ClusterDesign & EERA DTOC workshop
Amsterdam, 24 September 2014

EERA Design Tool for Offshore wind farm Cluster (DTOC)

EERA DTOC
THE EUROPEAN ENERGY RESEARCH ALLIANCE
DESIGN TOOLS FOR OFFSHORE WIND FARM CLUSTER

PETER HAUGE MADSEN. Director
Charlotte Hasager. Senior scientist
DTU Wind Energy

Support by

SEVENTH FRAMEWORK PROGRAMME

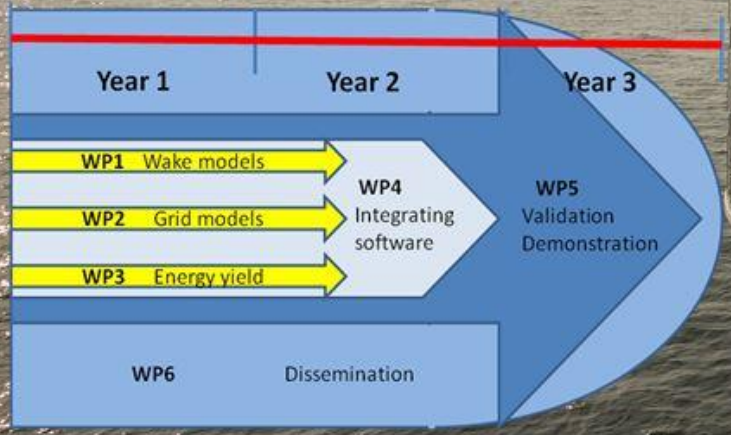
EERA DTOC in a nutshell

EERA-DTOC

European Energy Research Alliance – Design Tools for Offshore Clusters

Charlotte Hasager, Gregor Giebel, Pierre-Elouan Réthoré, EERA Wind members and industry
Contact: cbha@dtu.dk or grgi@dtu.dk, mob +45 4056 5095

Start 1 January 2012, runs for 3.5 years
Total funding is ~4 M€, EU share is 2.9 M€.



Product Vision:

A robust, efficient, easy to use and flexible **tool** created to facilitate the **optimised design of** individual and clusters of **offshore wind farms**.

A keystone of this optimisation is the **precise prediction of** the future long term wind farm **energy yield and** its associated **uncertainty**.

DTU Wind Energy
Department of Wind Energy

www.EERA-DTOC.eu

Risø Campus
Frederiksborgvej 399, P.O. Box 49, Build. 118
DK-4000 Roskilde, Denmark
www.vindenergi.dtu.dk

Project partners

- DTU Wind Energy (former Risø)
- Fraunhofer IWES
- CENER
- ECN
- EWEA
- SINTEF
- ForWind
- CRES
- CIEMAT
- University of Porto
- University of Strathclyde
- Indiana University
- CLS
- Statkraft
- Iberdrola Renovables
- Statoil
- Overspeed
- BARD
- Hexicon
- Carbon Trust
- E.On
- RES

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"Design Tool for Offshore wind farm Clusters" is the first EERA project. EERA is based on national science activities.

EERA – European Energy Research Alliance

Background: The EERA JP Wind Energy was officially launched at the SET-Plan conference in Madrid in June 2010. The strategy and main activities of the JP is described in the "Strategic Action Plan" (yearly updated).

The programme vision is:

- to provide strategic leadership for the scientific–technical medium to long term research
- to support the European Wind Initiative and the Technology Roadmap's activities on wind energy, and on basis of this
- to initiate, coordinate and perform the necessary scientific research.

Joint Programme and Sub-programmes
Wind Conditions. Coordinated by Prof. Erik Lundtang Petersen, DTU Wind Energy (DK)
Aerodynamics. Coordinated by Dr. Peter Eecen, ECN (NL)
Offshore Wind Energy. Coordinated by Dr. John O. Tande, SINTEF (NO)
Grid Integration. Coordinated by Dr. Kurt Rohrig, FhG IWES (DE)
Research Facilities. Coordinated by Dr. Pablo Ayesa Pascual, CENER (ES)
Structural design and materials. Coordinated by Dr. Denja Lekou, CRES (GR)

EERA DTOC funding from EC FP7

Topic ENERGY.2011.2.3-2:
Development of design tools for Offshore Wind farm clusters

Open in call*: *FP7-ENERGY-2011-1
Funding scheme: Collaborative project

- EERA DTOC is 3.5 years: January 2012 to June 2015
- Budget is 4 m€ hereof 2,9 m€ from EC

- Parallel project is ClusterDesign coordinated by 3E

FP7: Expected impact

- To contribute to the SET-Plan on the development of offshore wind power.

- To demonstrate the capability of designing virtual wind power plants composed of wind farms and wind farm clusters while minimizing the negative spatial interactions, improving the overall power quality output and providing confidence in energy yield predictions.

