LAWINE: Lidar Application for WINd energy Efficiency

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First come, first served
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Outline

• LAWINE project background

• Aim

• Partners

• Approach

• Results

• Conclusions and outlook
LAWINE: Background

Availability of accurate wind measurements for wind energy deployment

- Determination of the wind resource
- Certification measurements of wind turbine prototypes
- Power performance assessments during the operation of a wind farm
LAWINE: Aim

Technology and services are developed to use LiDAR systems in offshore wind power plants to significantly reduce the cost of energy.

• Accurate assessment of the wind resource
• Effective and reliable power performance
• The optimized operation of wind turbines and farms
**LAWINE: Approach**

**Validation and demonstration of LiDAR technology at ECN test site**
- Duration: December 2012 – December 2015
- Division into tasks:
  - Task A: Wind resource assessment
  - Task B: Windscanner experiments
  - Task C: Power performance using nacelle mounted LiDAR
  - Task D: Nacelle mounted LiDAR assisted turbine control
  - Task E: Wind farm optimization and wind farm control
  - Task F: Efficiency improvement in LiDAR measurement campaign
  - Task G: Development European research infrastructure ESFRI
  - Task H: LiDAR calibration facility
LAWINE: EWTW test site
LAWINE: GB and scanning LiDAR

- **Ground based LiDAR**
  - Excellent agreement between mast and gb LiDAR
  - Bin averages: \( a = 1.0054, R^2 = 0.99985 \)
  - Scatter: \( a = 1.0148, R^2 = 0.99377 \)
  - Further study on wind resource assessment application using EWTW data

- **Scanning LiDAR**
  - Wakes captured by scanning LiDAR
  - Further study on usability for wake characterization
LAWINE: Nacelle LiDAR (2 beam)

- **Power performance**
  - Very well wind speed comparison with mast (2.5D, undisturbed sector)
  - Very well power curve + uncertainties comparison

- **Yaw misalignment**
  - -3.6º (± 0.5º) offset determined in 7 days with accuracy of 95%

- **Wake characterization**
  - Wake identification
  - Next step bckwd looking wake evolution, meandering etc.
LAWINE: Nacelle LiDAR (5 beam)

• Purpose: FF wind turbine control
  - Availability 99.67%

• Wind shear
  - 2 beam configuration (LOS0 & LOS3)
  - LiDAR@185m vs MM@383m

• Wind evolution from LiDAR to rotor plane
  - Evaluation of convection speed (Taylors hypothesis?)
  - Future work with TU-Delft PhD

• Evaluation of benefit for FF control
  - To be continued this year
Conclusions and outlook

- 2013: Year of installations. >2014: Analyses
- First results show
  - Excellent agreement LiDARs vs masts on- and offshore
  - Power performance validation
- Outlook
  - Wake characterization
  - Improved wind resource assessment
  - Optimized wind farm control
    - Wake control (using wake characterization study)
    - Improved load monitoring using fleet leader (O&M cost reduction)
- Publicity
  - ECN website: https://www.ecn.nl/nl/nieuws/item/grote-meetcampagne-voor-goedkopere-windenergie/
  - NORCOWE website: http://www.norcowe.no/index.cfm?id=407604
  - EWEA Offshore 2015 and DEWEK 2015 poster
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