EERA research programme on wind energy and the offshore challenges

Trondheim, EERA DeepWind' 2016

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www.eera-set.eu

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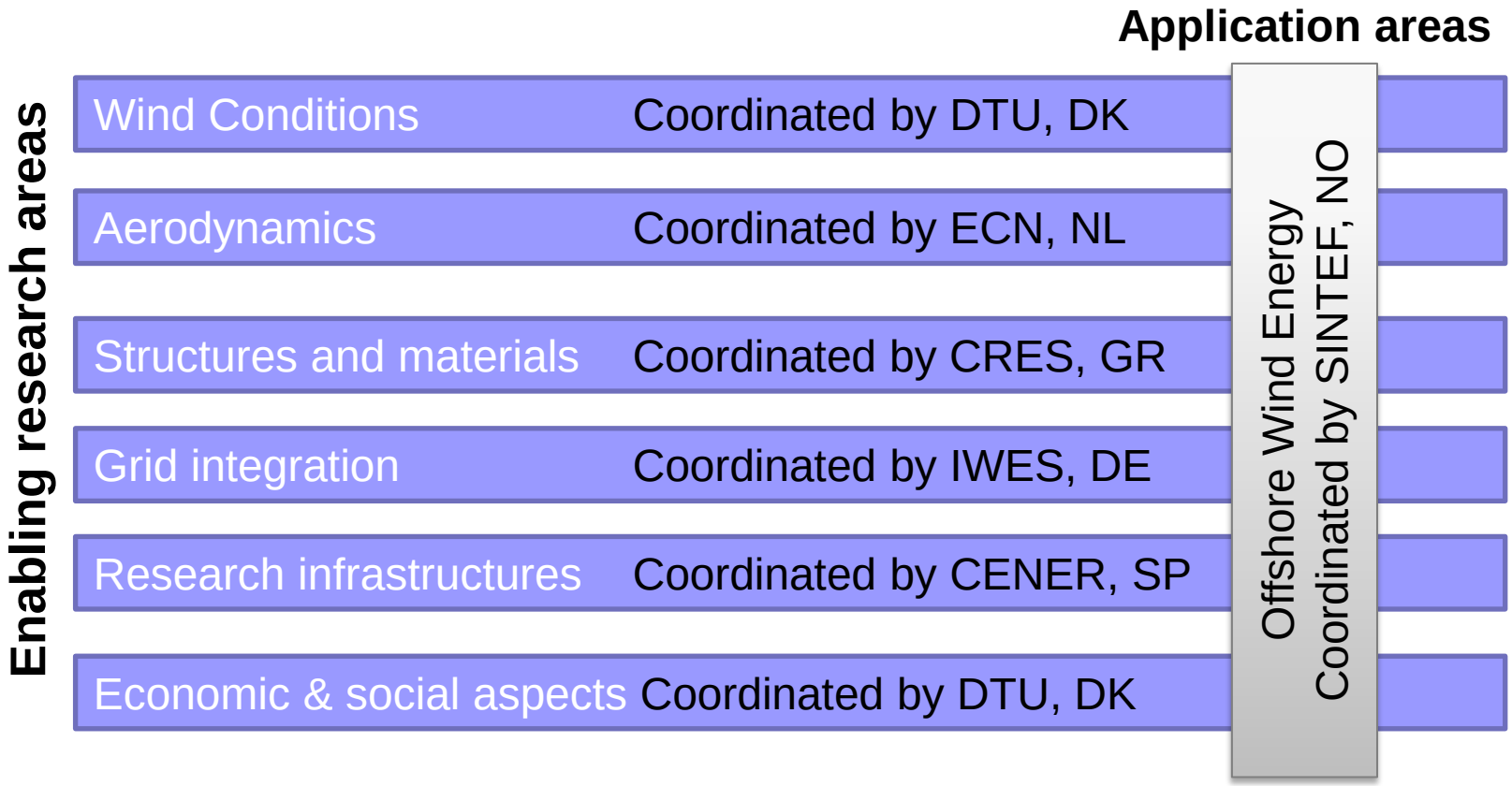
http://setis.ec.europa.eu/

EERA JPWIND and IRPWIND

- The vision of the EERA Joint Programme for Wind Energy is to move from a voluntary network of research organisations towards a “virtual research centre” running an Joint Research Programme and help develop a common European Research Area.
- JPWind started in 2010 on a voluntary basis. Since then activities and the number of members have grown substantially.
- In March 2014 the Integrated Research Programme scheme co-funded by the European Commission called “IRPWIND” was started.
- **IRPWIND is designed to take EERA JP Wind to the next level towards creating a European Integrated Research Programme on wind energy and comprises both CSA and research components**