ENERGY.2011.2.3-2: Call objective

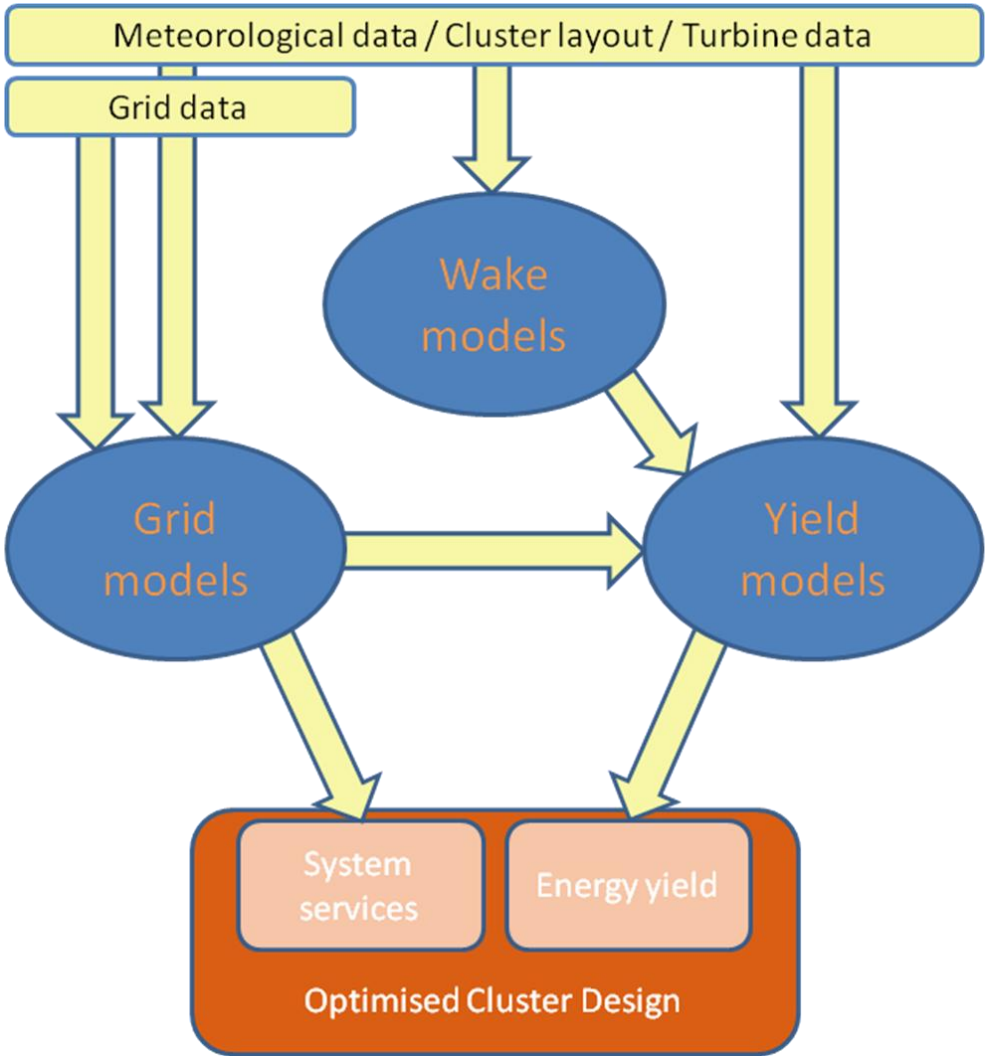
The objective of this topic is to develop new **design tools** to optimise the exploitation of individual wind farms as well as wind farm clusters, in view of transforming them into virtual power plants.

Such design tools should integrate:

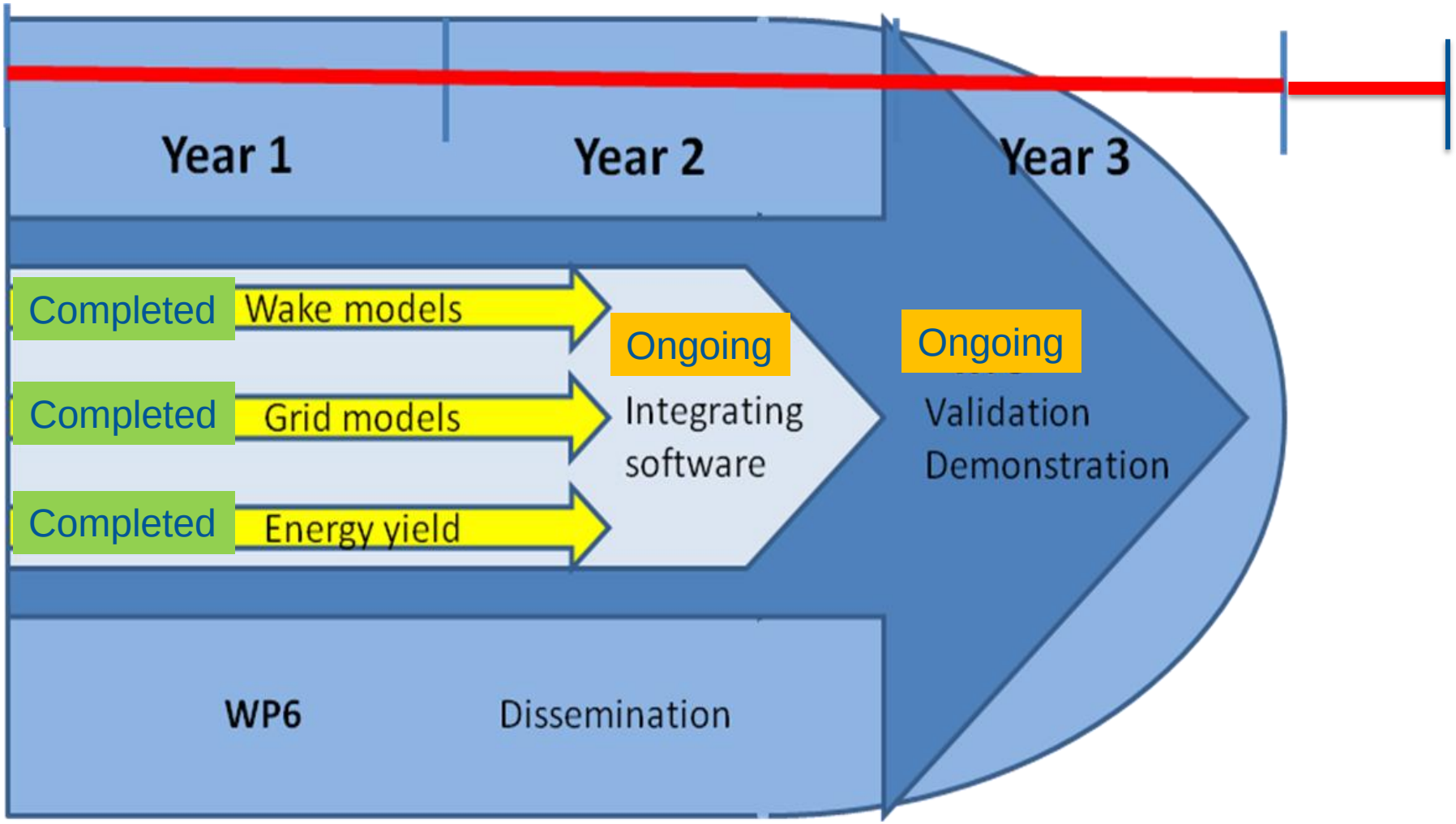
- Spatial modelling: medium (within wind farms) to long distance (between wind farms) **wake effects**
- **Interconnection optimisation**: to satisfy grid connection requirements and provide power plant system service.
- **Precise energy yield** prediction: to ease investment decisions based on accurate simulations

The project should focus on offshore wind power systems and **make optimal use of previously developed models**.

EERA DTOC concept



WP structure



WP4/5 progress in detail

Integrating software

- Selecting software – done
- Defining interfaces and links – done
- Implementation – ongoing
- Internal testing - ongoing

Validation and demonstration

- Scenario definitions – done
- Set up scenario runs – ongoing
- Demonstration completed (early 2015)

Demonstration

- Validation of wake models based on:

Validation

- ❖ scanning lidar data and ship-based lidar near Alpha Ventus (ongoing)
- ❖ satellite data at more than 10 wind farms in the North Sea (ongoing)
- ❖ SCADA data from Lillgrund and Rødsand-2 in the Baltic Sea (ongoing)

EERA DTOC main components

- Use and bring together existing models from the partners
- Develop open interfaces between them
- Implement a shell to integrate
- Fine-tune the wake models using dedicated measurements
- Validate final tool

