

Status og perspektiver for norsk og internasjonal utvikling av offshore vindkraft

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Sammendrag

- ✓ Det vil bli gitt en status for internasjonal utvikling av offshore vindkraft, med oversikt over teknologi, marked og utfordringer.
- ✓ Det vil pekes på muligheter og perspektiver spesielt for norske aktører, både som utbyggere og leverandører av varer og tjenester.
- ✓ NOWITECH, Norwegian Research Centre for Offshore Wind Technology, som er et Forskningscenter for Miljøvennlig Energi (FME) etablert av Forskningsrådet vil presenteres med eksempler på resultat som kan bidra til verdiskapning og redusert kostnad for offshore vindkraft.
- ✓ Aktivitet i den europeiske teknologiplattformen for vindkraft TPwind og i den europeiske forskningsalliansen for vindkraft EERA JPwind vil presenteres.

NOWITECH in brief

- ▶ A joint pre-competitive research effort
- ▶ Focus on deep offshore wind technology (+30 m)
- ▶ Budget (2009-2017) EUR 40 millions
- ▶ Co-financed by the Research Council of Norway, industry and research partners
- ▶ 25 PhD/post doc grants
- ▶ **Key target: innovations reducing cost of energy from offshore wind**
- ▶ Vision:
 - large scale deployment
 - internationally leading

Research partners:

- ▶ SINTEF ER (host)
- ▶ IFE
- ▶ NTNU
- ▶ MARINTEK
- ▶ SINTEF ICT
- ▶ SINTEF MC

Industry partners:

- ▶ CD-adapco
- ▶ DNV GL
- ▶ DONG Energy
- ▶ EDF
- ▶ Fedem Technology
- ▶ Fugro OCEANOR (TBC)
- ▶ Kongsberg Maritime
- ▶ Rolls Royce SmartMotor
- ▶ Statkraft
- ▶ Statnett
- ▶ Statoil

Associated research partners:

- ▶ DTU Wind Energy
- ▶ Michigan Tech Uni.
- ▶ MIT
- ▶ NREL
- ▶ Fraunhofer IWES
- ▶ Uni. Strathclyde
- ▶ TU Delft
- ▶ Nanyang TU

Associated industry partners:

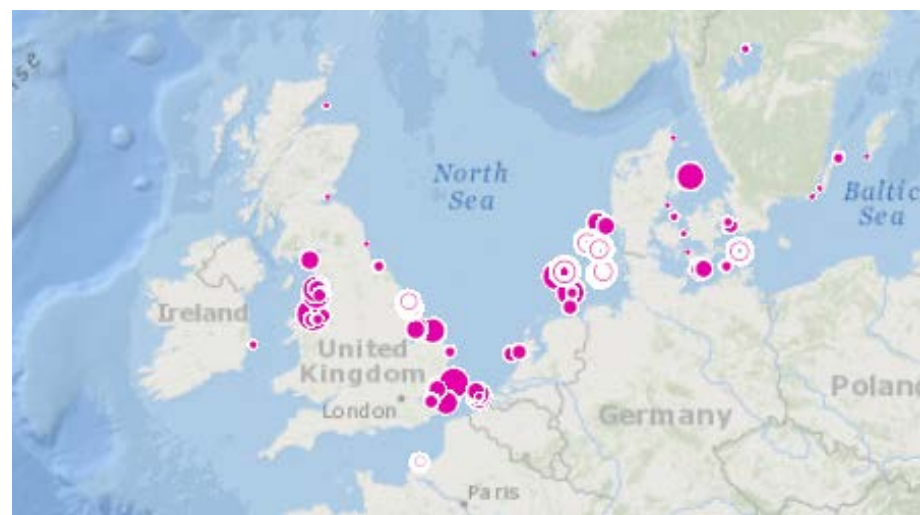
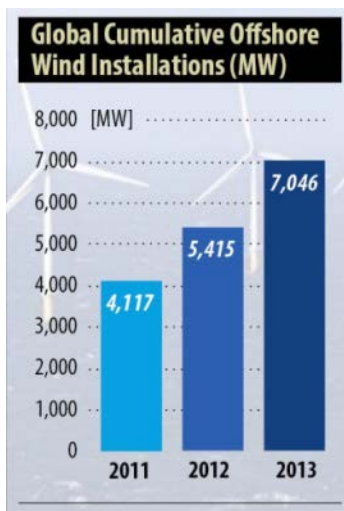
- ▶ Devold AMT AS
- ▶ Energy Norway
- ▶ Enova
- ▶ Innovation Norway
- ▶ NCEI
- ▶ NORWEA
- ▶ NVE
- ▶ Wind Cluster Mid-Norway

Offshore wind technology

Development at an early stage, but in strong progress and with huge potential



Horns Rev 1 wind farm
(160 MW built in 2002)



Operating offshore wind capacity (2013):
6.5 GW in Europe + 0.5 GW in Asia
EWEA goal is 40 GW (2020) and 150 GW (2030)

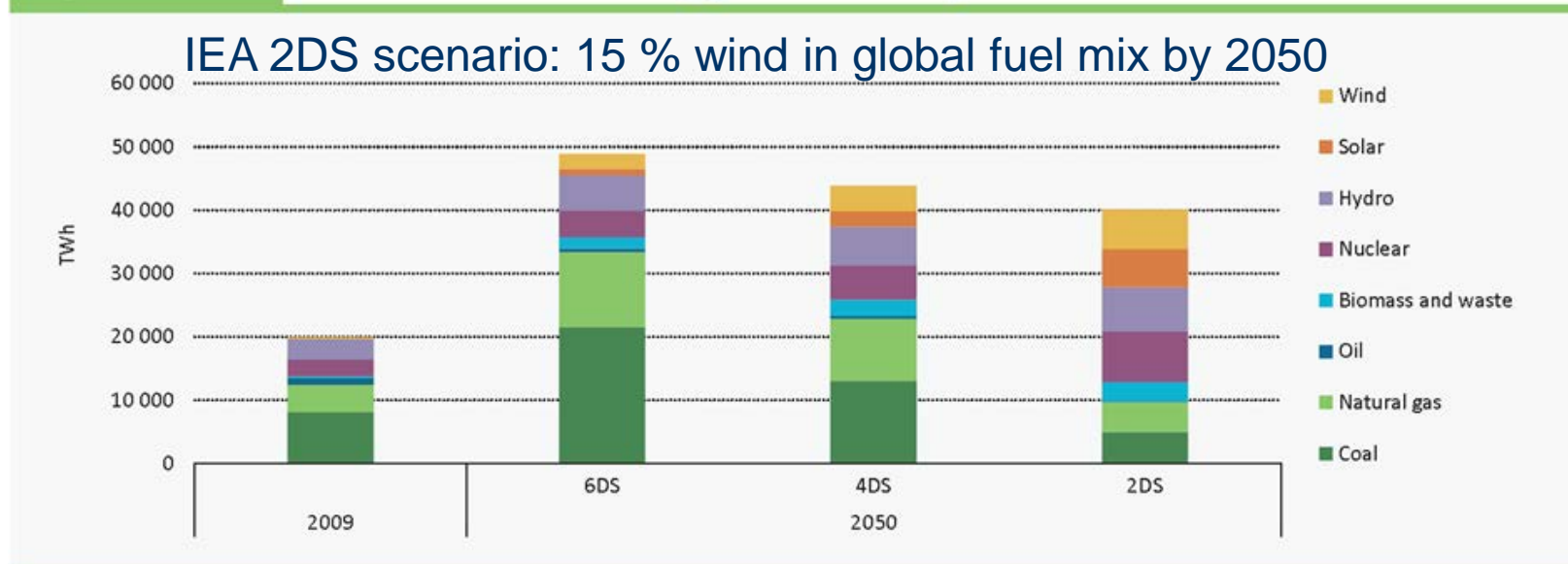
Offshore wind is vital in a sustainable future

- ▶ Battle climate change
- ▶ Security of supply
- ▶ Industry value creation

Stern Review (2006):
..strong, early action on climate change far outweigh the costs of not acting.