EERA JP WIND structure and sub-programmes



New pilot programme on cold climate in the making

EERA JP WIND Members

Full participants		Associated Participants	
DTU Wind Energy	DK	DHI, University of Aalborg, Dublin(IR)	DK
ECN	NL	TU Delft, WMC	NL
SINTEF	NO	NTNU, IFE, UoB, CMR MARINTEK, Sintef MC	NO
CRES	GR	NKUA	GR
CENER	ES	CIEMAT, IREC, CTC, CIRCE, Tecnalia, IK4 Alliance	ES
Fraunhofer IWES	GER	IEN (PO), DLR, TU München	GER
Forwind - University of Oldenburg	GER	Forwind Hannover, Uni. of Stuttgart, RWTH Aachen	GER
LNEG	POR	University of Porto	POR
VTT	FI		
TUBITAK	TU	METUWIND	
University of Strachclyde	UK	NAREC, Loughborough Uni.	UK
CNR	IT	POLIMI, RSE	IT
Belgian Energy Research Alliance	BE		
EPFL	CH		

14 full participants & 30 associated participants from 14 countries.
Applicants in process: NTUA (GR), TNO (NL), UCC (IR)

IRPWIND objectives

- The aim of EERA and the IRPWIND is to foster **better integration of European research activities in the field of wind energy research** with the aim to accelerate the transition towards a low-carbon economy and maintain and increase European competitiveness.

- The IRPWIND is expected to both benefit existing priority settings as well as to improve the quality and implementation of future priority settings through **the coordinating effect on the research communities**.

- An objective is to **integrate the various capacities and resources in the joint research activities** described in this IRP- with other ongoing European and National projects carried out by IRPWIND partners and/or other EERA JP Wind members.

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IRPWIND – what it's all about?

IRPWind

Integration, coordination and alignment (as well as R&D)

- Strategic level (ETIP, EERA Wind Strategy, National strategies)
- Operational level
  - Integration of activities (EERA DoW, workshops, IRPWIND mobility scheme)
  - New joint activities (ERA NET+, Berlin model, ad hoc)
- Transparency – who does what, national programmes
- Complete research programme

Towards a European Wind Energy Programme and a virtual research institute based on national and European activities

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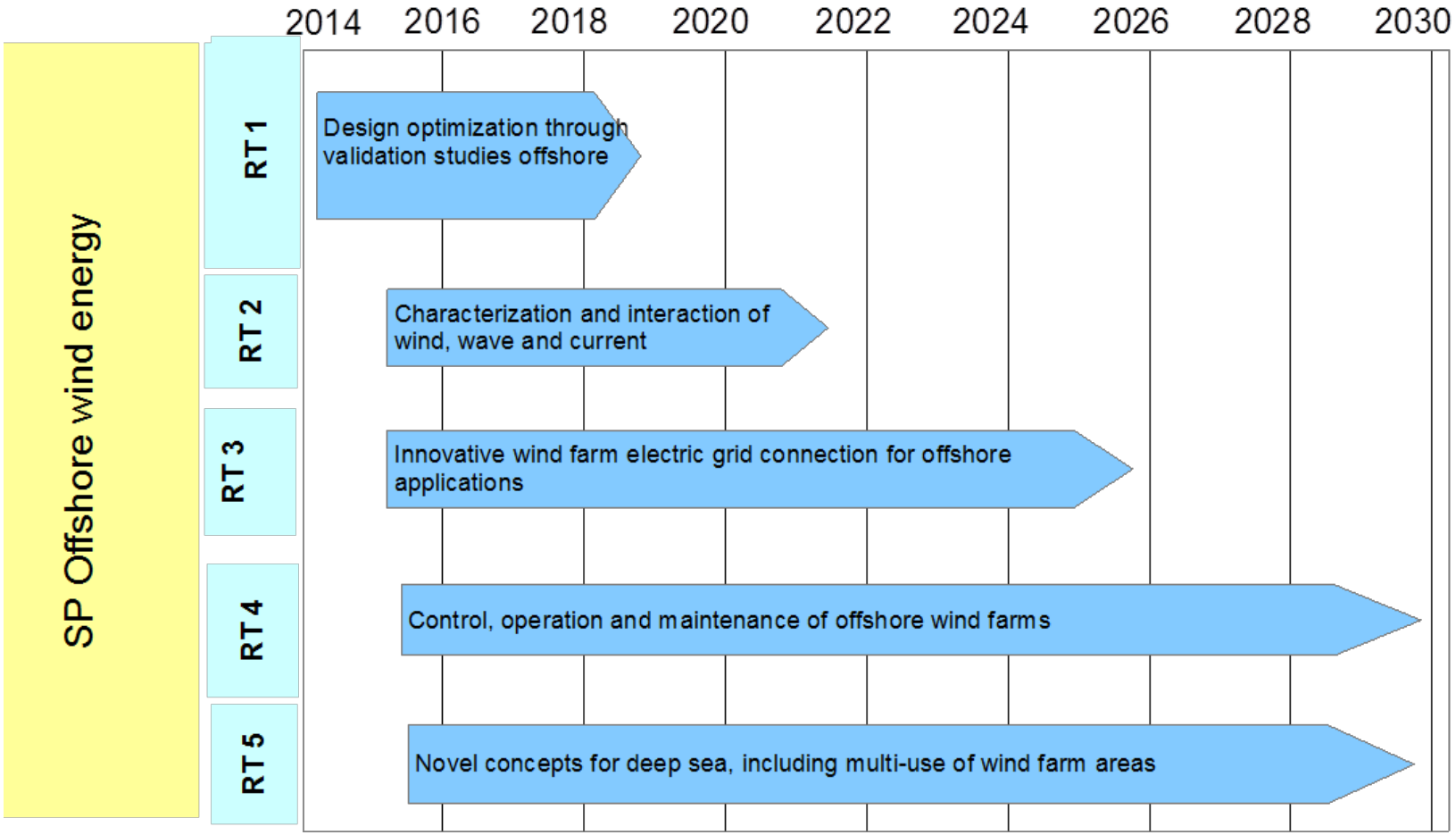
EERA Wind Energy R&D Strategy

