guidelines
  – Vocabulary and definitions
  – Best practice calculations and reporting
  – IEC, IEA, Measnet, ...

• ‘Human factor’ largely unknown
Thank you for your attention!

Handouts and papers from CREYAP exercises available from DTU web site
CREYAP references


**Offshore**

