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Offshore Wind Power Production in Critical Weather Conditions

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Offshore wind power production in critical weather conditions

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SEVENTH FRAMEWORK PROGRAMME
EUROPEAN COMMISION

TWENTIES

Transmission system operation with large penetration of Wind and other renewable Electricity sources in Networks by means of innovative Tools and Integrated Energy Solutions

Consortium and budget

10 European Member States
1 Associated Country

United Kingdom (2)
ALSTOM GRID
UNIVERSITY OF STRATHCLYDE

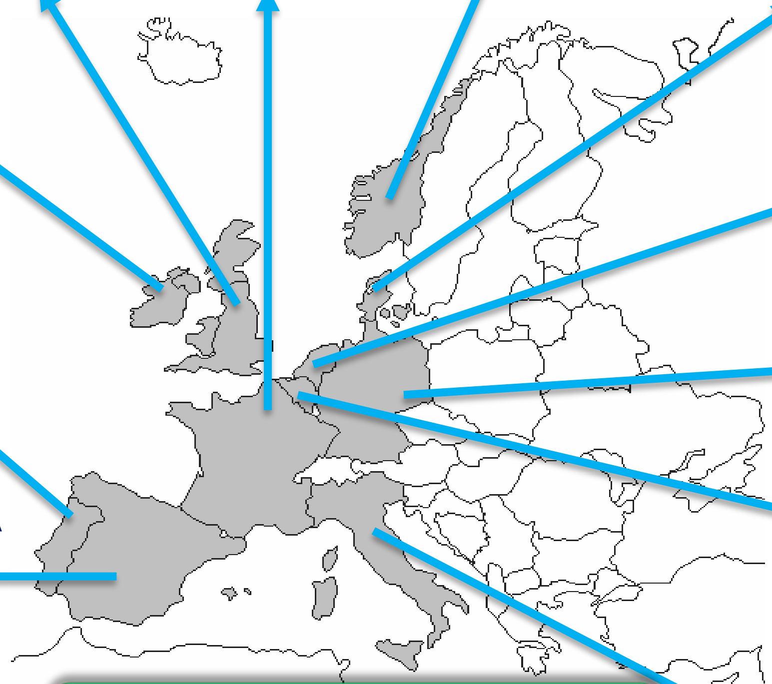
France (2)
RTE
EDF

Norway
SINTEF

Denmark (3)
DONG ENERGY
ENERGINET
DTU ENERGY

Ireland
UCD

Portugal
INESC-PORTO



The Netherlands
TENNET

Germany (3)
FRAUNHOFER IWES
50 HzT
SIEMENS Wind Power

Spain (5)
RED ELECTRICA DE ESPAÑA
IBERDROLA
ITT COMILLAS
GAMESA
ABB S.A.

Belgium (6)
ELIA SYSTEM OPERATOR
EWEA
CORESO
UNIVERSITY LIEGE
UNIVERSITY LEUVEN
UNIVERSITE LIBRE BRUXELLES

Italy
RSE

Total budget: 56.8 M€
EU contribution: 31.8 M€

Twenties
Transmitting wind

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Project objectives

Task force 1: What are the valuable contributions that intermittent generation and flexible load can bring to system services?

Task force 2: What should the network operators implement to allow for off-shore wind development?

Task force 3: How to give more flexibility to the transmission grid?

→ **6 high level demonstration objectives**

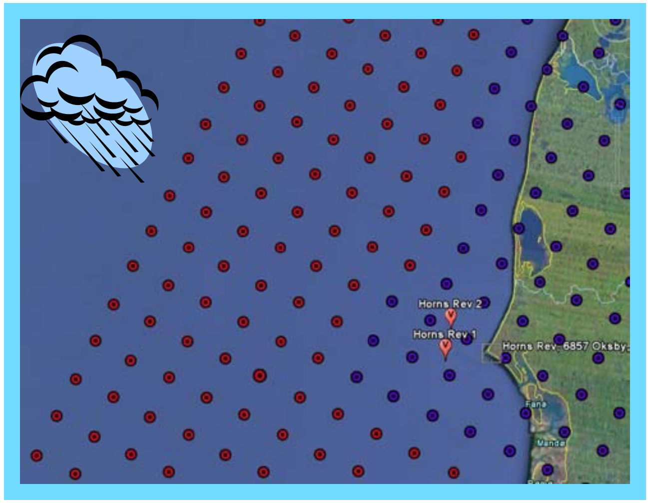
Overall: How scalable and replicable are the results within the entire pan-European electricity system?

→ **2 replication objectives**

DEMO 4 STORM MANAGEMENT (Leader: ENERGINET)

Main objective

- Demonstrate shut down of wind farms under stormy conditions without jeopardizing safety of the system.



Approach

- Horns Rev 2 (200MW).
- Flexible turbine control.
- Storm front forecasts.
- Investigate cost of changed production associated with the planned down regulation.
- Coordinate wind farm control with HVDC interconnector control and with hydro power plant operation.

Wind power

Water power

Technical University of Denmark

Replication work packages: barriers and up scaling

WP 15: Economic impacts of the demonstrations, barriers towards scaling up and solutions (Leader: IIT)

- Assess the local **economic and/or technological impact** of each demo.
- Identify the **barriers to scale-up** the outcomes at a member-state or regional level, and propose **solutions** to overcome these barriers.

WP 16: EU wide integrating assessment of demonstration replication potential (Leader: DTU Wind Energy)

- Assess **portability** of voltage control, frequency control and VPP model **to other countries and regions**.
- Evaluate North European 2020 **offshore wind power variability**, **hydro potential and barriers** and **grid restriction** studies.
- Pan European economic impact study.