Figure 1.10 Fuel mix in electricity generation, by scenario



Key point *Diversification of fuels and increased use of low-carbon sources in the 2DS achieves a high degree of decarbonisation in electricity generation by 2050.*

Copy from IEA Energy Technology Perspectives 2012

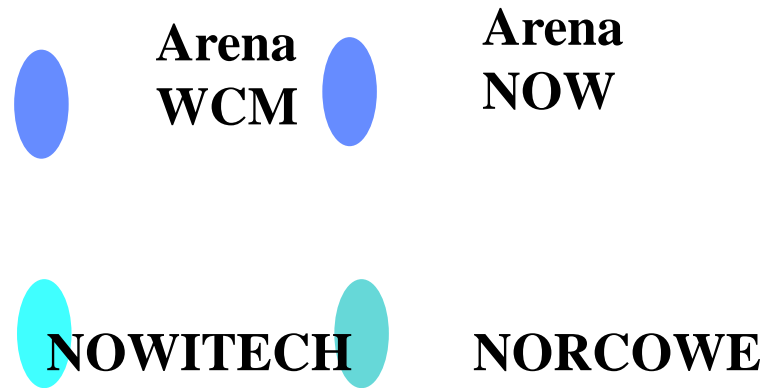
2013 installed wind:
 Total 318 GW incl 7 GW offshore
2050 2DS wind:
 6000 TWh/3000 h = 2000 GW
Required annual installations to reach 2DS goal for wind:
 2000 GW / 40 y = 50 GW/y
 + end of lifetime replacements

Norwegian competence is attractive

- ▶ Aibel
- ▶ Aker Solutions (Alpha Ventus, ++)
- ▶ DNV GL
- ▶ Fedem
- ▶ Fred Olsen
- ▶ Fugro Oceanor
- ▶ Kongsberg Maritime
- ▶ Nexans Norway
- ▶ Norsk Automatisering
- ▶ Reinertsen
- ▶ Statkraft (Sheringham Shoal, Dudgeon, Doggerbank)
- ▶ Statoil (Hywind, Sheringham Shoal, Dudgeon, Doggerbank)
- ▶ Olav Olsen
- ▶ Owec Tower (Beatrice, ++)
- ▶ ++



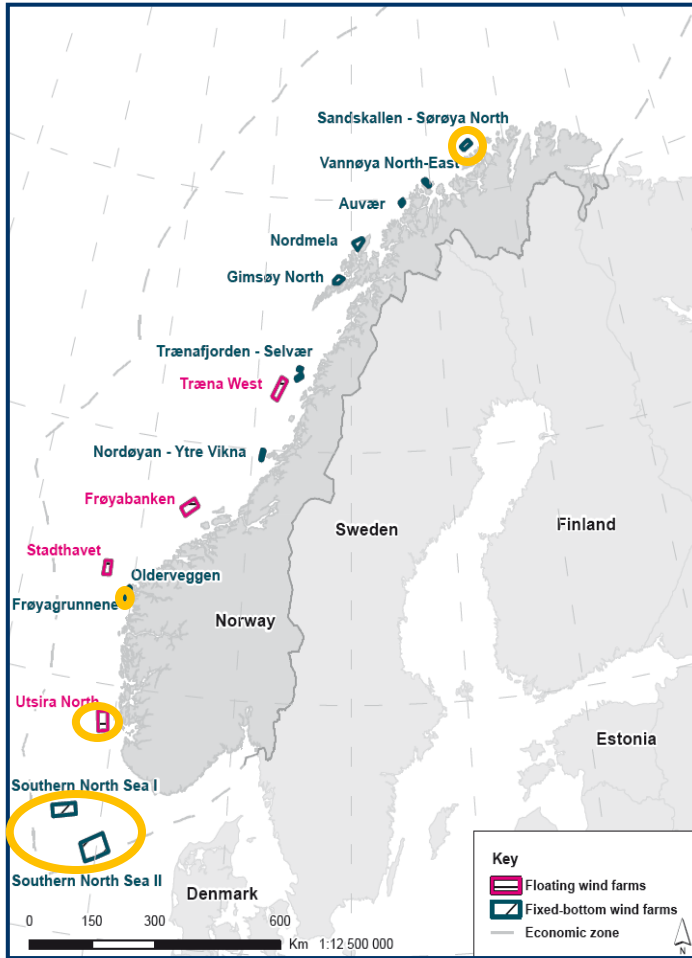
Strong industry and R&D cluster



**Norwegian Research Centre for
Offshore Wind Technology**

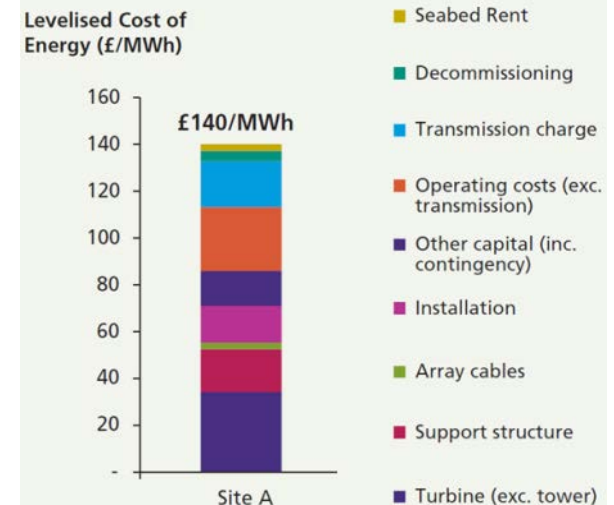
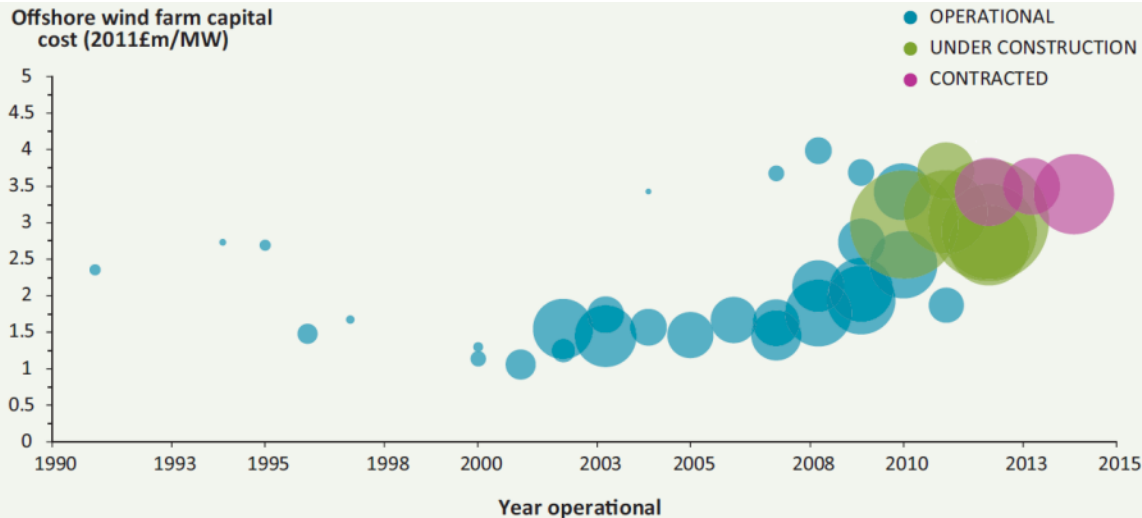
**Norwegian Centre for
Offshore Wind Energy**

