
norcowe
Norwegian Centre for Offshore Wind Energy
CENTRE FOR ENVIRONMENT-FRIENDLY ENERGY RESEARCH
Norwegian Centre for Offshore Wind Energy

NORCOWE at a glance

We build future industry competence through instrumentation, education and research

- Part of the Research Council of Norway's scheme: Centres of Environment-friendly Energy Research
- Budget of 232 MNOK (29 MEUR; 38 MUSD) for 2009-2017
- Pre-competitive and industry driven research

CENTRE FOR ENVIRONMENT-FRIENDLY ENERGY RESEARCH

Partners

R&D partners:

- Christian Michelsen Research
- Uni Research
- University of Agder
- University of Bergen
- University of Stavanger
- Aalborg University (DK)

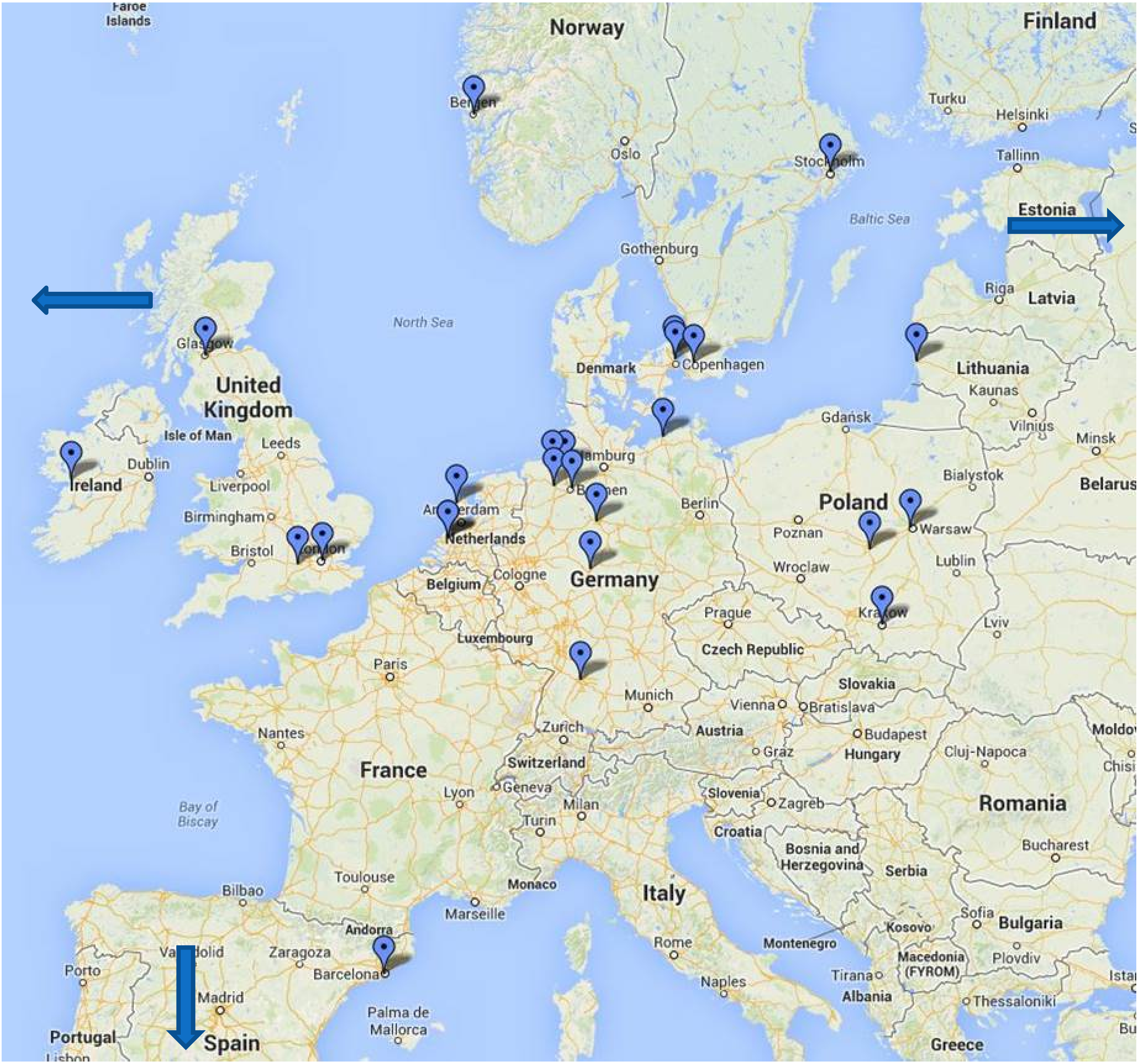
User partners:

- Statkraft
- Statoil
- Acona Flow Technology
- Meteorologisk institutt (met.no)
- StormGeo
- Leosphere

Memorandum of Understanding

- DTU Wind
- Fraunhofer IWES
- The National Renewable Energy Lab (NREL)
- ECN (the Netherlands)
- Arena NOW

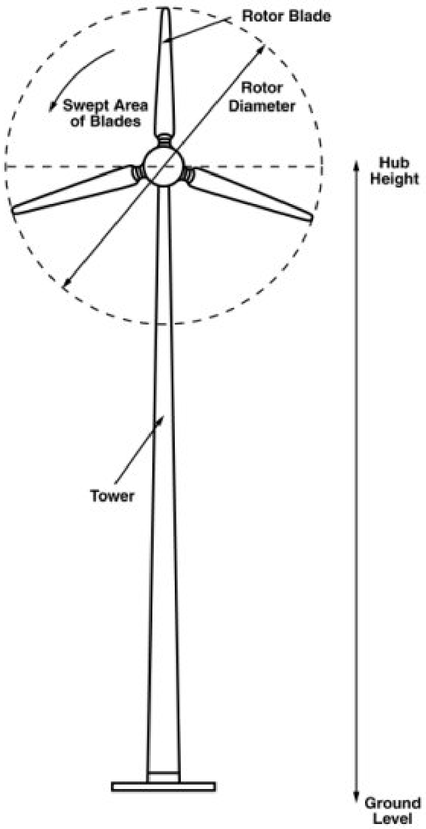
Collaborations in Europa, USA, Australia, South-Africa, China and Japan



Measurement campaigns

atmosphere – wind turbine/farm interaction

$$P_{out} = \frac{1}{2} C_p A \rho v^3$$



extraction of energy from the mean flow:

- conversion into mechanical/electrical power (including WT losses)
- conversion into turbulence kinetic energy (TKE)

the flow behind one (several) turbines is therefore characterized by:

- reduced average wind speed
- increased turbulence level

both factors affect the performance of the turbines behind negatively:

- reduced power output
- increased load and fatigue

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LIMECS -
LiDAR measurement campaign Sola

Valerie Kumer, Jochen Reuder, Birgitte Furevik

Campaign Sola

- 2 Windcubes v1 and a scanning Windcube 100S were located at two sites in Sola from March 2013 to July 2013

Campaign Sola

- Site 1: Airport Stavanger Sola

Campaign Sola

- Site 2 : automatic radiosonde launcher met.no

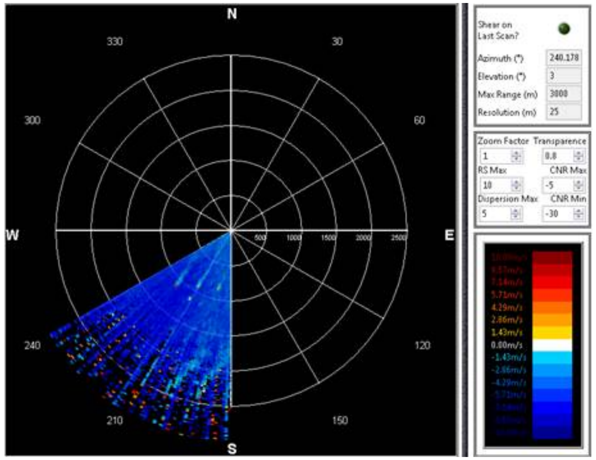
Intentions and Aims

- Test campaign:
  - Evaluations of the performance of the WindCube 100S, through comparisons among different data sets (Raso,WLSv1,Metsation)
  - Comparison of rawinsonde and LiDAR wind measurements between 40 and 3000 m (cooperation with met.no)
  - Wind vector retrievals
- Development and setup of appropriate and reliable scanning patterns
- Validation of fine scale Numerical Models (cooperation with met.no)
- Investigation of land-sea boundary layer transitions