WP 17: EU Offshore barriers (Leader: TENNET)

- Address the issues of **smart licensing of submarine interconnectors** with and without wind parks in the North Sea and Baltic Sea.
- Identify **common licensing barriers** and propose regulatory measures.

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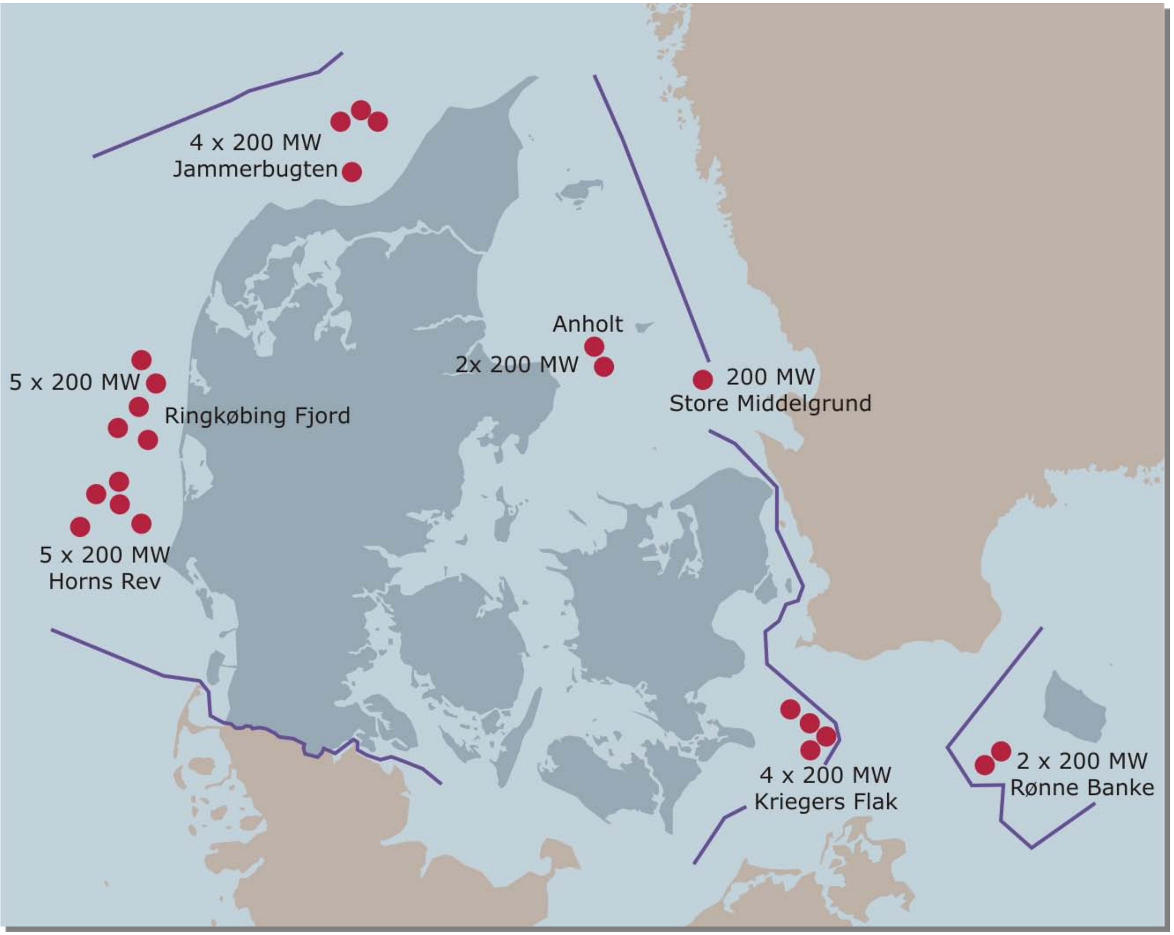
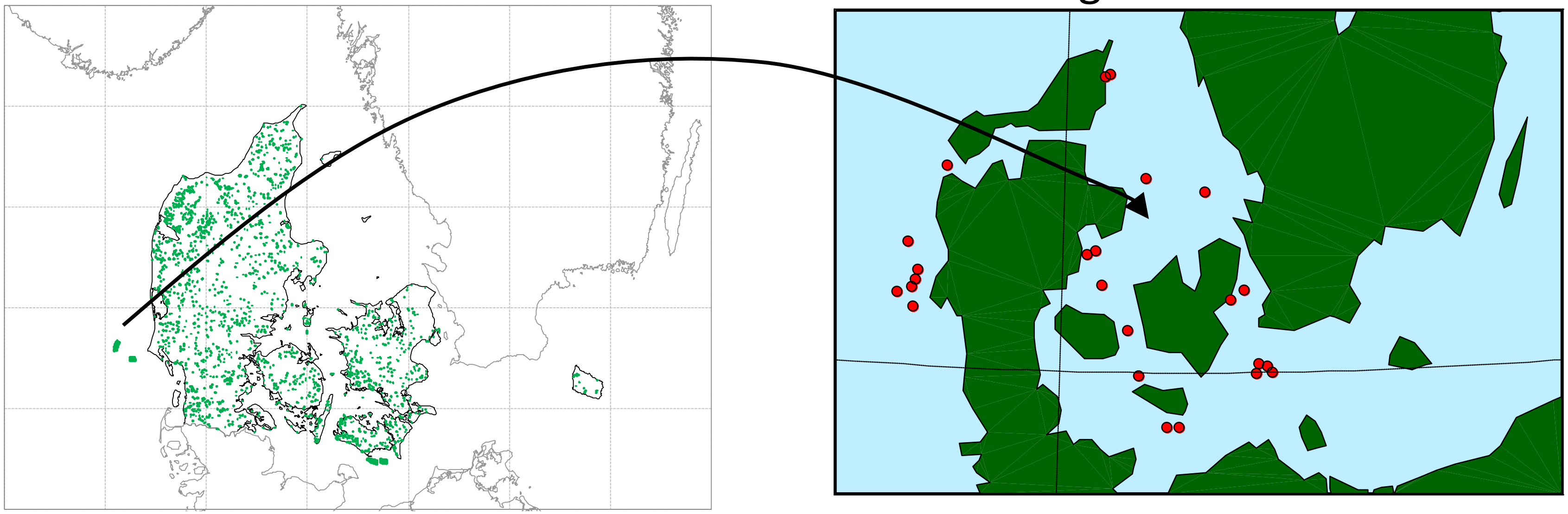
Future offshore projects in Denmark