Example– Offshore sub-programme Roadmap and priorities

IRPWind



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IRPWIND mobility

- A very concrete way of facilitating more integration of national activities
  - **Flexible and non-bureaucratic** programme:

  Mobility scheme of 2 to 4 weeks for IRP Wind and EERA Managers.

  Mobility scheme of 4 to 26 weeks for all scientists.

  - 4 yearly cycles of calls

- Basic idea: Travelling researcher bring own project which are "related to" similar project at the hosting institution

The fourth call is now open with a deadline on 31 January 2016.

- Report: each report such provide input to the overall reporting of the IRP and possibly also be presented at the yearly event.

- Application: The mobility programme is **open for all** EERA JPWIND partners.

- **16 researchers** have until made use of the programme and we have room for more mobility applicants.

IRPWIND: Research Infrastructure

Key activities in 2015:

- Network creation:
- Research Wind Turbines
- Wind Tunnels
- Grid integration

- Mapping of existing Research Infrastructure in Europe

Upcoming activities:

- Call for joint experiments
  - Subjects for the call for experiments will be research wind turbines, wind tunnels and grid integration.
  - The call will be open to all EERA JP WIND members and will be issued no later than February 2016.
  - The call is supported by the criteria in the document on “Rules & Conditions for joint experiments” elaborated in the IRPWIND work package on Research Infrastructure.
  - **Total budget**: 850.000€ - to be split between to calls and among 3 types of experiments.
  - **Reference budget per experiment:** 150.000€

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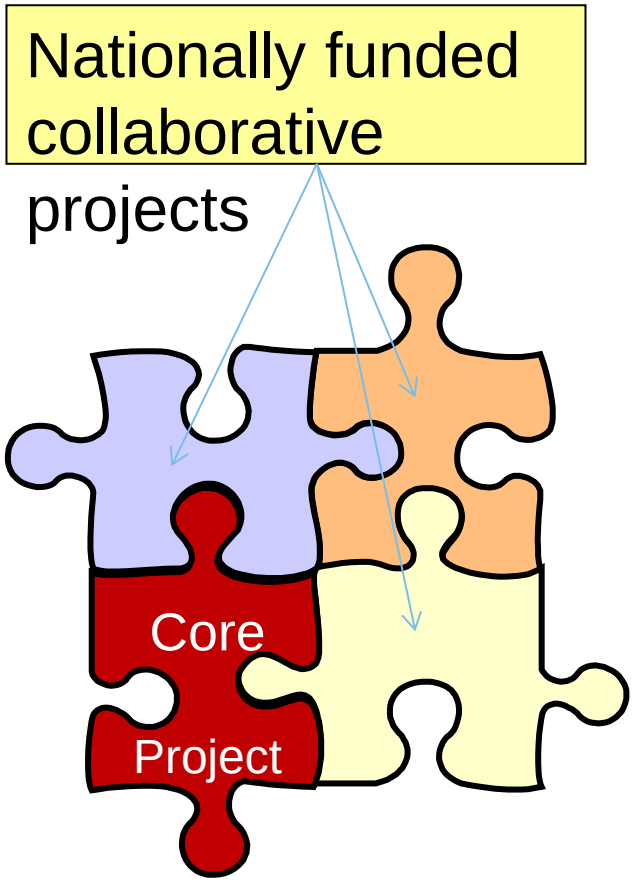
IRPWIND core research projects

IRPWind

WP 6: **Design of offshore wind farms**

WP 7: **Improved & validated Structural Reliability**

WP 8: **European-wide measures and structures for a large-scale wind energy integration**



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IRPWIND WP6: Design of offshore wind farms

WP	Lead	PM	Start	End
WP6.1: Data assimilation	Hannover	46.0	12	36
WP6.2: Benchmark of models	CENER	105.5	1	36
WP6.3: Model development	Strathclyde	97.0	12	48