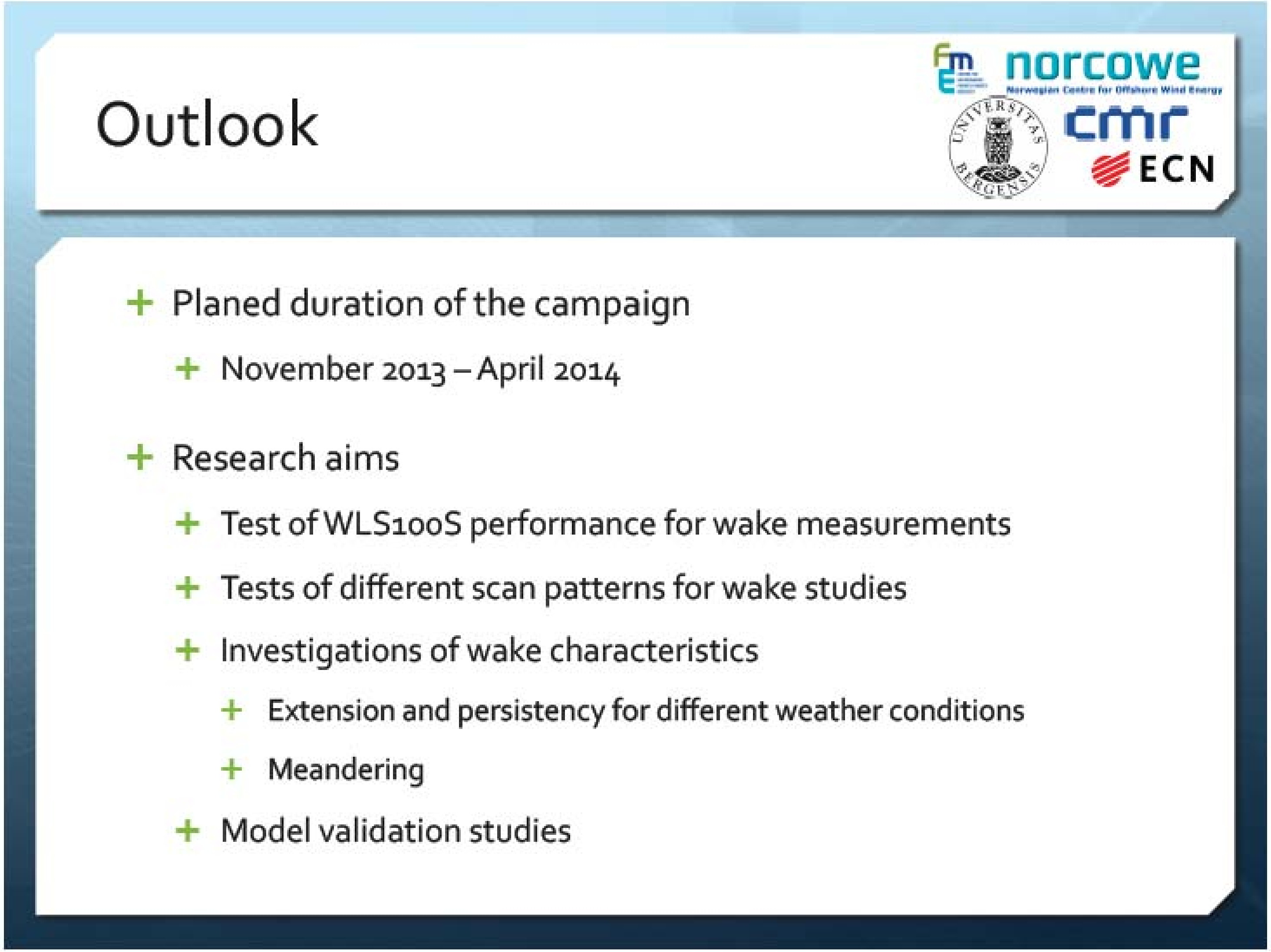
WINTWEX-W campaign November 2013-April 2014

ECN/NORCOWE LiDAR campaign

- October 2013 - April 2014
- 2 nacelle mounted LiDARs
- 5 LiDARs in the field
  - 1 scanning
- SUMO flights in April



WINTWEX-W campaign November 2013-April 2014



Offshore measurement campaign

- @ North Sea wind farm
- 2014-2015

- Offshore wake propagation
- Boundary layer characterisation
- Power performance
- Structural loading

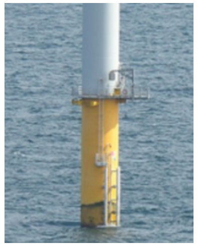
Lidar needs for offshore campaigns

Nacelle

- Forward looking lidar

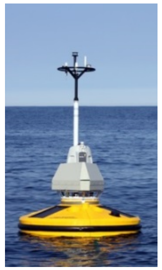
Transition piece

- Scanning lidars



Floating (buoy / ship-based)

- Motion compensated lidar



Wind farm layout with model reduction techniques (MRT)