A possible Norwegian market, but uncertain



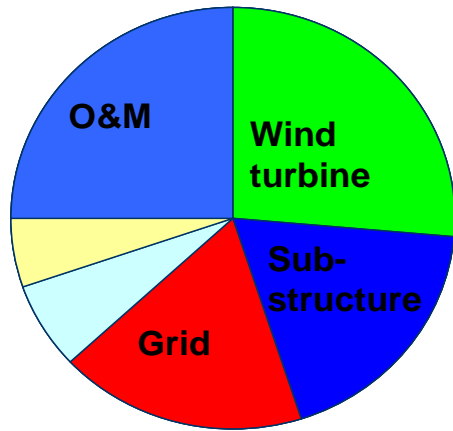
- ▶ NVE has identified 15 areas for development of offshore wind farms (total ~10 GW); five are suggested prioritized (public inquiry due 4/4-13)
- ▶ Applying the petroleum taxation regime to offshore wind farms for supply to oil and gas installations may create a immediate Norwegian market (total ~100-1000 MW)
- ▶ The significance of a Norwegian market is in the near term not for large scale energy supply, but to support development and qualification of Norwegian technology and suppliers

Main challenge: Reduce Cost of Energy

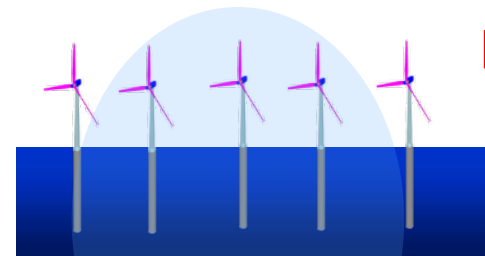


Graphics from: The Crown Estate (2012) Offshore wind cost reduction pathways study

From R&D to innovations to cost reductions



NOWITECH focus area



Market impact

Pilot implementation



Prototype



Lab testing



Knowledge



Idea

Industry driven development

0 ————— 4 ————— 10 → TRL

Innovations in NOWITECH (def.)

.. are **research results** with potential to be further developed into new or significantly improved goods, services or processes **providing value** for industry and/or society.

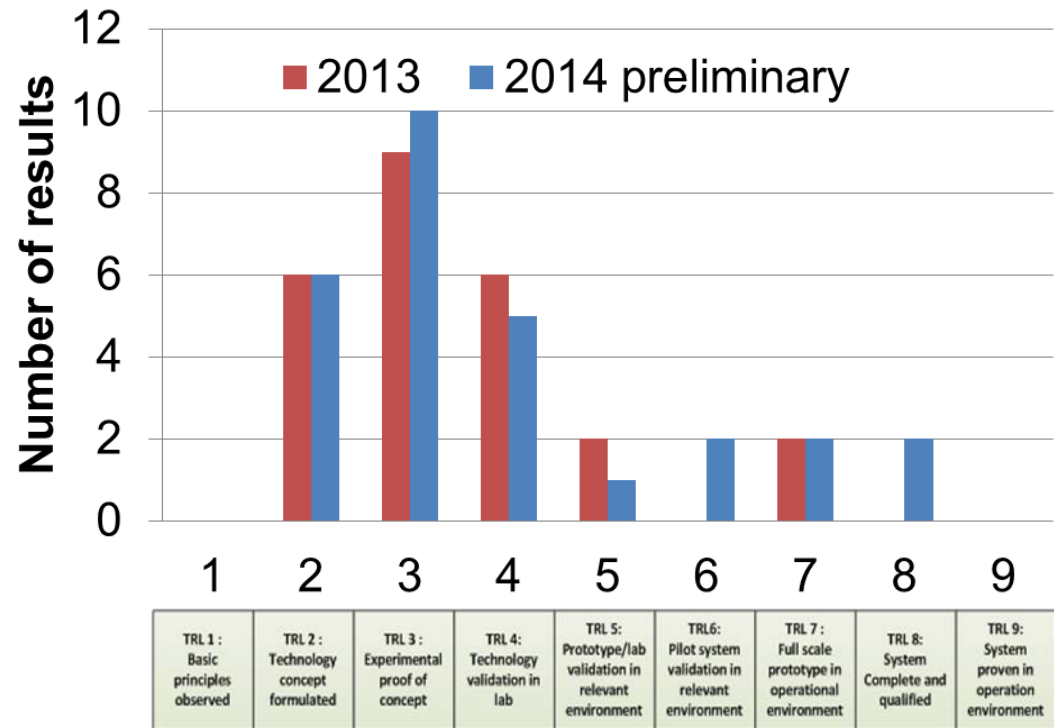
The innovation strategy of NOWITECH

...is to bring forward relevant research results to a certain maturity at which further development is typically industry based towards more competitive and commercial application.

Transfer of knowledge between R&D and industry is critical for successful innovation

Successful innovations are achieved

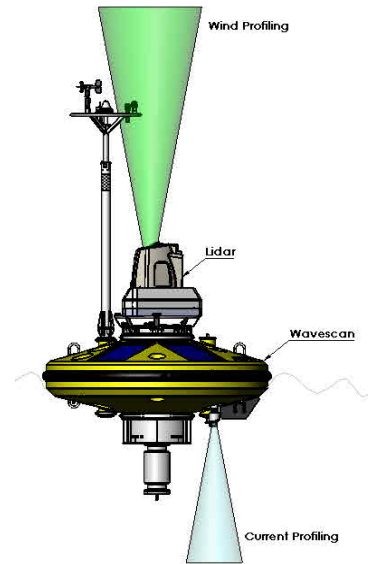
- ▶ NOWITECH funding provides for development until TRL 4-5 (lab scale testing) and ready for takeover by more commercially directed projects typically with industry lead.
- ▶ A conservative count gives thirty industry relevant results / innovations. More than ten software tools are in development, and results are mitigating to commercial use, licence agreements, and business developments.