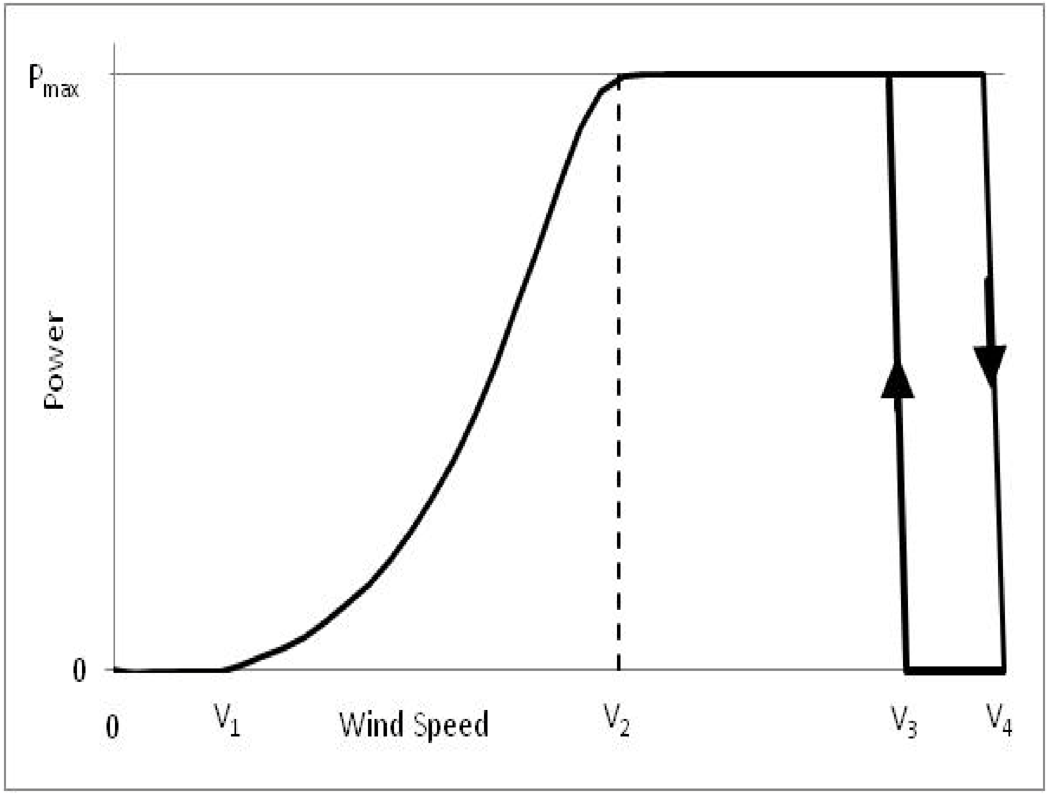
Upscaling of Horns Rev 2 to > 3 GW offshore wind