Chad Jarvis and Yngve Heggelund, CMR

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Wakes

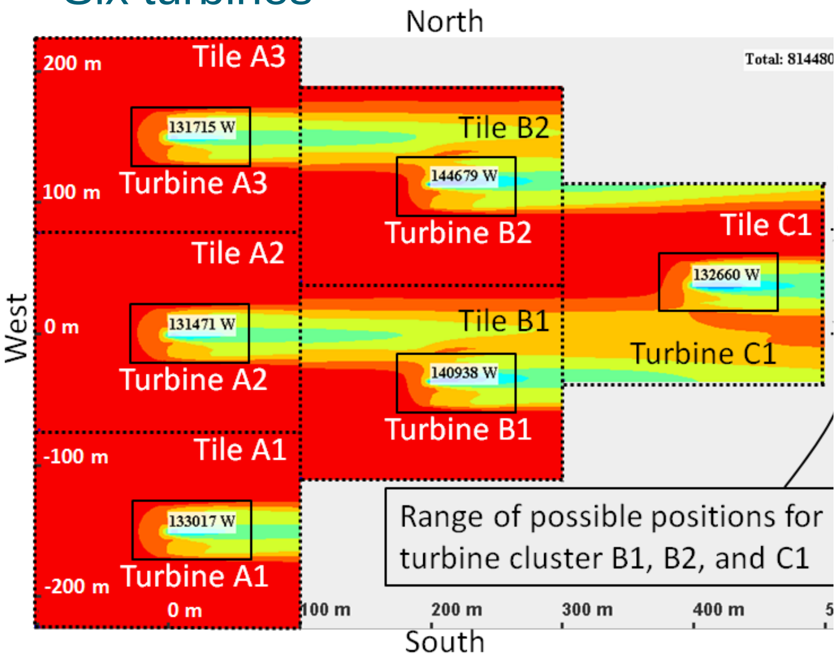
- Wakes reduce the power production of downstream turbines.
- To find the layout which maximizes power production, it is important to accurately estimate the effect of wakes.

Model reduction based on CFD

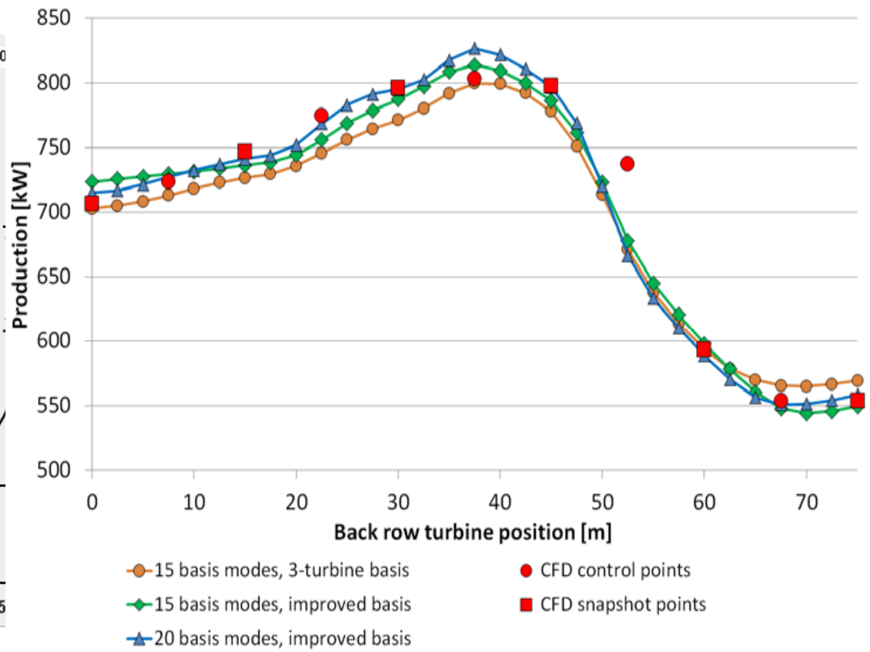
- Reduction of the solution space, while keeping the most important degrees of freedom
- The solutions space is constructed from a set of steady state CFD simulations of the RANS equations
- The solution time is reduced from the order of hours to seconds

Results so far

Six turbines



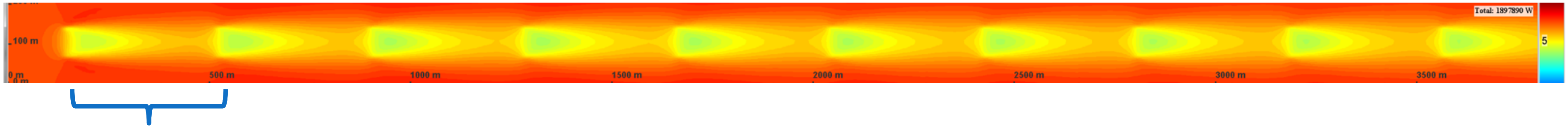
Solution of the x-component of the flow field (m/s) at hub-height for the optimal position of turbine cluster B1, B2, and C1.



Production estimates for the wind farm for different positions of the three downstream turbines. The value 0 m refers to a center position directly behind turbine A2, and 75 m refers the uppermost position.

