

Innovations in offshore wind energy

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Director NOWITECH

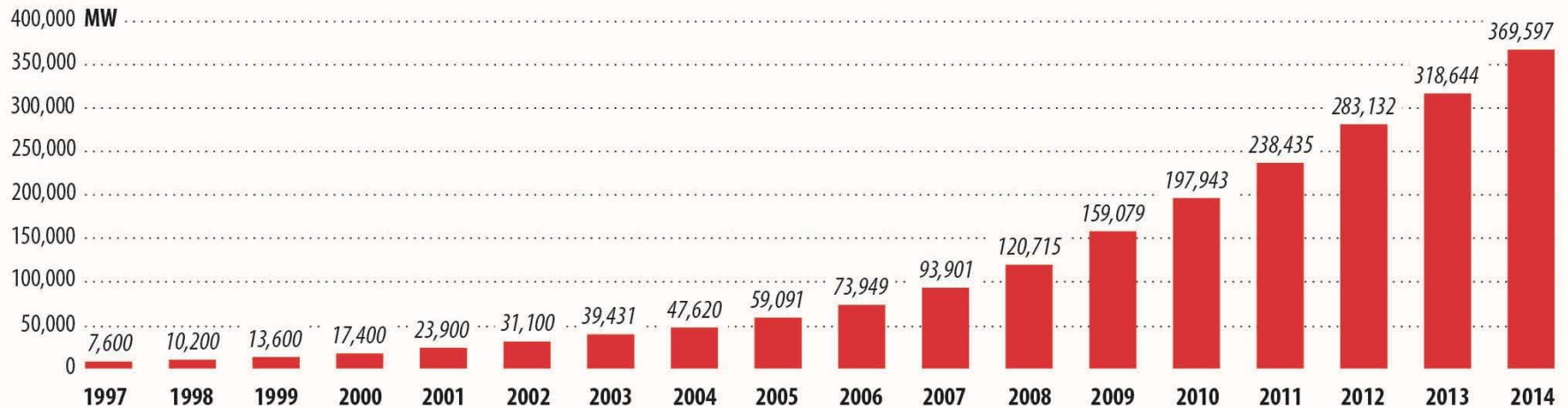
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Wind energy in strong development

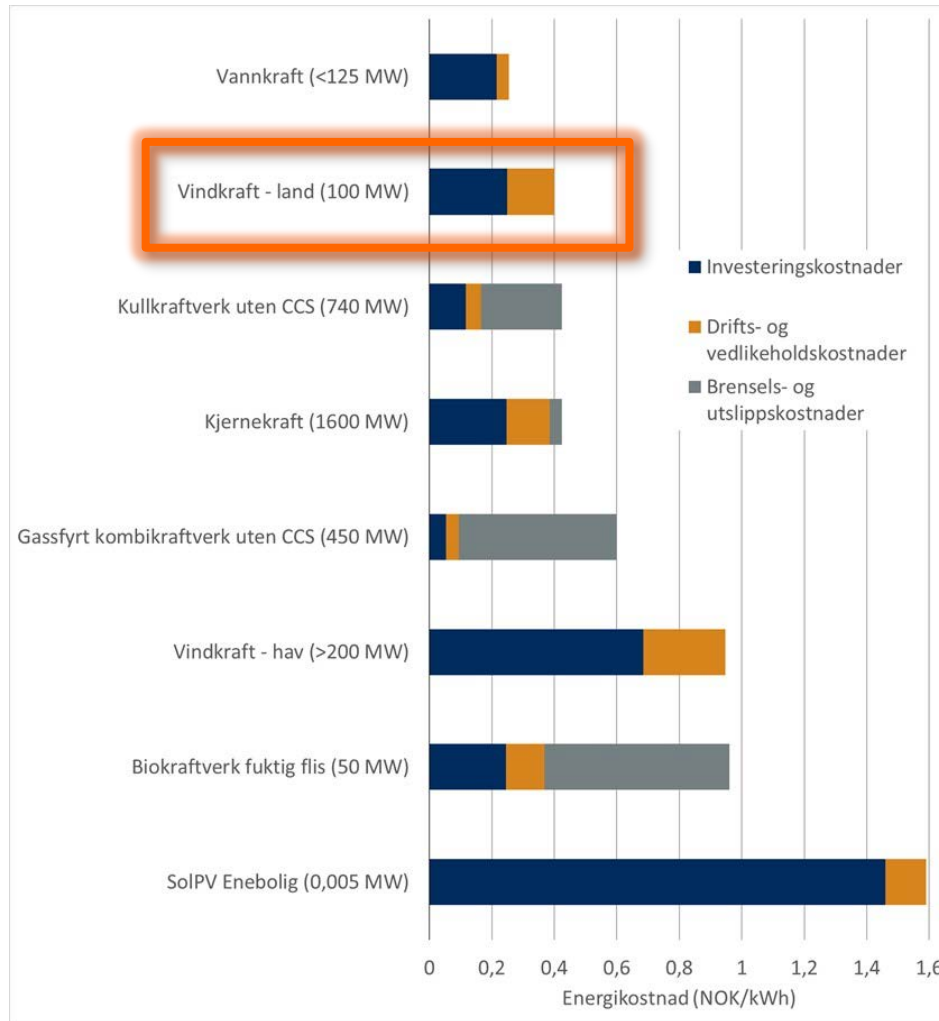
GLOBAL CUMULATIVE INSTALLED WIND CAPACITY 1997-2014



Source: GWEC

- ✓ Land based: 8 GW in 1997; 361 GW in 2014
- ✓ Offshore: 8 GW in 2014; 361 GW in 2031 ??