Base 2.811 MW

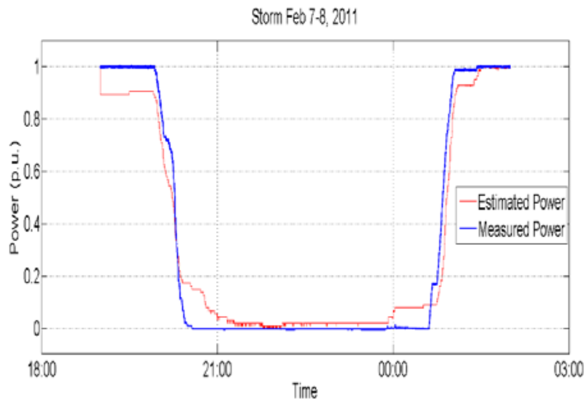
High: **3.211 MW**

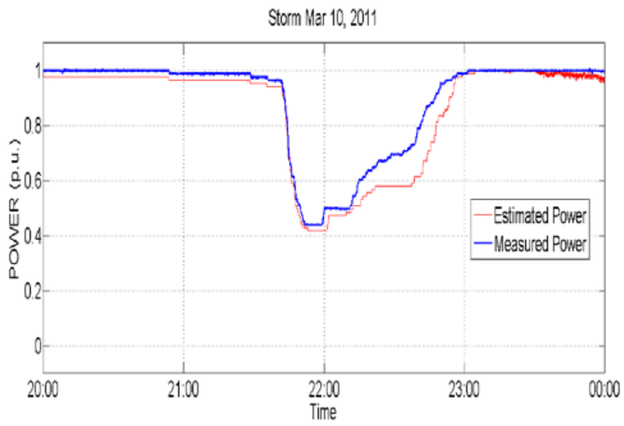


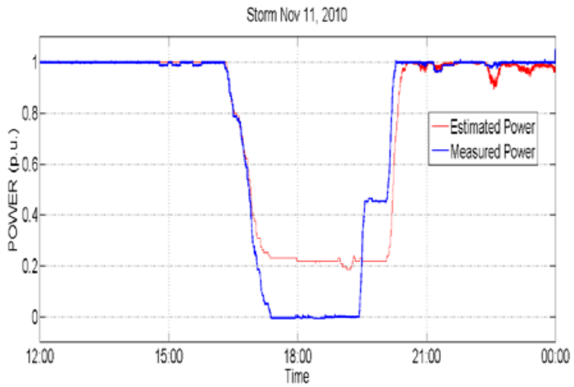
Wind turbine storm control

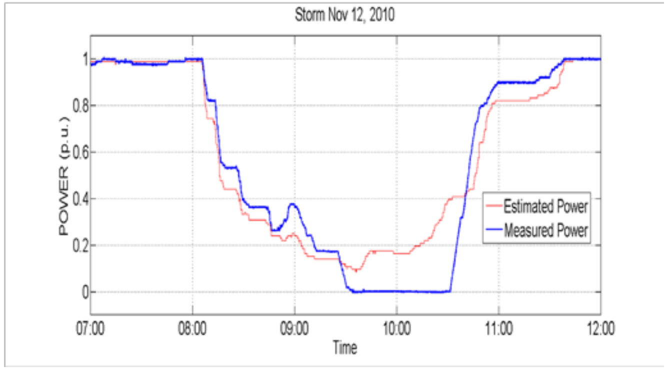


Wind turbine storm control

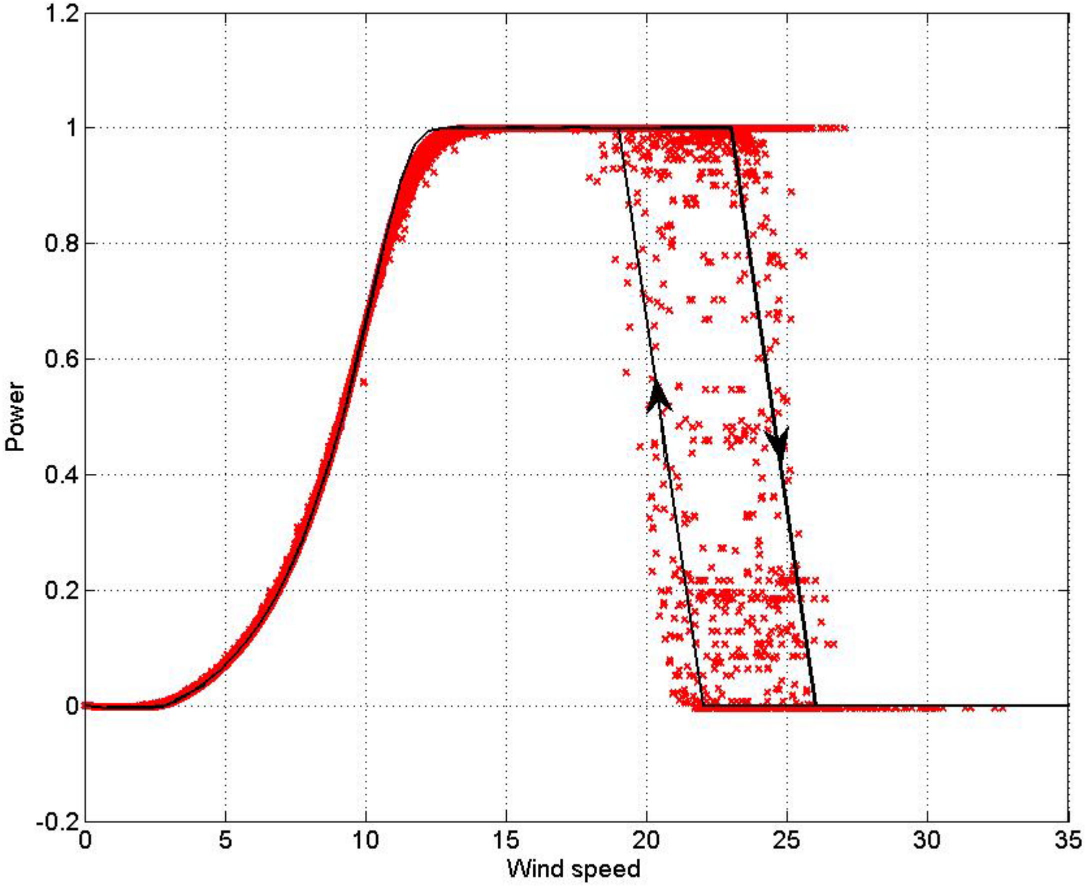