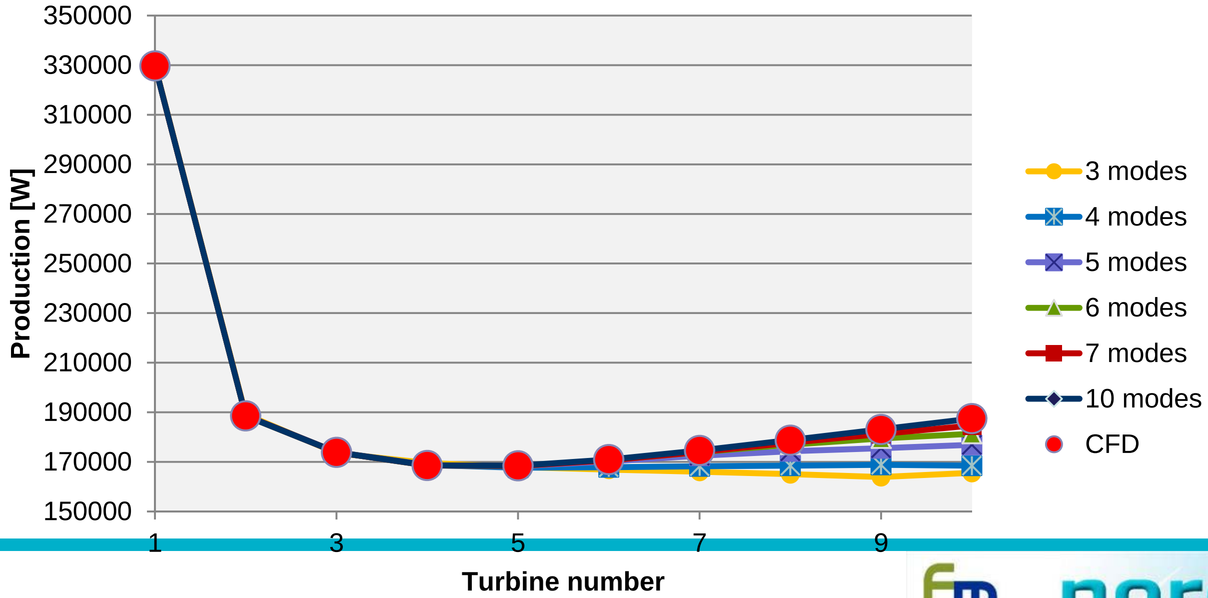
Results so far (cont.)

Ten turbines in a row with a distance of 5 rotor diameters



5 rotor diameters

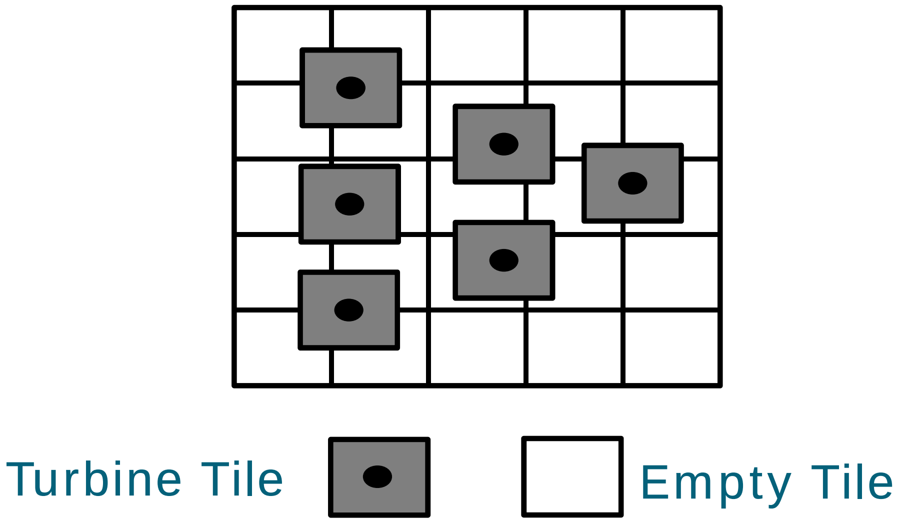
Using the first N turbines of a CFD simulation of ten turbines to construct a basis, which is then used to compute the production in the reduced space.



The power production of each turbine. The basis constructed from the first 3 turbines of the CFD simulation is labeled 3 modes etc.