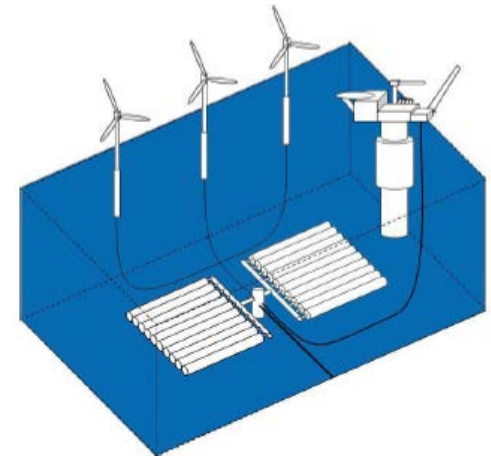
Innovation has many faces



SiC coating

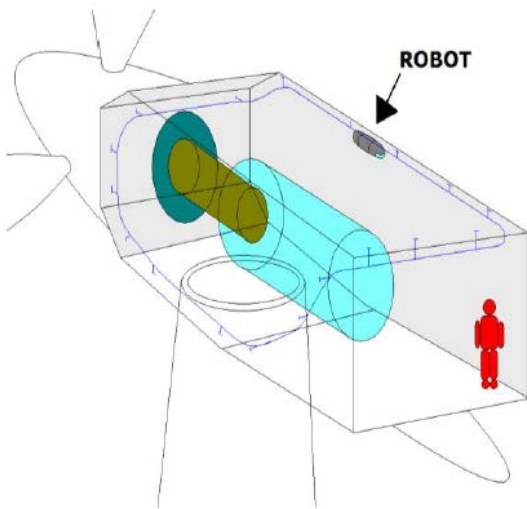


Fugro Oceanor
SEAWATCH

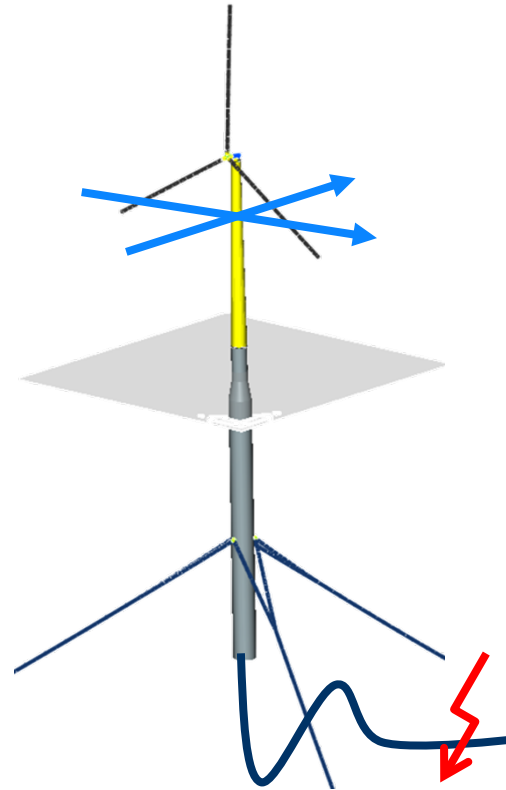


Sub-Hydro

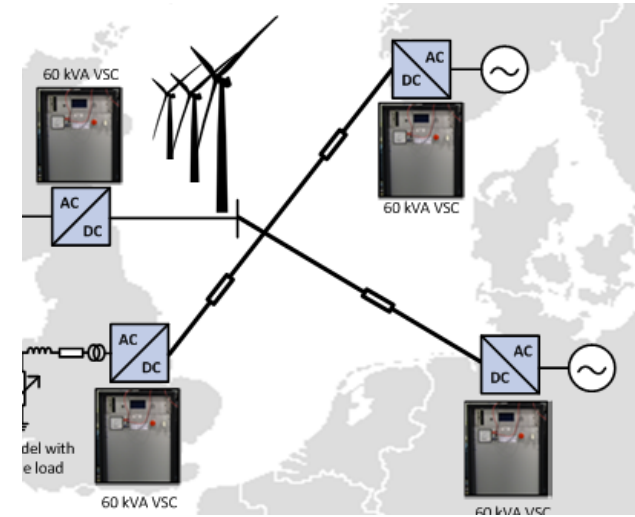
Innovation is not a linear process



Remote Presence



Integrated numerical tools



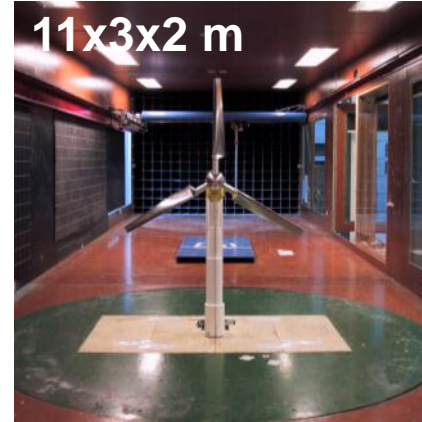
Lab scale HVDC grid

Relevant labs on campus



Ocean basin 80x50x10 m

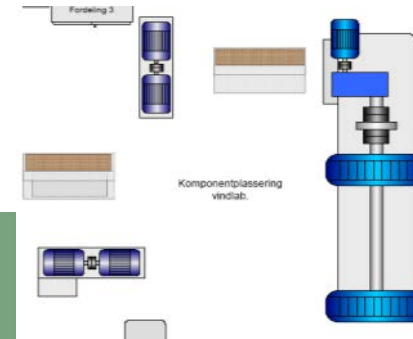
Wind tunnel
11x3x2 m



Material testing



SmartGrids lab

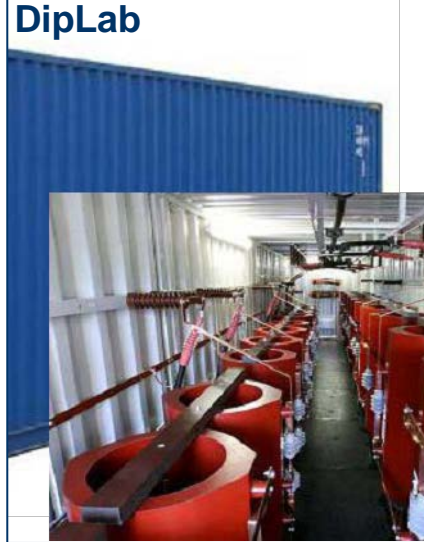


Strong field facilities for R&D in development

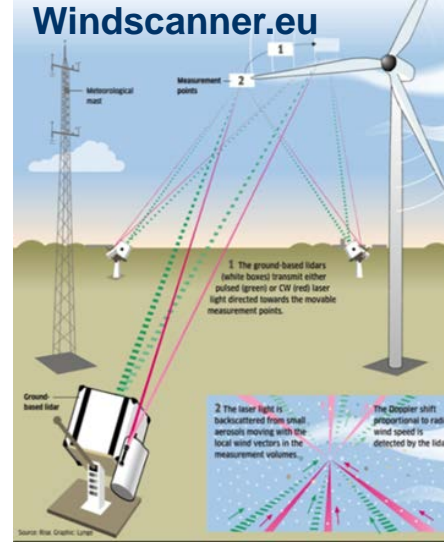
EFOWI: Met-ocean
2xbuoys, 3xlidars, etc
(NORCOWE/NOWITECH)