Wind energy on land is cost competitive



NVE: Kostnader i energisektoren (2015)

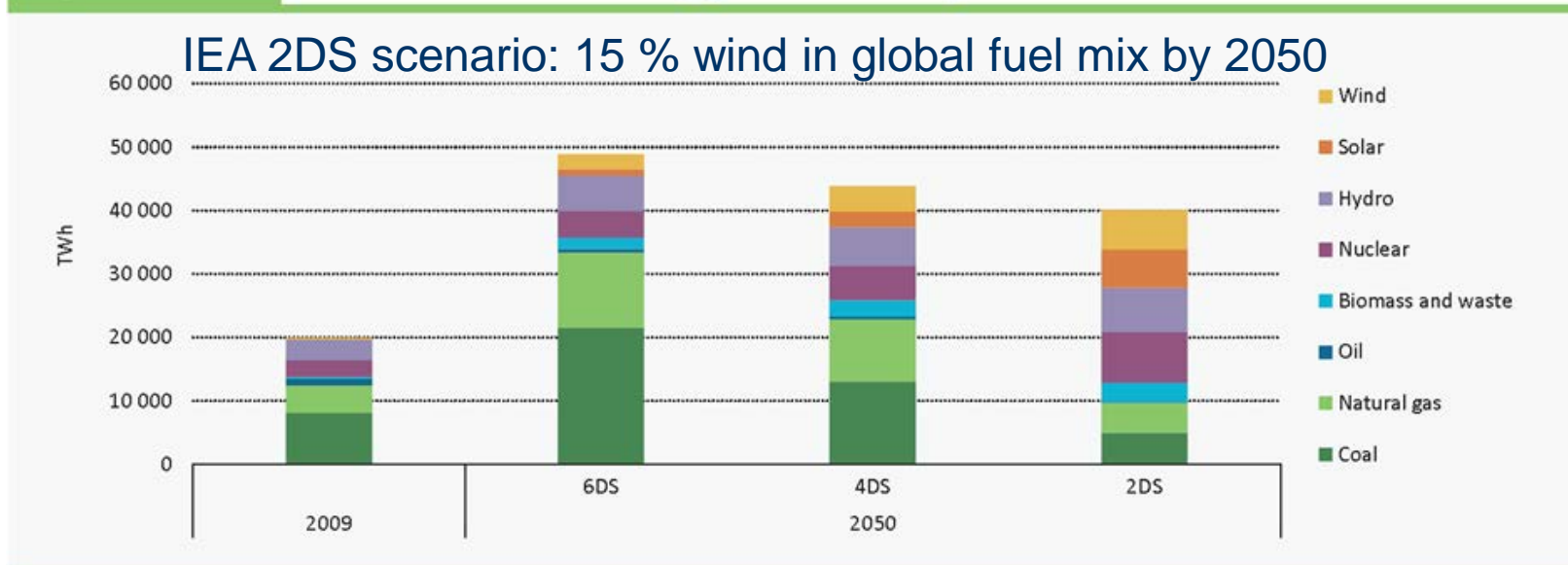
A huge long-term market for green technologies

- ▶ 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



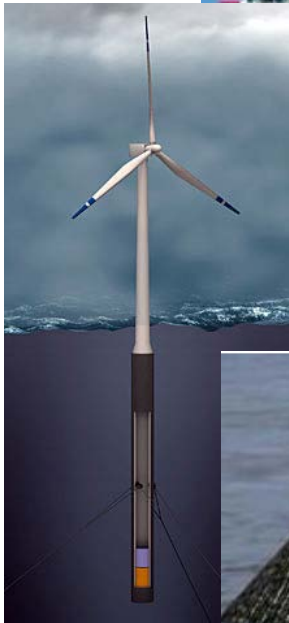
Key point *Diversification of fuels and increased use of low-carbon sources in the 2DS achieves a high degree of decarbonisation in electricity generation by 2050.*