Future plans

- Arbitrary interactive movement of turbines in a wind farm on a grid of empty background tiles



- Continued verification with CFD on larger realistic wind farm cases, and for more wind conditions

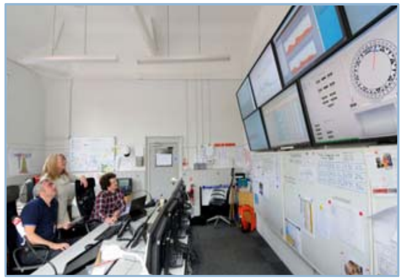
O&M AND LOGISTICS FOR OFFSHORE WIND TURBINE PARKS

PhD student Ole-Erik Endrerud
Prof. Jayantha P. Liyanage

Centre for Industrial Asset Management
University of Stavanger

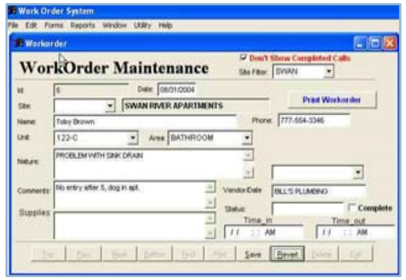
Operational infrastructure (OI)

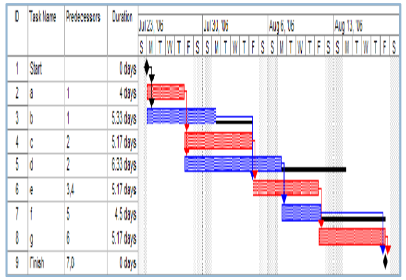
The basic physical and organizational structures and facilities



Work management system (WMS)

The system of processes used to plan, execute and control industrial assets.



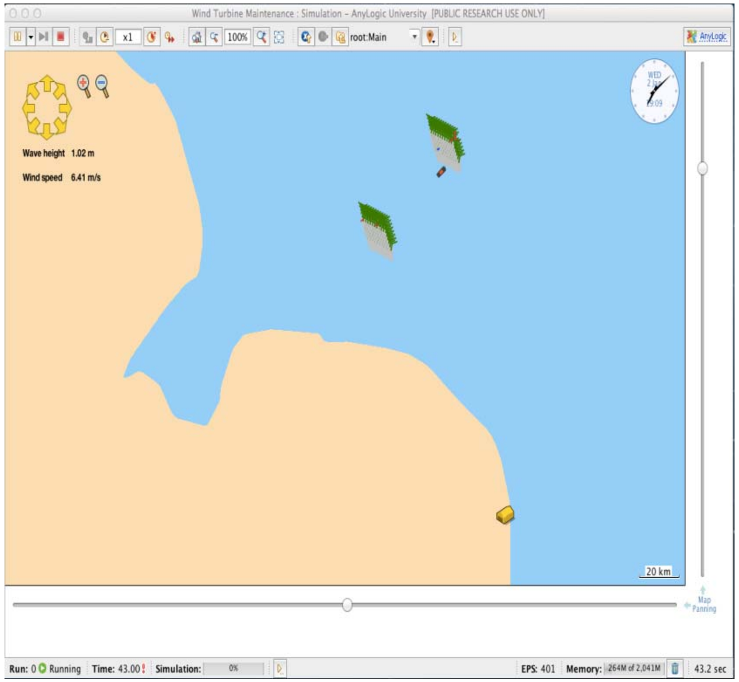


Purpose

Present a maintenance and logistics model of a large-scale wind turbine park in order to investigate how different maintenance strategies and logistics support will affect availability and life-cycle costs.

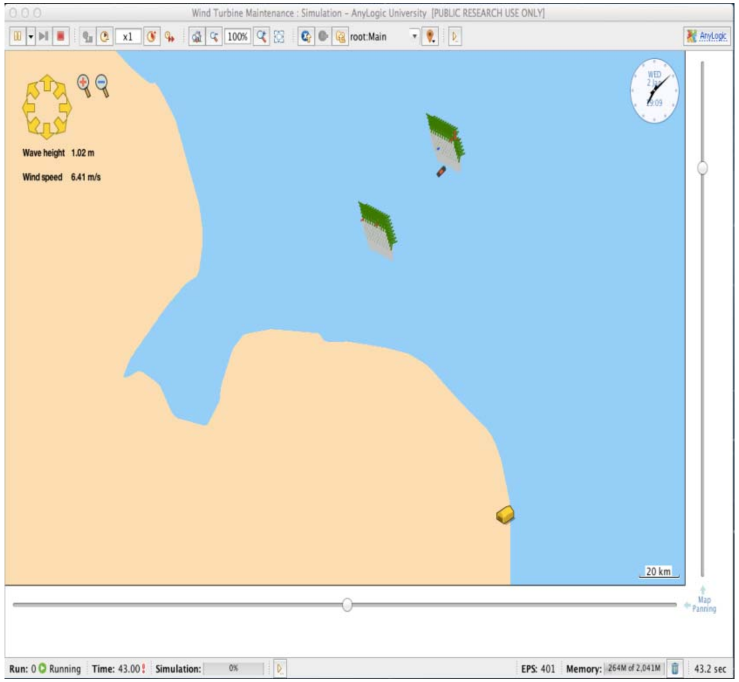
This model can be a decision tool when designing and optimizing maintenance strategies, operational infrastructure and work management systems.