DipLab



Windscanner.eu



FLEXWT:
1.5 MW floating turbine

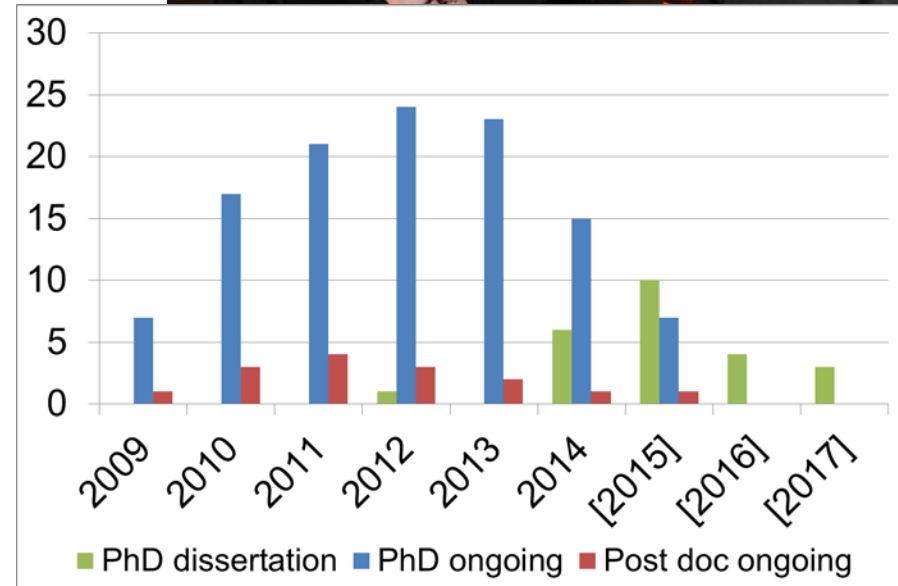


Test station for wind turbines – VIVA AS
Average wind speed 8.4 m/s @ 50 m agl



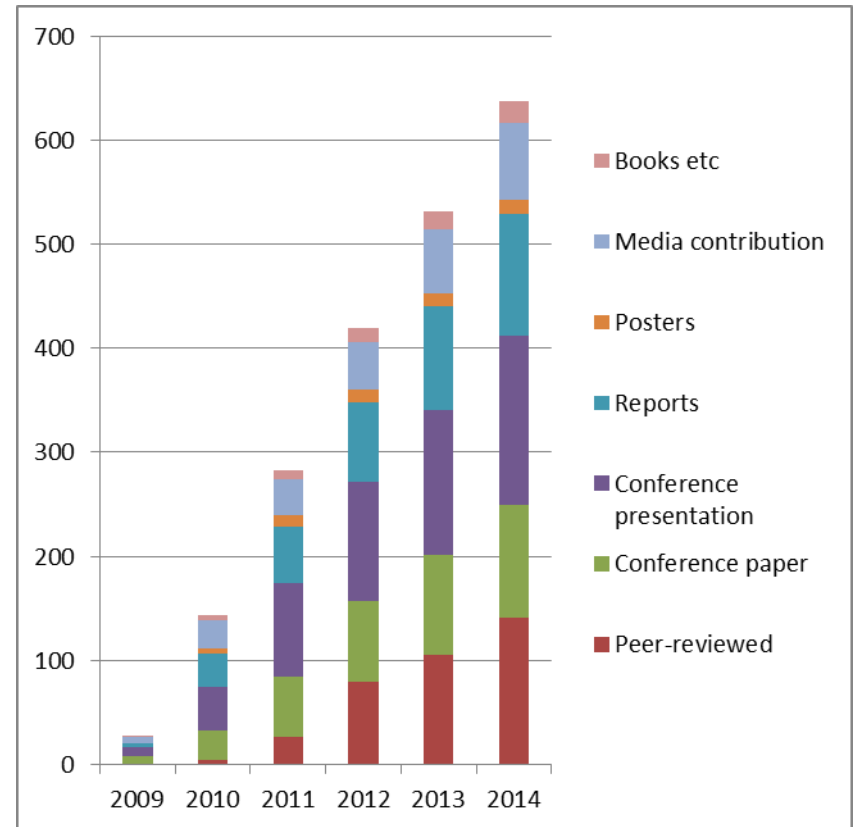
Recruitment and education

- ▶ 24 PhD and 5 post doc students are granted by NOWITECH
- ▶ In addition, through other funding, 25 PhD students and 3 post docs are ongoing at NTNU
- ▶ Since start of NOWITECH some hundred master students have specialized within wind energy
- ▶ The Erasmus Mundus European Wind Energy Master (EWEM) programme gives further weight to the wind education at NTNU and NOWITECH



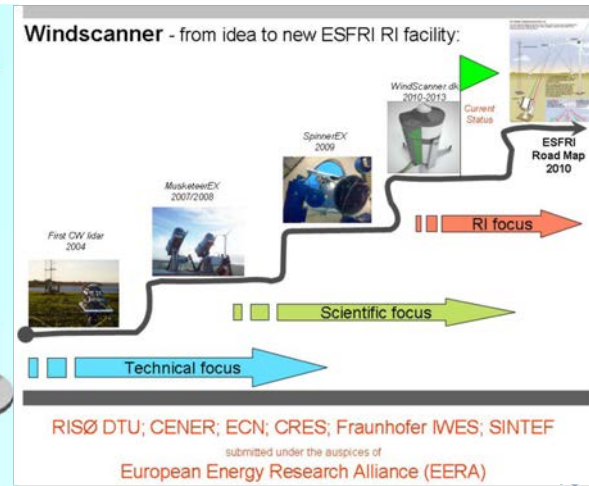
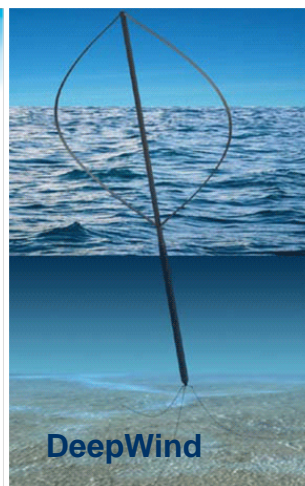
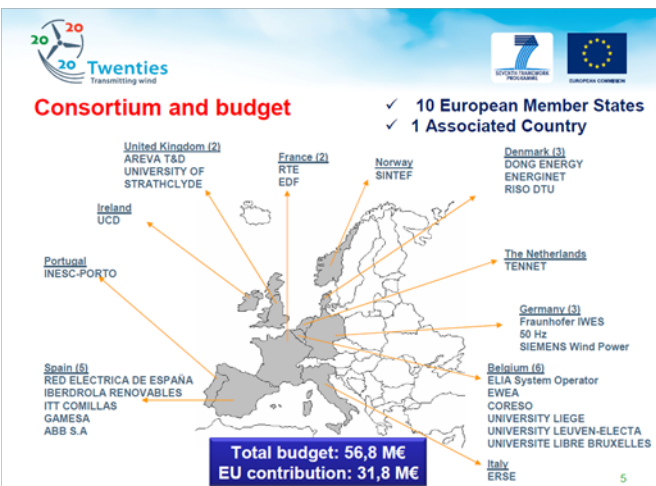
Efficient dissemination of results

- ▶ Active use of web, newsletters and e-room for information sharing
- ▶ 637 publications by NOWITECH at e-room database with full text access for all partners
- ▶ Workshops/meetings for partners
- ▶ Established seminar series on **Industry meets Science; next: 20 November 2014**
- ▶ Wind energy R&D conference held every January in Trondheim; **next: EERA DeepWind'2015, 4-6 February.**



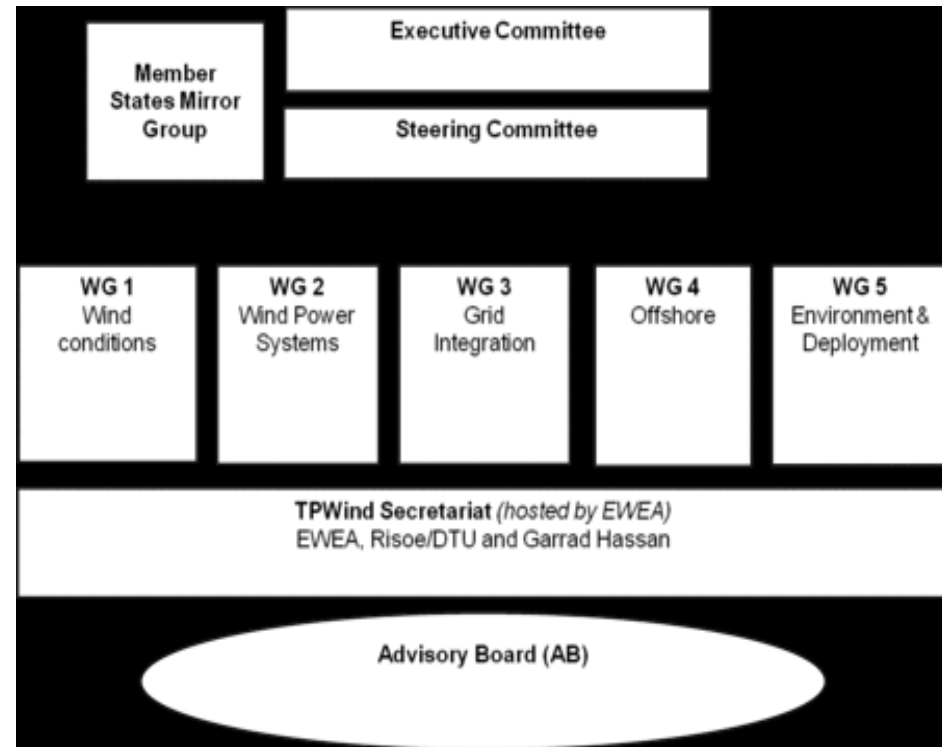
An attractive partner on the international scene