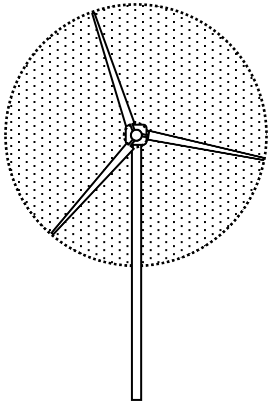
Wind farm storm control

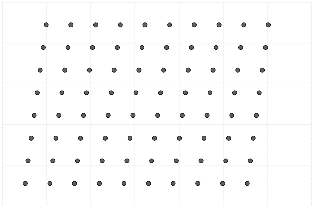


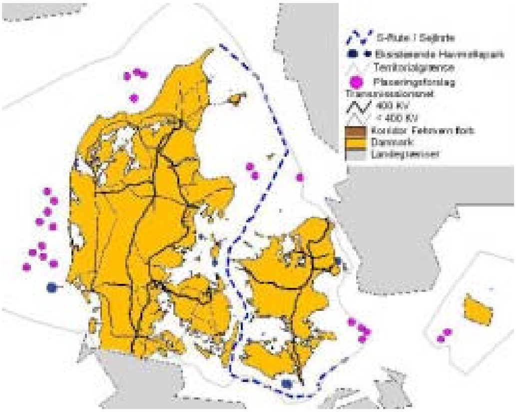
CorWind

model for simulation of Correlated Wind power fluctuations

2002 | 2007 | 2009



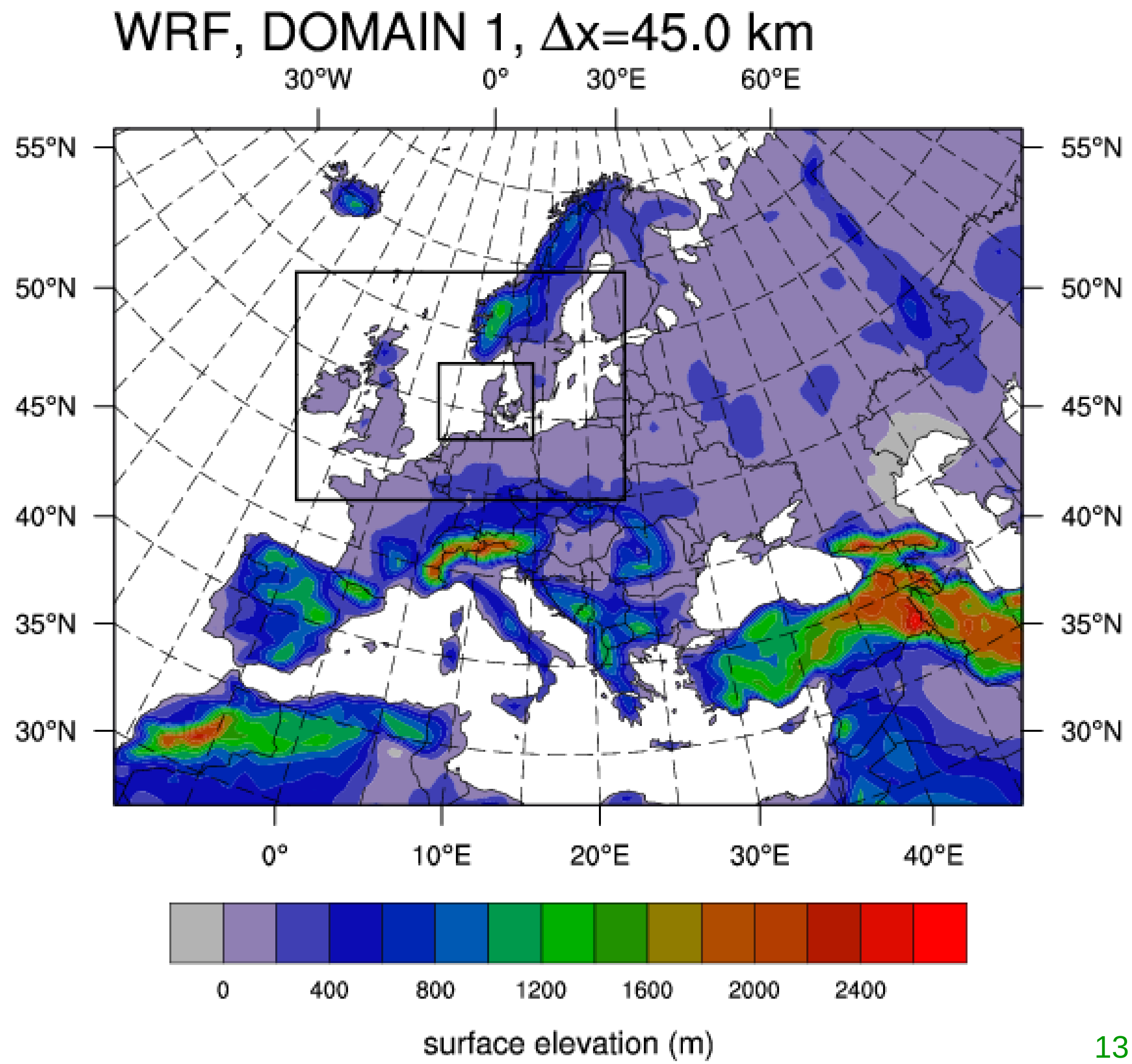