UiS O&M Wind Simulation Model



- Created model of Wash-area and vessel market.
- Investigate vessel charter contracts and maintenance management of operating several parks.
- Failure model made more realistic with wind turbine sub-systems instead of failure categories.

UiS O&M Wind Simulation Model



- Investigating possibility for developing wind park development tool for the industry based on this model.

The potential of remotely piloted aircraft systems (RPAS) for wind energy related measurements

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NORCOWE – Arena NOW
Offshore Wind Operations/Science Meets Industry
10. September 2013, Bergen

UNIVERSITETET I BERGEN
Geofysisk institutt

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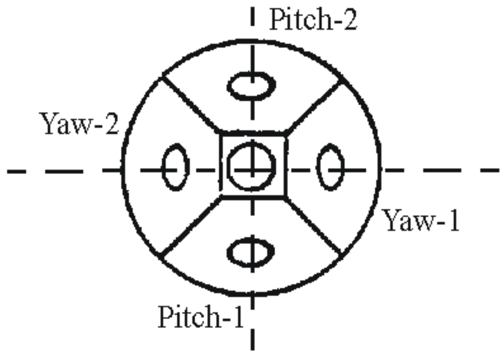
RPAS – some (semi) operational systems

SUMO – turbulence sensor

miniaturized 5-hole probe from Aeroprobe Inc., USA (3 mm diameter)

differential pressure measurements (static-dynamic, left right, up-down)