- ▶ Active in EERA, TPwind, EAWE, IEA, IEC
- ▶ Heading offshore works within EERA JPwind and TPwind
- ▶ Partner in EU projects, e.g.: Twenties (2009-), DeepWind (2010-), HiPRWind (2010-), EERA-DTOC (2012-), InnWind (2012-), WindScanner (2012-), LeanWind (2014-), EERA IRP wind (2014-), BestPaths (2014-)



"A dedicated voice for Technology and Policy R&D, speaking for the wind energy sector and its stakeholders"

- ▶ established in 2005/2006
- ▶ a permanent forum composed of more than 180 wind energy experts representing the EU wind power sector (industry and R&D community).



Strong impact on EU wind R&D agenda:

- ▶ The “Strategic Research Agenda / Market Deployment Strategy” (SRA/MDS), published by TPWind in 2008, which outlines the R&D challenges faced by the European wind energy sector. This publication quickly became a reference text in the sector
- ▶ The “European Wind Initiative” (EWI), published by the European Commission in 2009 in its Communication on “Investing in the Development of Low-Carbon Technologies” (COM(2009) 519) suggesting total public and private R&D investment of €6 bn for 2010-2020.



TPwind activities: New SRA in 2014

2011:

- ▶ Develop the EWI 2013 – 2015 Implementation Plan
- ▶ Prepare EWI 2012 Work Programme
- ▶ Renewal of the Steering Committee

2012:

- ▶ Update the SRA to be published spring 2014
- ▶ Prepare EWI 2013 Work Programme

2013

- ▶ Update the SRA to be published spring 2014
- ▶ Develop the EWI 2016 – 2018 Implementation Plan
- ▶ Prepare EWI 2014 Work Programme

2014

- ▶ Publish renewed [Strategic Research Agenda \(SRA\)](#)
- ▶ Renewal of the Steering Committee and WG members
- ▶ Minimum activity until new EU funding for secretariat is granted



New SRA offshore topics and KPIs



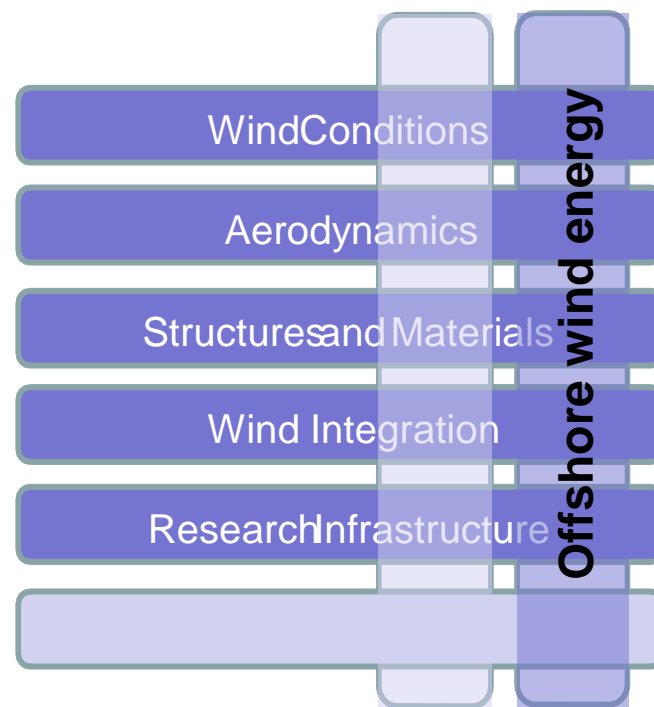
- ▶ Reduce LCOE by 50% from present levels for similar sites by 2030.
- ▶ Wind turbine capacity factors of 50% by 2020
- ▶ Modularisation and mass manufacturing of sub structures
- ▶ 40% reduction in O&M costs from present levels by 2020
- ▶ Reliable and efficient offshore transmission system
- ▶ Minimised soil property uncertainties for site specific sub structure design

"Coordinating energy research for a low carbon Europe"

- ▶ established in 2009/2010.
 - ▶ a permanent forum with 13 full participants & 23 associated participants from 14 countries, and increasing....
 - ▶ committed resources 200 py
- 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.

EERA JPwind comprises 7 SPs

- ▶ Wind Conditions. Coordinated by Risø DTU in Denmark.
- ▶ Aerodynamics. Coordinated by ECN in the Netherlands.
- ▶ Offshore Wind Energy. Coordinated by SINTEF in Norway.
- ▶ Grid Integration. Coordinated by Fh IWES in Germany.
- ▶ Research Facilities. Coordinated by CENER in Spain.
- ▶ Structures and Materials. Coordinated by CRES, Greece
- ▶ (New) Socio-economic aspects. Coordinated by DTU, Denmark



Participants in EERA JP wind energy (July 2014)

Full Participants: DTU (DK), ECN (NL), CRES (GR), CENER (ES), FhG IWES (DE), LNEG/INETI (PO), SINTEF Energy Research (NO), VTT (FIN), University of Strathclyde (UK), Forwind/University of Oldenburg (DE), Tubitak Uzay (TU), CNR (IT), BERA (B)

Associate Participants: Forwind/University of Hannover (DE), Forwind/University of Bremen (DE), University of Porto (PO), NTNU (NO), IFE(NO), MARINTEK (NO), DHI (DK), University of Aalborg (DK), IEN (PO), UCD (IR), WMC (NL), DUT (NL), CTC (ES), IREC (ES), ENEA (IT), NKUA (GR), CIEMAT (ES), CIRCE (ES), Tecnalia (ES), IK4 Alliance (ES), POLIMI (IT), UoB (NO), CMR (NO), Middle East Technical University – Center for Wind Energy (TU), MARINTEK (NO) and NAREC (UK)

Applicants in progress: University of Stuttgart (DE), SINTEF MC (NO), DLR (DE), TU München (DE), University of Aachen (DE).

The EERA JP Wind portfolio...

(Windtrust)

Wind Energy integration

NSON

2 x H2020 proposals

Wind conditions

New European Wind Atlas (ERANET+)

EERA-DTOC

Offshore Wind Energy

6 x H2020 proposals

INNWIND.eu

Aerodynamics

AVATAR

Structures & materials

1 x H2020 proposal

Research Infrastructures

WindScanner.eu

1 x H2020 proposal

National projects....