EERA DTOC portfolio of models

Name	Partner	Status	Programs	Input/ output	Script/ GUI	Database interface	IPR	Com
CFDWake	CENER		Fluent, C++, OpenFOAM	ASCII	script	Yes		
CorWind	Risoe DTU	Ope	DOS exe Delphi	CSV files	no	no	+	+
CRES-farm	CRES	Ope	Linux/ Fortran77	ASCII	no	no	+	
CRES--flowNS	CRES	Ope	Linux/ Fortran77	ASCII	no	no		
DWM	Risoe DTU	Ope	Fortran, pc, pc-cluster	ASCII	script		+	
ECNS	ECN	Beta	Linux/ Fortran90	ASCII	No	No	+	
EeFarm	ECN	Alpha	Matlab	Matlab scripts	Script/ GUI	yes	+	+
Farm-farm interaction	ECN	Ope	Fortran	ASCII	No	no	+	
FarmFlow	ECN	Ope	Delphi	ASCII/ binary	GUI	Yes	+	+
FlowARSM	CRES	Alpha	Linux/ Fortran77	ASCII	no	no		
FUGA	Risoe DTU	Ope	Fortran, C, Delphi, pc	ASCII	Script/ GUI	No	+	
NET-OP	SINTEF	Proto type	Matlab	ASCII	script	No	+	
Skiron/WAM	CENER	Ope	Unix/ Fortran	GRIB	script	yes		
TOPFARM	Risoe DTU	Beta	Matlab/C/ Fortran	ASCII	script		+	
UAEP	Risoe DTU		Matlab, pc	ASCII/ binary	no	yes		
VENTOS	UPorto	Beta	Unix/ Fortran	ASCII	no	yes	+	+
WAsP	Risoe DTU	Ope	Windows pc	ASCII	Script/ GUI	No	+	+
WCMS	Fraunhofer	Ope	Matlab/JAVA	OracleDB		yes	+	
WRF	Risoe DTU	Ope	Unix, Linux, Fortran90	netCDF	Shell script	yes		
WRF/ROMS	CIEMAT	Ope	Linux/ Fortran	netCDF	script	yes	+	

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Run on Windows, on a single PC

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Runs on Cluster under UNIX/Linux

User Requirements

EERA DTOC vision

- A **robust, efficient, easy to use** and flexible tool created to facilitate the **optimised design** of individual and clusters of offshore wind farms.

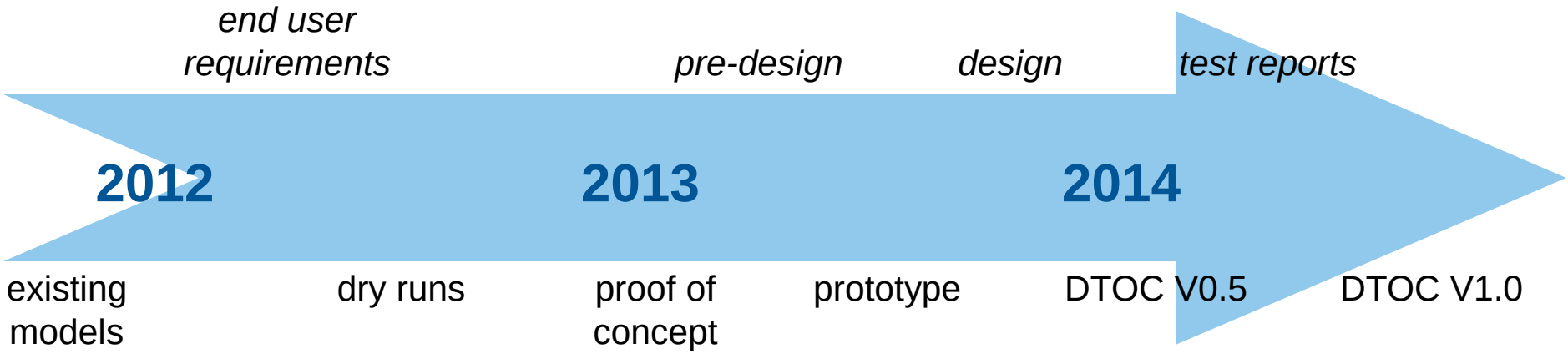
- A keystone of this optimisation is the precise prediction of the future **long term wind farm energy yield** and its associated uncertainty.

Open interfaces

- The sub-models are protected by IPR…
- …but the interfaces in the model chain are going to be open

- File formats for data exchange are based on existing industry standard formats, e.g. the WAsP types based on XML and ESRI shape file standard

DTOC software development timeline



Validation and demonstration

Data needs

SCADA wind farm data (see next slide)
Electrical grid cost
Wind turbine parameters (INNWIND, AVATAR, NREL, WAsP)

Data from wind farms

- Horns Rev 1 SCADA data comparing to nine wake models (completed)
- Lillgrund SCADA data comparing to ten wake models (completed)
- Rødsand-2 SCADA data comparing to several wake models (ongoing)

SCADA data stays at DTU (Kurt S. Hansen)

- Alpha ventus SCADA data comparing long-range scanning wind lidar, ship-based wind lidar wind, FINO-1 met mast several wake models (ongoing) comparing to several wake models (ongoing)

SCADA data stays at ForWind

- Satellite SAR from more than 10 large offfshore wind farms comparison qualitative to several wake models (ongoing)

(No SCADA data)

Industry partners are very important!

Iberdrola, Statoil, Carbon Trust, Hexicon, Statkraft, E.On, RES

Support by

EERA DTOC project
FP7-ENERGY-2011-1/ n°282797