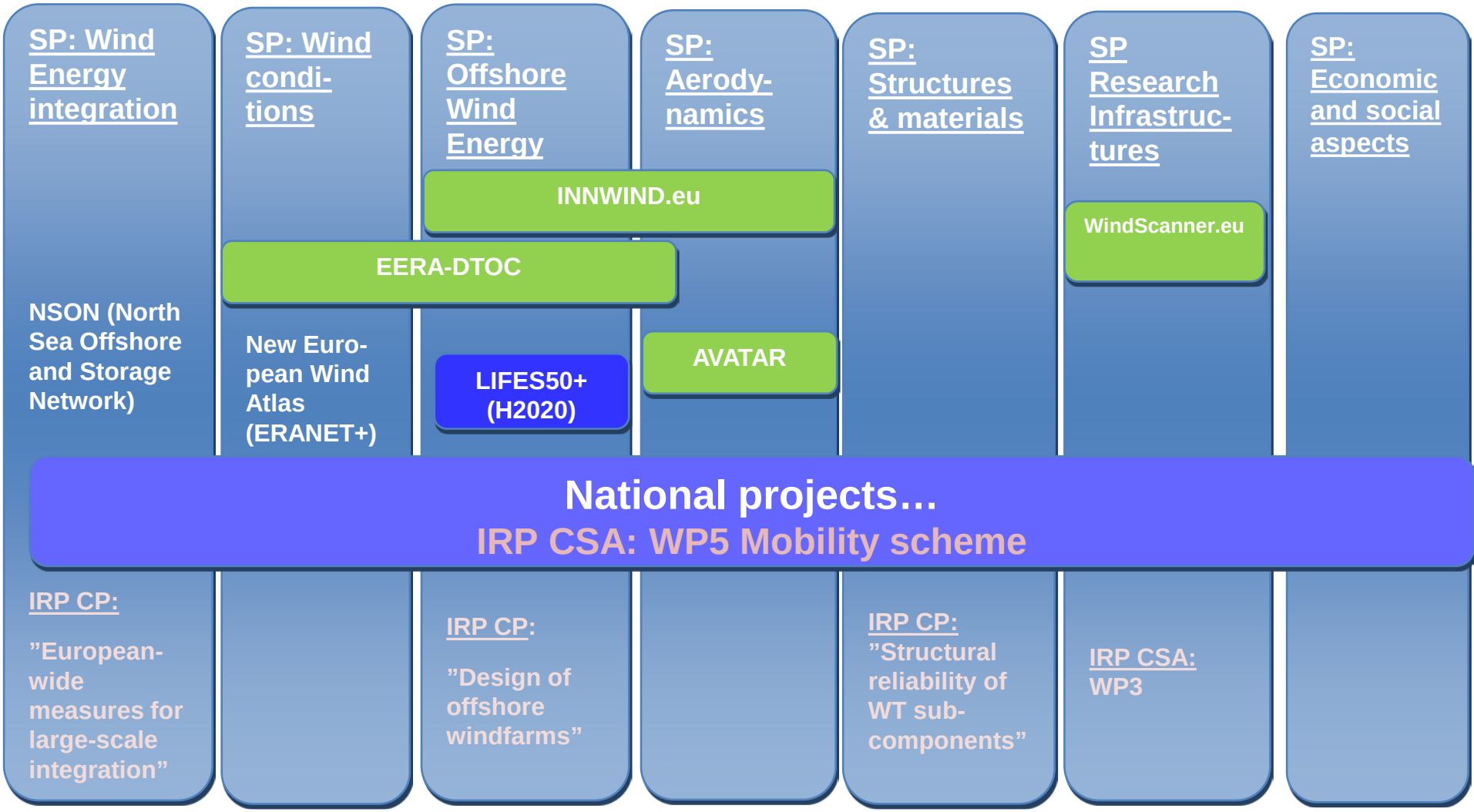
Participants

- ✓ DTU Wind Energy
- ✓ CRES
- ✓ ECN
- ✓ SINTEF Energy Research (WP lead)
- ✓ CENER
- ✓ NTNU
- ✓ University of Strathclyde
- ✓ Tecnalia
- ✓ ForWind – Oldenburg & Hannover
- ✓ MARINTEK

Objective

to accelerate the design optimization of wind turbines and support structures for offshore wind farms, through validation of integrated design models, and subsequent development of methods and design criteria

The EERA JP Wind project portfolio (with and without IRPWIND)



IRPWIND WP6:
Results providing basis for value creation

- **Database of measurements from offshore wind farms, both bottom-fixed and floating, and also from relevant lab-scale experiments. IRPwind will provide open data.**
- **Development of a benchmark validation procedure and an inventory of validation test cases.**
- **Implementation of a web-based European platform for the management of model benchmarking activities.**
- **Integrated design tools and guidelines taking into account loads, control and grid support, on turbine and wind farm level, providing reduced uncertainties and reduced cost of energy.**
- **Investigation of new control systems, at the turbine level and the farm level, providing additional protection to individual turbines and enabling optimized wind farm operation minimizing the cost of energy.**

IRPwind WP6:
Design of offshore wind farms

Status (cont.)