provides flow velocity and angles of sideslip and attack with 100 Hz resolution



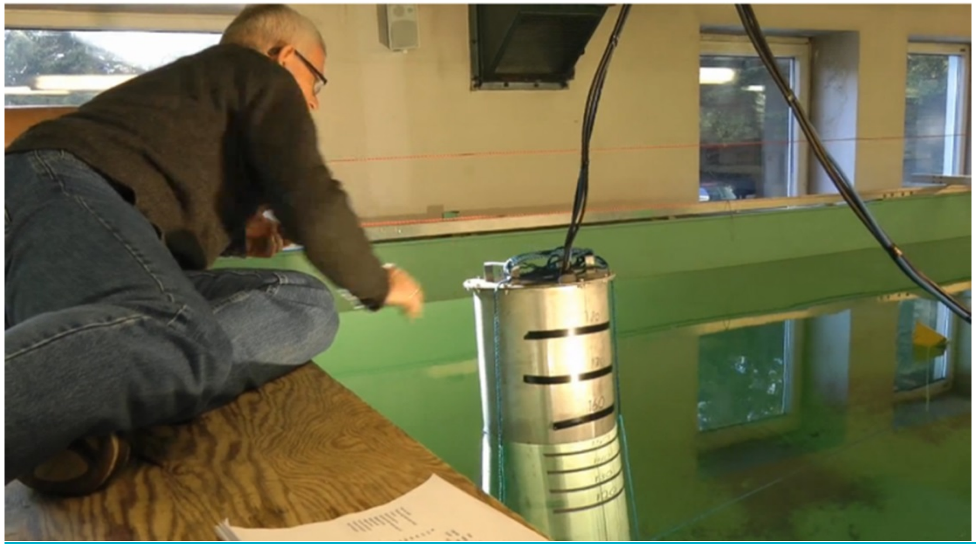
Spin-off Projects

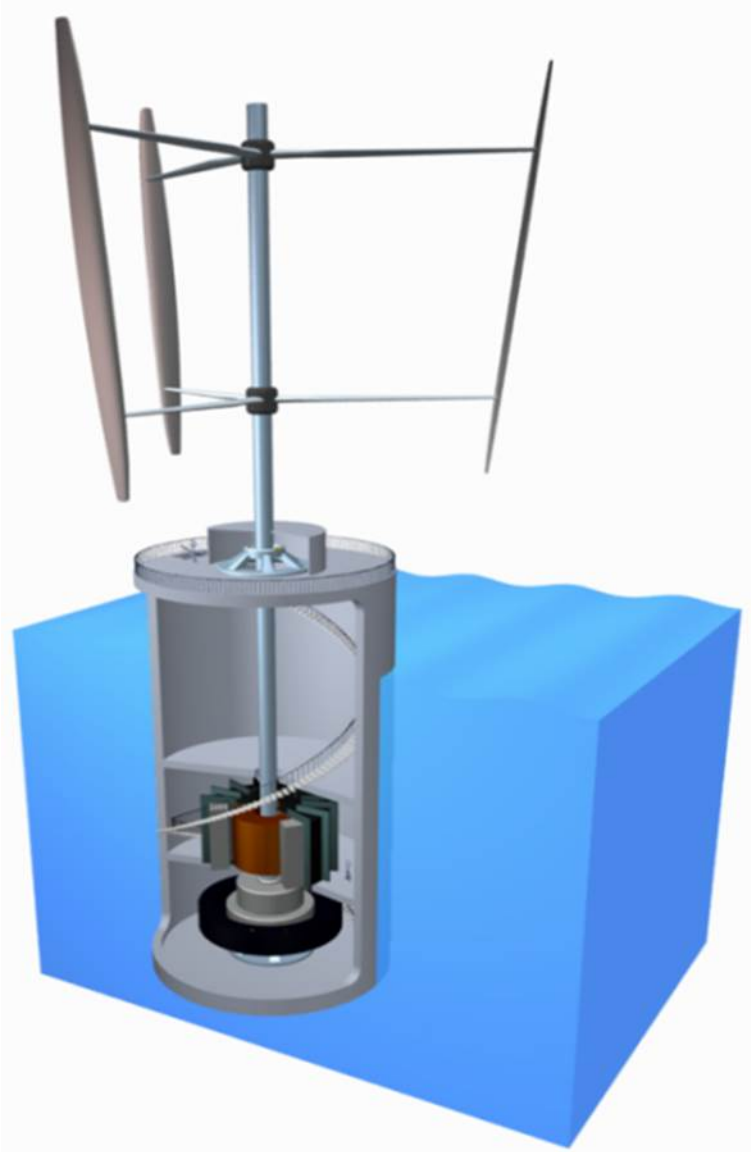
Spin-off project: wave and LiDAR

- LiDAR on Stuart platform
- Controlled wave motion
- Fugro OCEANOR
- Buoy mounted LiDAR

Spin-off project: Gwind

- Floating vertical axis wind turbine
- Gyros used for dampening
- Prototype in Stavanger harbour
- Managed by TTO office Prekubator





Spin-off project: decision support for installation of offshore wind

- Funding: RCN and Statoil
- Partners: Uni Research, Met.no, Aalborg University, MARINTEK, University of Bergen and Christian Michelsen Research
- Develop methods for decision support based on physical limitations of equipment
- Incorporate uncertainty
- Manage the weather window

Key conferences/activities 2014

- Science Meets Industry, Stavanger: April 2
- Work Package meetings: May 6-7 at UiA (Grimstad)
- PhD Summer School: August 11-15 at Stand Hotel Fevik
- OWO/Science Meets Industry, Bergen: September 9
- NORCOWE day, Bergen: September 10

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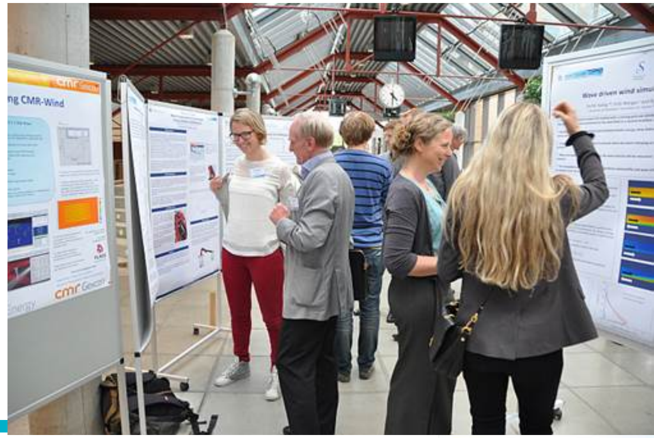

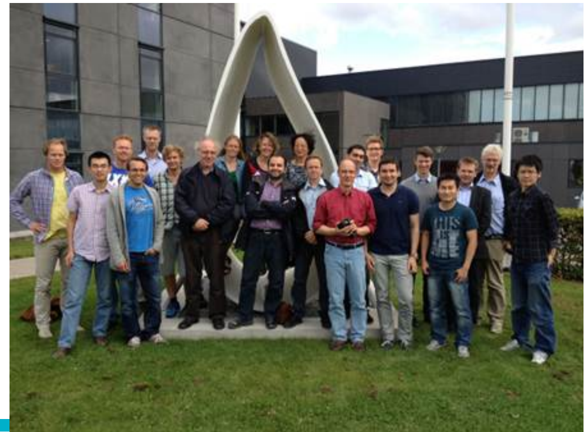

NORCOWE summer school 2014

Innovative methods and concepts in offshore wind energy

- August 11-15 at Strand Hotel Fevik, Aust Agder

- Focus on
  - New methods in analysis and measurements
  - Next generation and new concepts within wind energy
  - Impact of innovation on offshore technology
  - Group work

- Open also for industry employees and non-NORCOWE PhD students

Contact us!

www.norcowe.no

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