Wind turbine(s) | Wind farm | Power system area

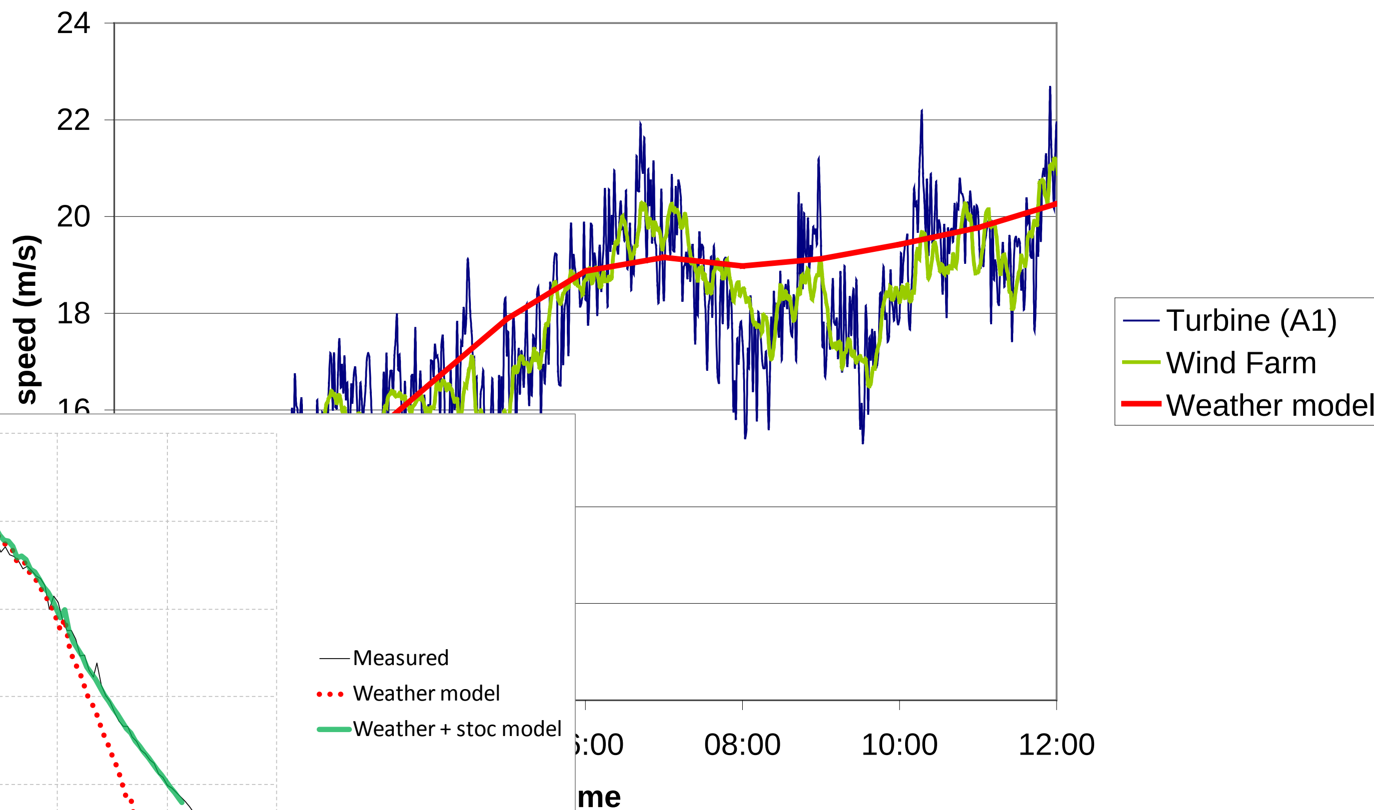
CorWind

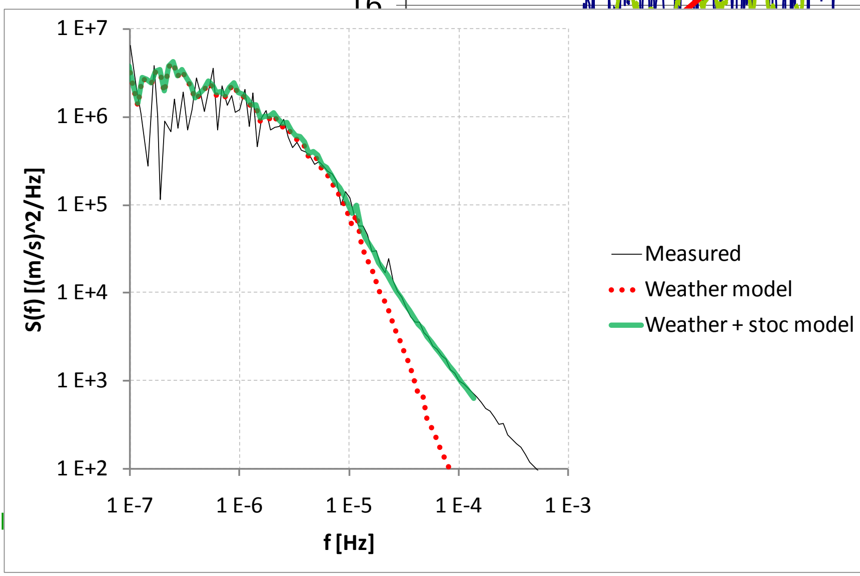
Weather model data to include (hourly) mean wind speed variations



CorWind

Extended geographical area – variable mean wind speed and direction (from weather model)