- ✓ Activities are coordinated with EERA SP offshore wind energy
- ✓ Sharing knowledge for joint benefits and efficient use of resources through expert workshops and conferences
- ✓ Preparation of strategy aligning with national and EU priorities
- ✓ Joint national and EU projects
  - ABYSS (DK-NO), kick-off 2014
  - NSON (NO-UK-DE), kick-off 2014
  - EERA DTOC, kick-off 2012
  - EERA InnWind, kick-off 2013
  - EERA IRPWind, kick-off 2014
  - LIFE50+, kick-off 2015
  - COWIND, FME application (NO)

Offshore milestones in 2016

IRPWind

Mile-stone	Description
M1	EERA DeepWind R&D Offshore Wind Conference: EERA partners will contribute in total to about 50 oral and 50 posters, and approx. 30 papers from the conference will go through peer-review and be published in Energy Procedia
M2	Benchmarks scheduled and launched; IRPwind milestone MS22
M3	Data in database for benchmark exercise; IRPwind milestone MS20

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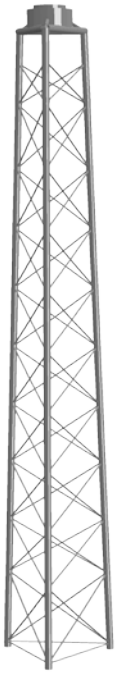
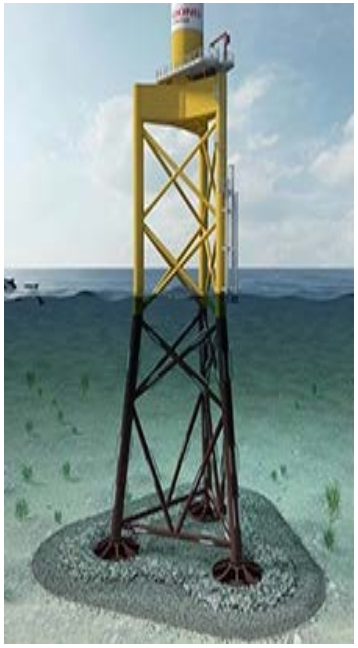
Innovative Support Structures

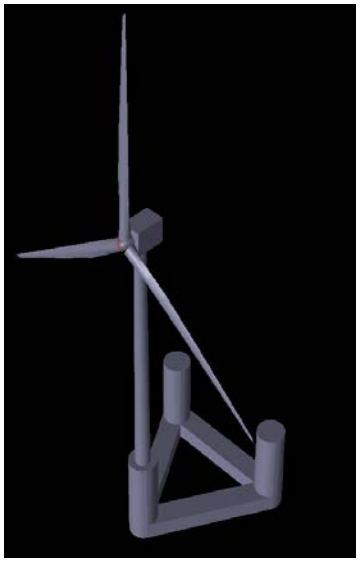
Innovative Jackets





Three legged frame structures, also as a full length structure to the nacelle or for legged structures with vibration absorption devices

Floating Solutions

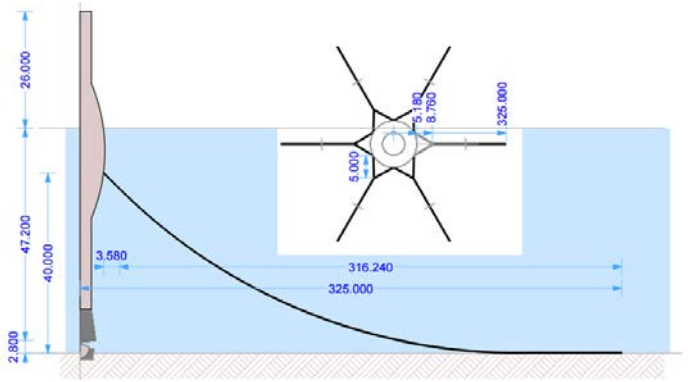


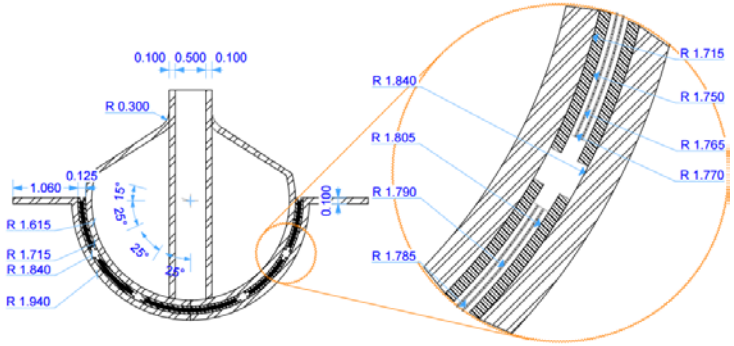
Guyed Tower with buoyancy and ballast chambers and Semi Submersible designed for a 10 MW wind turbine.