IRP CSA: WP5 Mobility scheme

IRP CP:

"European-wide measures for large-scale integration"

IRP CP:

"Design of offshore windfarms"

IRP CP:

"Structural reliability of WT sub-components"

IRP CSA: WP3

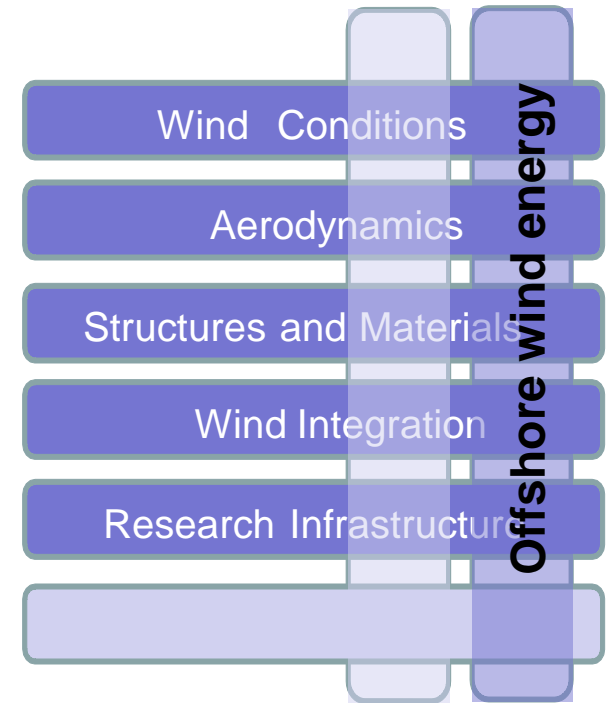
Overall objective

Pre-competitive research laying a scientific foundation for the industrial development of **more cost effective** offshore wind farms and enabling large scale **deployment at any seas**



Research objectives

- ✓ **Design optimization through validation studies offshore, including development of integrated numerical design tools and establishing a open database with measurements for validation of tools.**
- ✓ **Characterization and interaction of wind, wave and current as input for developing standard design load cases.**
- ✓ **Innovative wind farm electric grid connection for offshore applications.**
- ✓ **Control, operation and maintenance of offshore wind farms.**
- ✓ **Development of novel concepts for deep sea, including multi-use of wind farm areas giving step-changes in technology for reducing cost of energy from offshore wind farms.**



Key results

- ✓ Sharing knowledge for joint benefits and efficient use of resources
- ✓ Expert workshops
 - Integrated design tools (2010)
 - Offshore grid development (2010)
 - Predictive tools for O&M (2011)
 - Offshore wind farm grids (2012)
 - Offshore learnings / O&M (2013)
 - Innovative wind turbines (2013)
- ✓ Deep Sea Offshore Wind R&D
Conference: EERA DeepWind 2014
- ✓ Peer-reviewed papers are now published online in [Energy Procedia](#)
- ✓ Preparation of strategy aligning with national and EU priorities
- ✓ Joint national projects
 - ABYSS (DK-NO), kick-off 2014
 - NSON (NO-UK-DE), kick-off 2014; DK/DTU and NL/ECN to join
 - more in progress..
- ✓ New EU projects
 - EERA DTOC, kick-off 2012
 - EERA InnWind, kick-off 2013
 - **EERA IRPWind**, kick-off 2014
 - more in progress (6 proposals for H2020)..

IRPWIND – Integrated Research Programme: a strong foundation for EERA JP activities

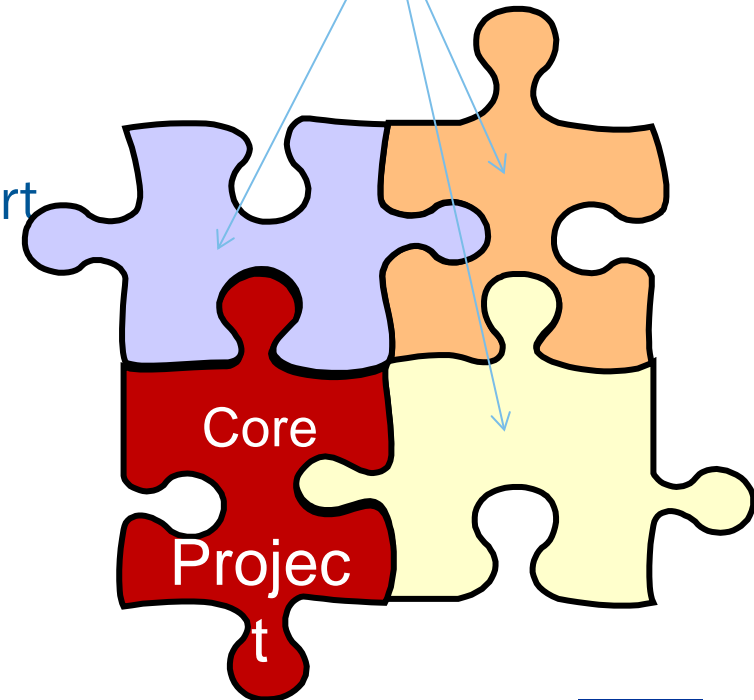


Total budget: 9,8 M EUR

- 6 M EUR for Core Projects (CP)
 - Offshore
 - Structural Reliability
 - Integration
- 4 M EUR for Coordination and Support Action (CSA)
 - Mobility
 - Research Infrastructure
 - Secretariat, management

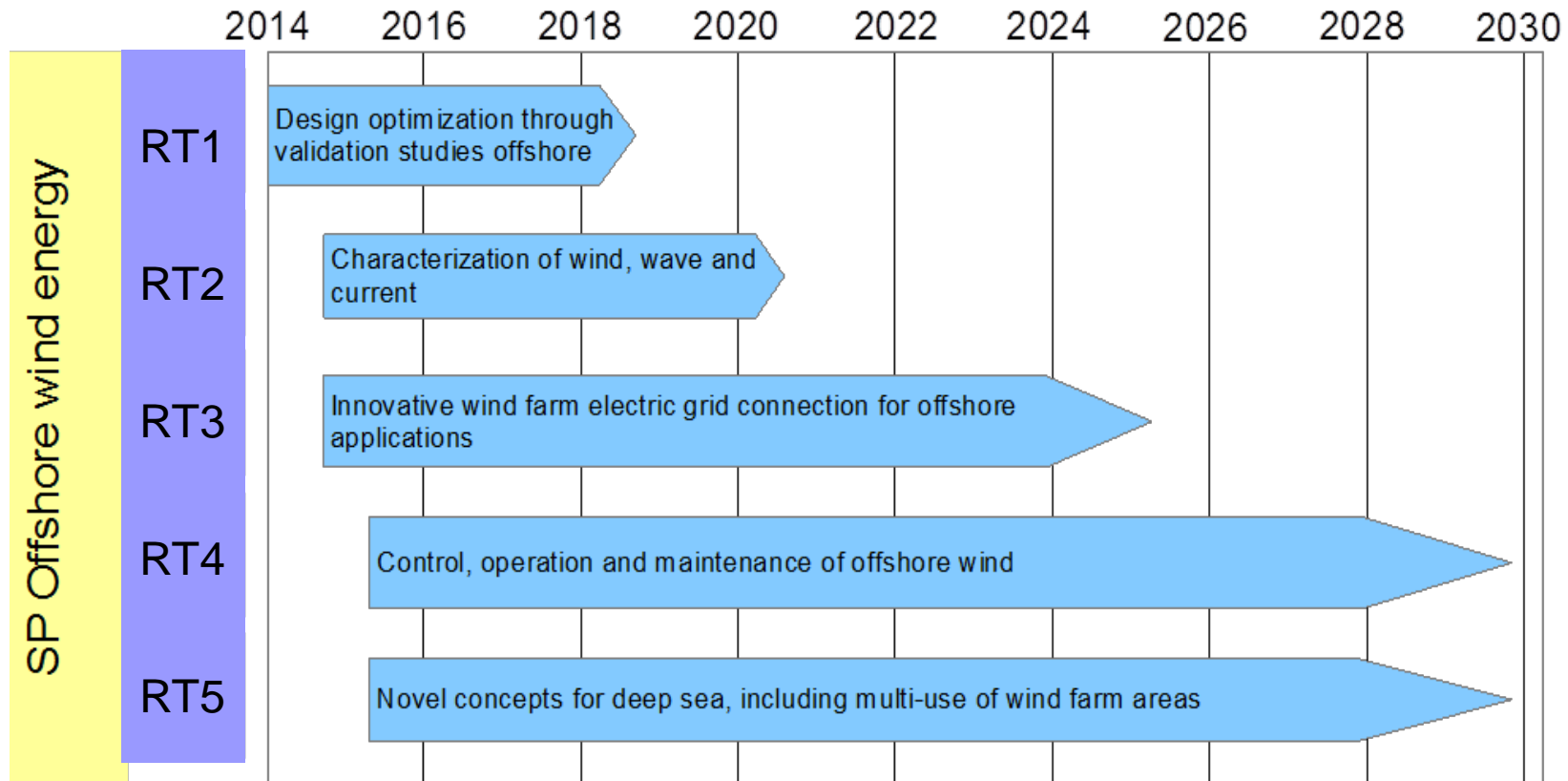
Not all EERA Wind members directly involved; but CSA-part benefits all