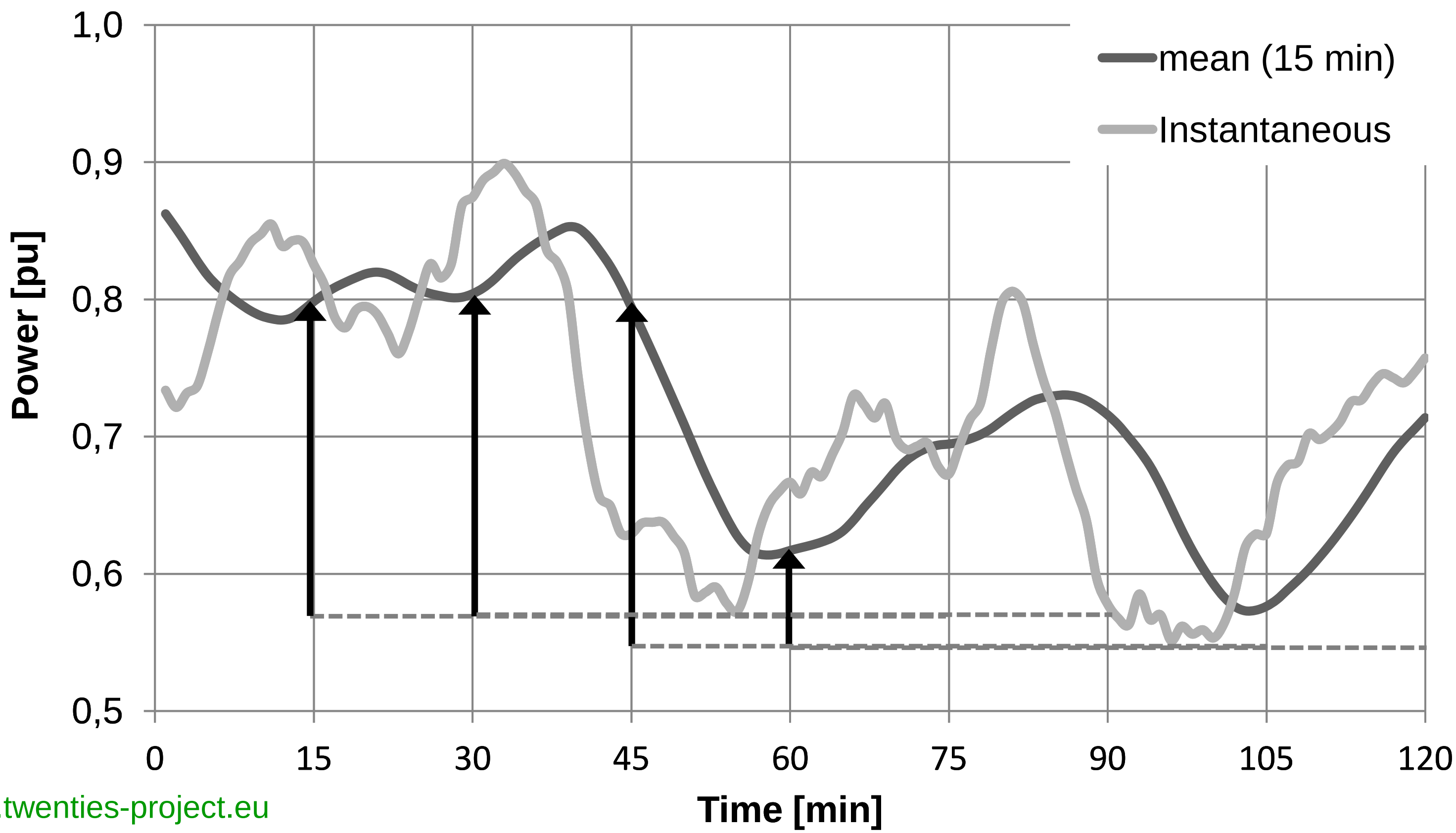


Critical weather periods

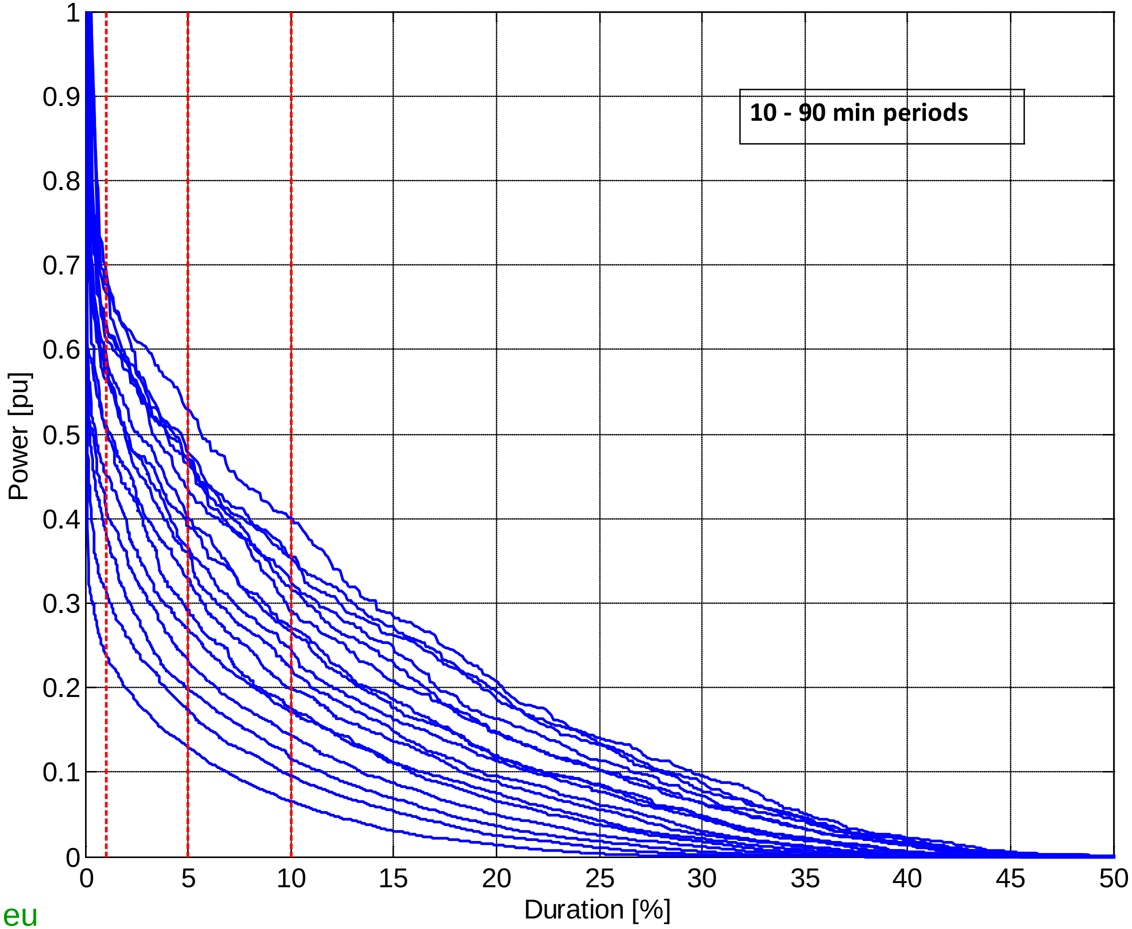
2001	01/01/2001	**2008**	21/03/2008
2005	02/01/2005		13/08/2008
2007	01/01/2007		08/11/2008
	08/01/2007	**2009**	11/06/2009
	18/03/2007		03/10/2009
	27/06/2007	**2010**	11/11/2010
	08/11/2007		07/02/2010
2008	25/01/2008	**2011**	10/03/2011
	27/02/2008		