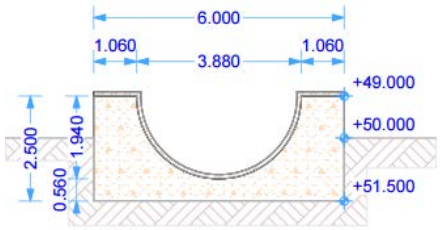
An Innovative Support Concept

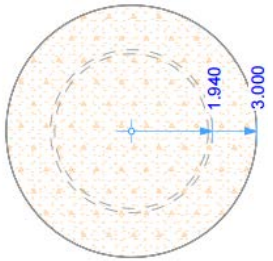
2 Bladed rotor on a Semi-floating platform:

- Jointed to the seabed
- Buoyancy chamber
- Mooring lines
- Avoid 2p, 4p excitation



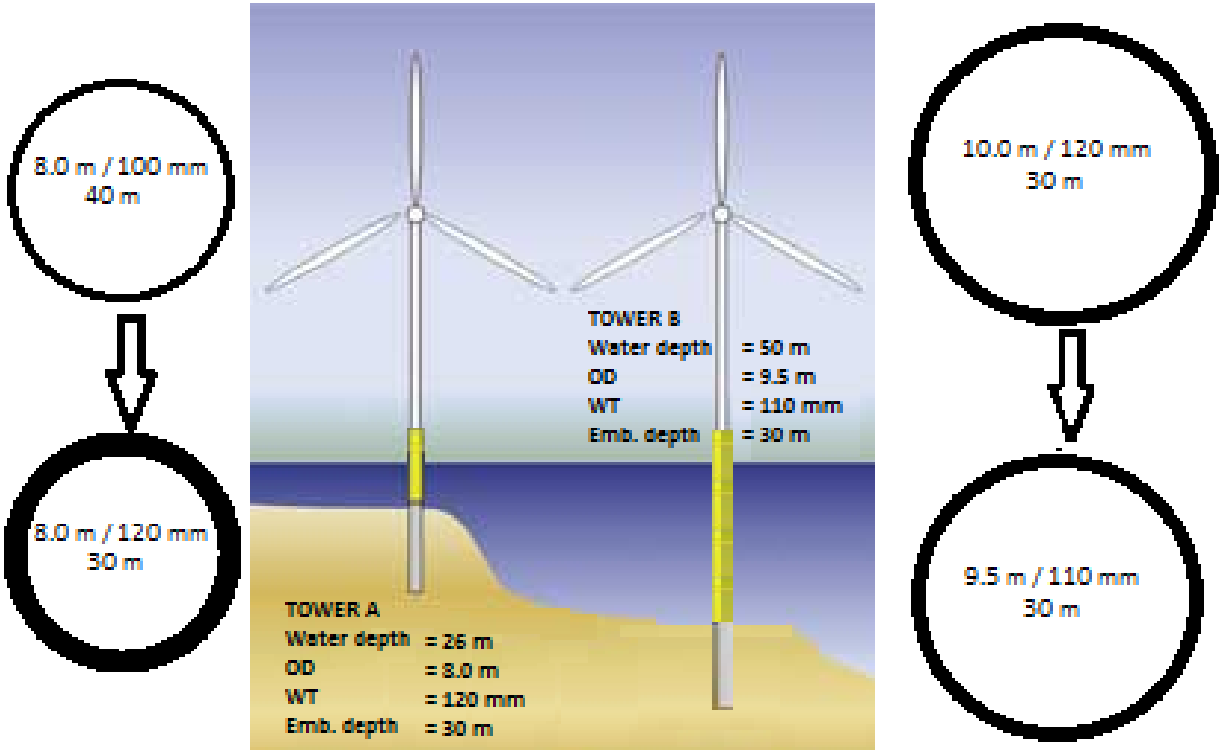






Monopiles at 50m water depth!

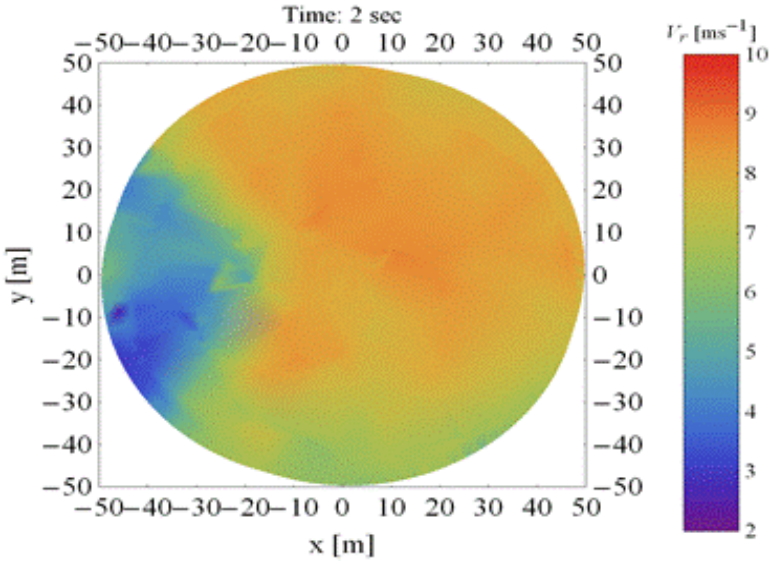
MONOPILE for the DTU 10 MW Reference turbine