Nationally funded collaborative projects



- Open for all EERA JP wind members
- A very concrete way of facilitating more integration of national activities
 - Approx 18 man/years plus travel expenses
 - Mobility periods of 1 month, 3 months and 6 months.
 - 4 cycles of calls
 - Everything to be evaluated annually
- Basic idea: Travelling researcher bring own project which are “related to” similar project at the hosting institution
- Application: describe the national projects, the main goals/activities, how is it relevant to the DoW, what is the alignment and integrative goals
- Report: each report such provide input to the overall reporting of the IRP and possibly also be presented at the yearly event.
- **Announcement of new mobility call at <http://www.irpwind.eu/>**

SP Offshore Research Strategy



RT1 is expected addressed as part of the EERA IRP programme.

RT2 is expected addressed as part of the ERA-net wind atlas project.

RT3, 4 and 5 are expectations for Horizon 2020 and would build on results from on-going EU projects (e.g. DeepWind and InnWind) and announced EU calls (e.g. oceans of tomorrow).

A portfolio of instruments for funding will be considered, also combinations of national projects

NOWITECH achievements



Successful innovations



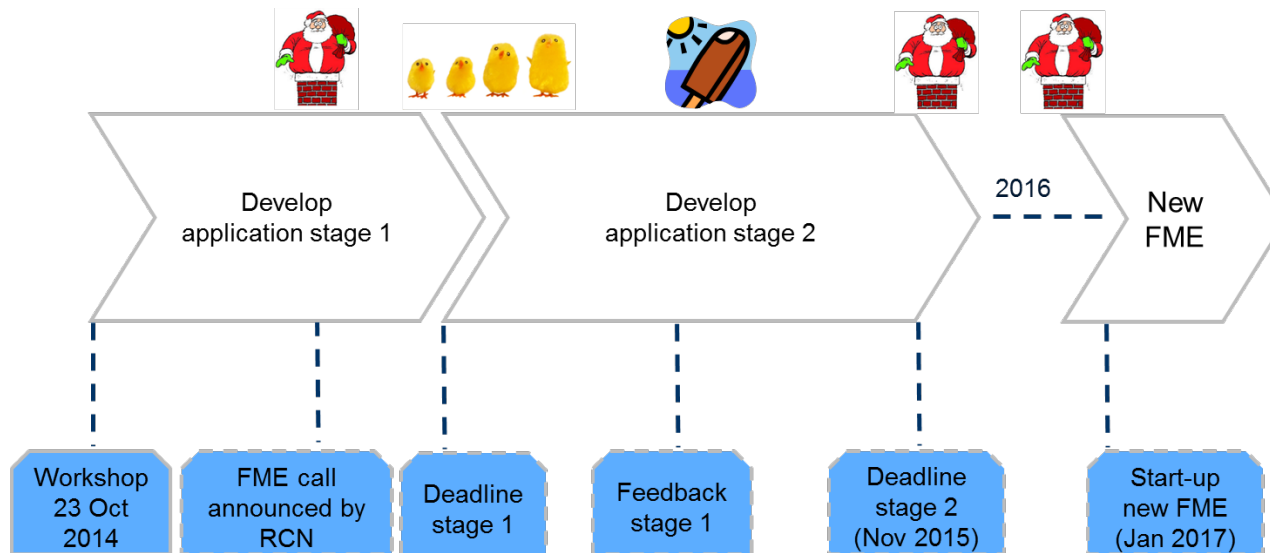
Excellence in research



Strong educational program

A new FME on offshore wind is in preparation

- ▶ As suggested by the boards of NOWITECH and NORCWE the research partners had a joint workshop to discuss a possible future new FME on offshore wind (2017-2024).
- ▶ This was successful with the partners agreeing on a process to prepare the best possible FME application on offshore wind energy.
- ▶ A core team was selected with Finn Gunnar Nielsen, Kristin G Frøysa, Trond Kvamsdal and John Olav G Tande for driving the process.
- ▶ Industry parties are invited to join a Industry Reference Group for the further reporting and dialogue on the development of the new FME.

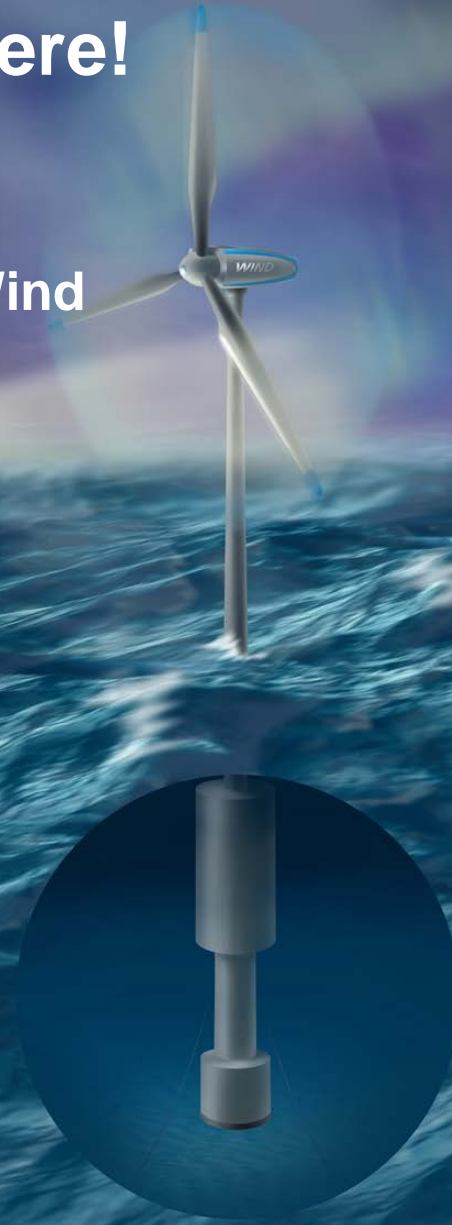


Make sure to be there!

EERA DeepWind'2015

**12th Deep Sea Offshore Wind
R&D Conference**

**Trondheim 4-6 February,
Norway**



**NOWITECH is a joint 40M€
research effort on offshore
wind technology.**

- **Integrated numerical design tools**
- **New materials for blades and generators.**
- **Novel substructures (bottom-fixed and floaters)**
- **Grid connection and system integration**
- **Operation and maintenance**
- **Assessment of novel concepts**

www.NOWITECH.no