Reserve Requirements

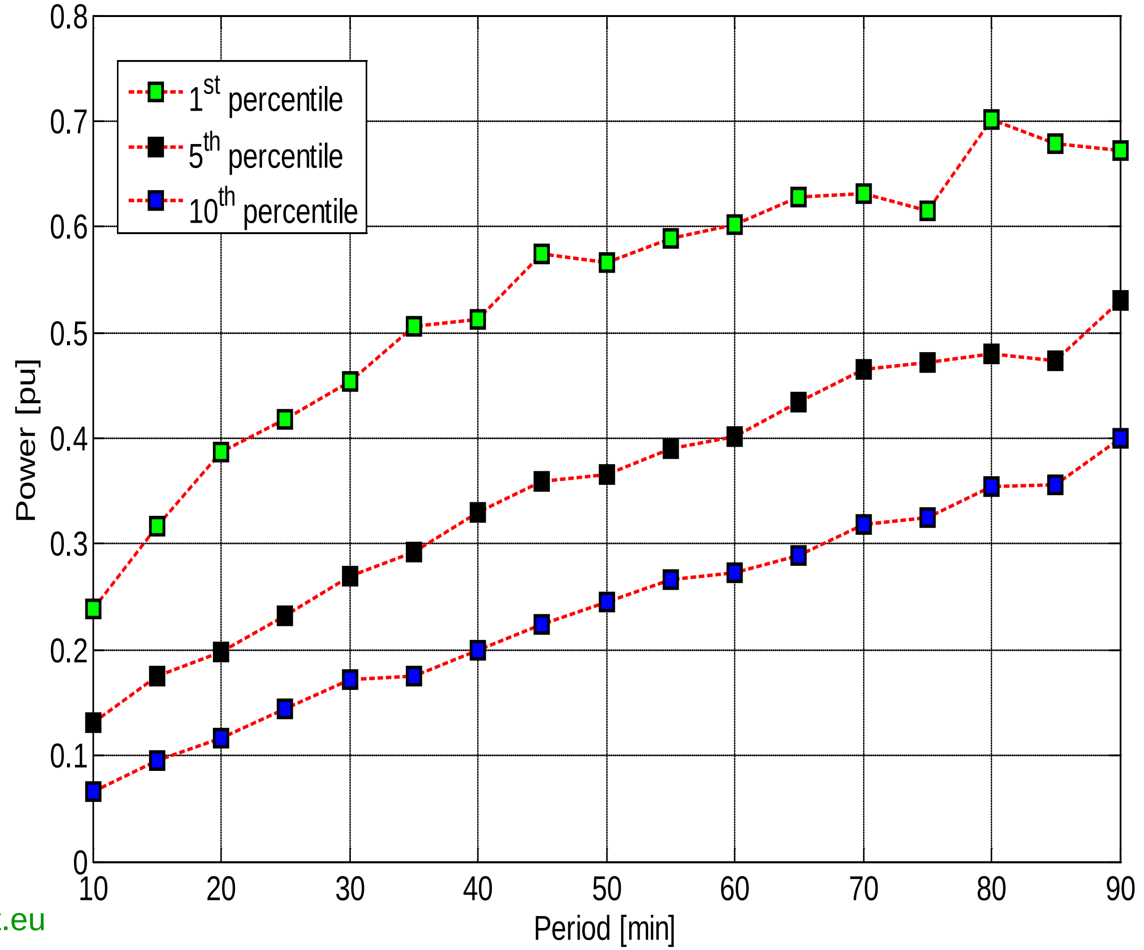
$$P_{\text{res}}(n) = P_{\text{mean}}\left[t(n) - T_{ave}\ ; t(n)\right] - P_{\text{min}}\left[t(n)\,; t\,(n) + T_{win}\right]$$



Results – duration curves



Results – percentiles



Conclusions

- **Offshore wind power development is on an early stage today, and will contribute massively to future European energy supply**
- **Offshore wind power is concentrated in relatively small geographical area, e.g. 50 x 100 km on the West Coast of Denmark**
- **Critical weather conditions can lead to large variations in offshore wind power production**
- **In 2020 scenario, in excess of 2000 MW of wind power can be lost in an hour during critical weather conditions in Denmark**
- **A smoother wind turbine storm control will improve the needs of reserves in the system**
- **TWENTIES project will assess the European impact 2020 and 2030 of planned offshore wind power**

Thank you!

"Unveiling the future energy system:
full scale demonstrations to reach 2020 targets"

TWENTIES Workshop

Room 18, 13:00 – 18:00

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