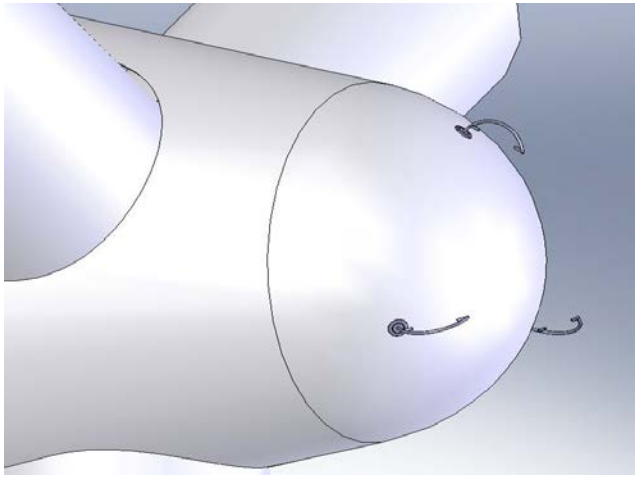
2700 tons

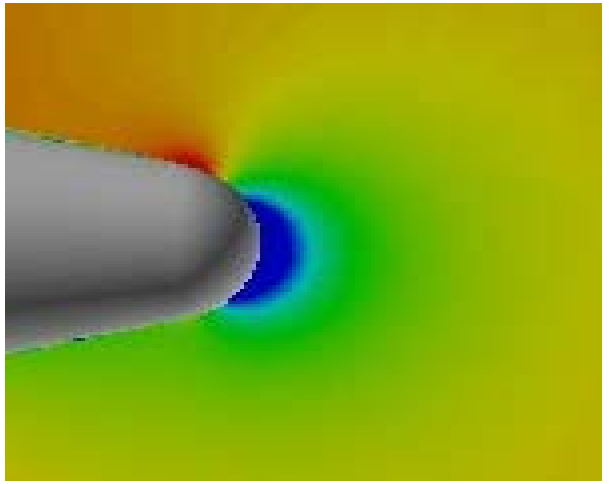
Wind Measurements for Controls

Spinner LIDAR



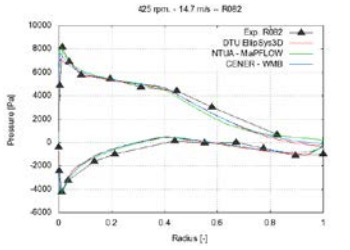
Spinner Anemometer

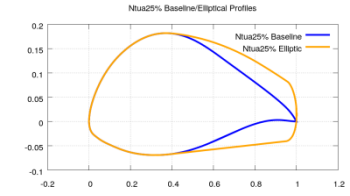


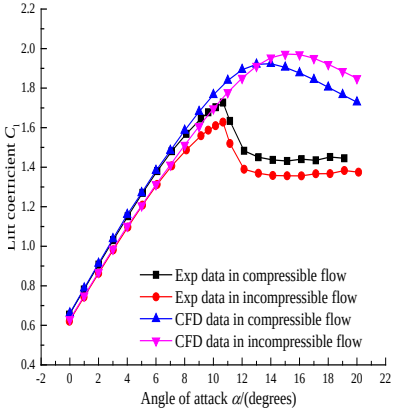


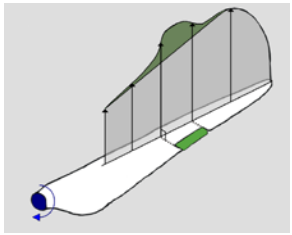
Advanced Blades

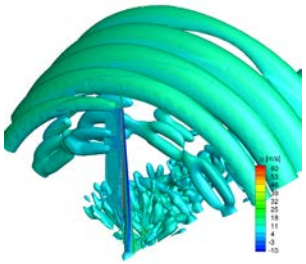
- Reynolds no. and compressibility effects separated
- Blade add-ons validated, spoilers, serrations, Gurney flaps
- Design of 2-bladed rotor, Low induction
- Bend-twist coupled RWT blade+ IPC+stretched = load and cost reduction
- New blade structure, truss, grid stiffeners,
- Scaled blade with BT coupling, wind tunnel test

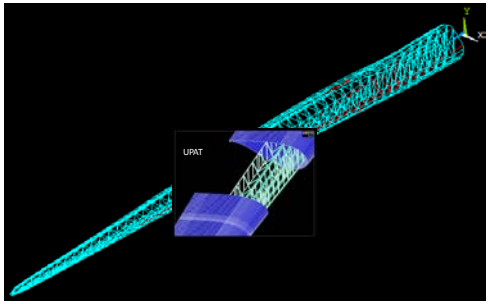


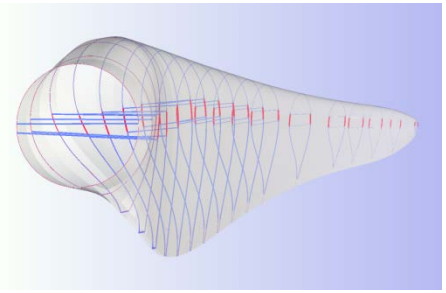




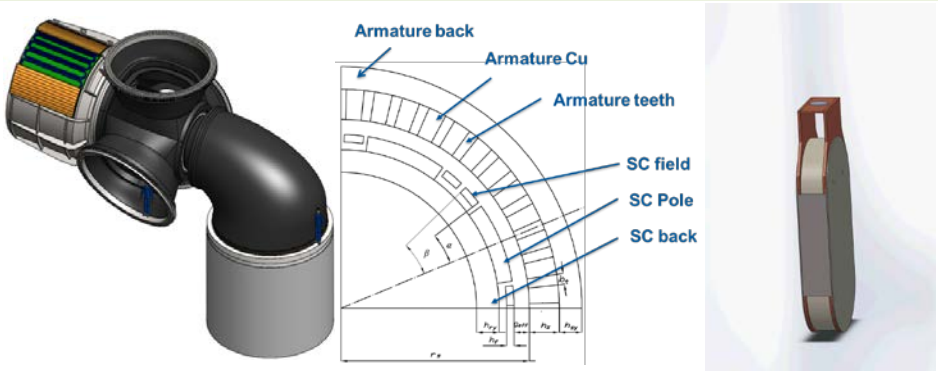








Direct Drive SC and PDD

CONCEPT	BRIEF DESCRIPTION	
DRIVE TRAIN		
Superconducting Generator	Two SC generator options are considered, the MgB_2 option and the RBCO one. The high price for the RBCO tape is indicating that MgB2 is most likely the fastest technology to be implemented bur RBCO is considered to become the cheapest technology in the long run.	
PDD Generator	The magnetic pseudo direct-drive (PDD) generator is realizing the possibility of applying magnetic gears in wind turbines. In a PDD generator, the magnetic gear and the electrical generator are mechanically as well as magnetically integrated.	

Synthesis

ROTOR	Component Mass (Δ%)	Component Cost (Δ%)	Overall CAPEX (Δ%)	Turbine CF (Δ%)	Wind Farm CF (Δ%)	LCOE (Δ%)
Low Induction Rotor	7.9%	15.4%	3.8%	7.5%	9.1%	-6.0%
Two-Bladed Rotor R1.08	-20.9%	-19.4%	-1.6%	4.7%	4.7%	-5.3%
Two-Bladed Rotor R1.12	-4.1%	-4.0%	-0.3%	8.3%	8.1%	-7.6%
Smart Rotor (Flaps)	-10.7%	-6.5%	-0.5%	0.2%	0.2%	-0.5%
Carbon Truss Blade Structure	-25.7%	-13.2%	-0.9%	0.0%	0.0%	-0.6%
Bend-Twist Coupled Rotor	-2.0%	-2.0%	-1.2%	0.0%	0.0%	-0.8%
Integrated BTC with IPC	18.4%	18.5%	1.0%	7.5%	7.2%	-6.1%
DRIVE TRAIN & NACELLE	Component Mass (Δ%)	Component Cost (Δ%)	Overall CAPEX (Δ%)	Turbine CF (Δ%)	Wind Farm CF (Δ%)	LCOE (Δ%)
SC MgB2-CSI Generator	47.2%	2.8%	0.7%	0.8%	0.7%	-0.4%
PDD Generator	2.5%	-13.1%	-3.0%	1.4%	1.2%	-3.2%
OFFSHORE SUPPORT STRUCT	Component Mass (Δ%)	Component Cost (Δ%)	Overall CAPEX (Δ%)	Turbine CF (Δ%)	Wind Farm CF (Δ%)	LCOE (Δ%)
Bottom-Mounted OSS		-14.7%	-4.5%			-3.0%
Semi-Sub Floater Design	95.1%	32.0%	9.8%			6.5%
Semi-Floater Concept		-34.8%	-10.6%			-7.0%
COMBINATIONS			Overall CAPEX (Δ%)	Turbine CF (Δ%)	Wind Farm CF (Δ%)	LCOE (Δ%)
LIR + PDD + Adv. Jacket			-4.4%	8.3%	10.0%	-11.5%
2B R1.12+PDD+Adv.Jacket			-9.5%	9.1%	9.1%	-13.0%
BTC/ITC+ PDD + Adv. Jacket			-6.5%	8.9%	8.4%	-10.8%

IRPWind

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Thank you and enjoy the conference!

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