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 (HVDC platform, 23000 tons, 900 MW)
- ▶ Aker Solutions (Alpha Ventus, ++)
- ▶ DNV GL
- ▶ Fedem
- ▶ Fred Olsen
- ▶ Fugro Oceanor
- ▶ Kongsberg Maritime
- ▶ Nexans Norway
- ▶ Norsk Automatisering
- ▶ Reinertsen
- ▶ SINTEF/MARINTEK/NTNU
- ▶ Statkraft & Statoil (Sheringham Shoal, Dudgeon, Doggerbank)
- ▶ Olav Olsen
- ▶ Owec Tower (Beatrice)
- ▶ ++ INTPOW: 150 Norwegian companies



Norsk engasjement i landbasert vindkraft

- ▶ Utbygging stimulert av grønne sertifikat i Norge
- ▶ Utbygd: 0,9 GW
- ▶ Konsesjon gitt: 7,3 GW
- ▶ Potensial for økt verdiskapning gjennom
 - ✓ forskning og utvikling
 - ✓ støtte til teknologiutvikling
 - ✓ premiering av utbyggere som benytter ny (norsk) teknologi



Norsk engasjement i offshore vindkraft

- ▶ Utbygging av offshore vindkraft utenfor Norge
- ▶ Leveranse av teknologi og tjenester til det globale markedet
- ▶ Potensial for økt verdiskapning gjennom:
 - forskning og utvikling
 - støtte til teknologiutvikling
 - utbygging i Norge for utvikling og kvalifikasjon av leverandørindustri



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
- ▶ Kongsberg Maritime
- ▶ Norsk Automatisering (TBC)
- ▶ Rolls Royce SmartMotor
- ▶ Statkraft
- ▶ Statnett
- ▶ Statoil

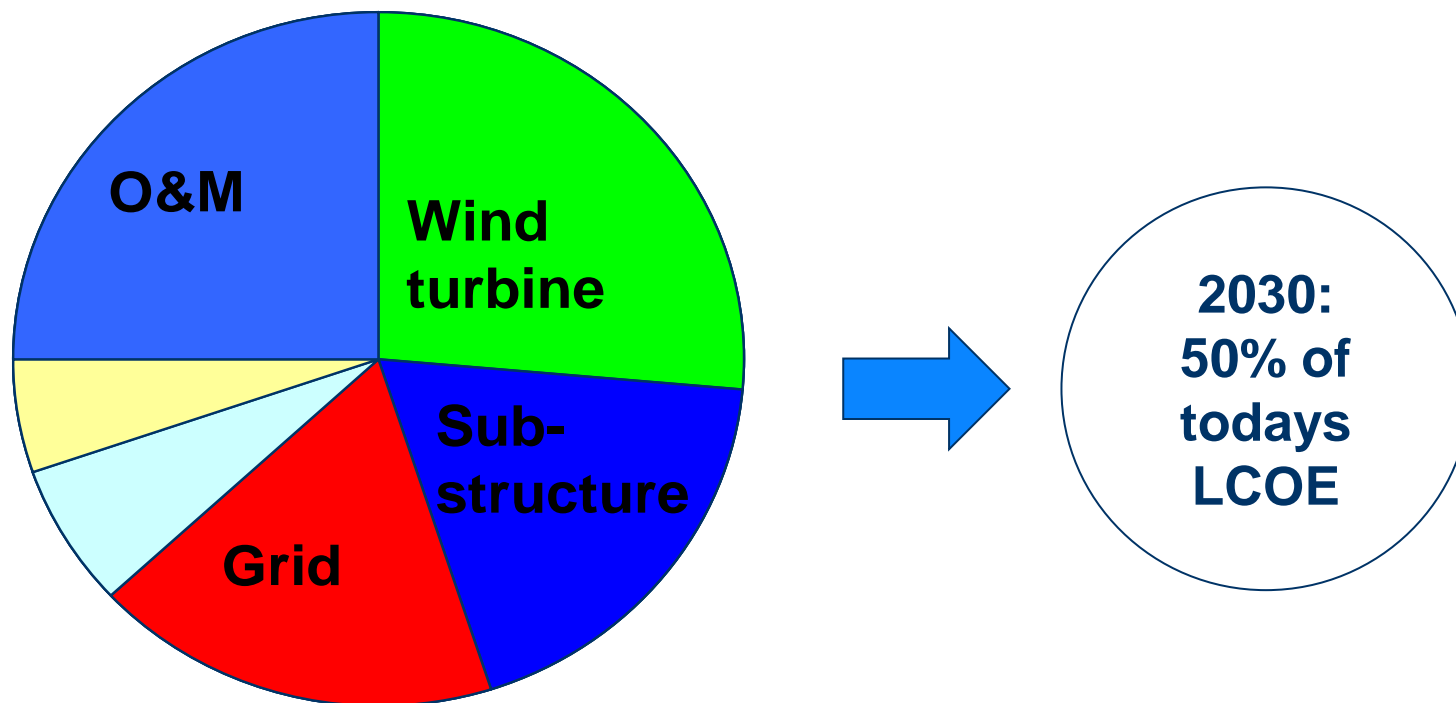
Associated research partners:

- ▶ 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 Norway

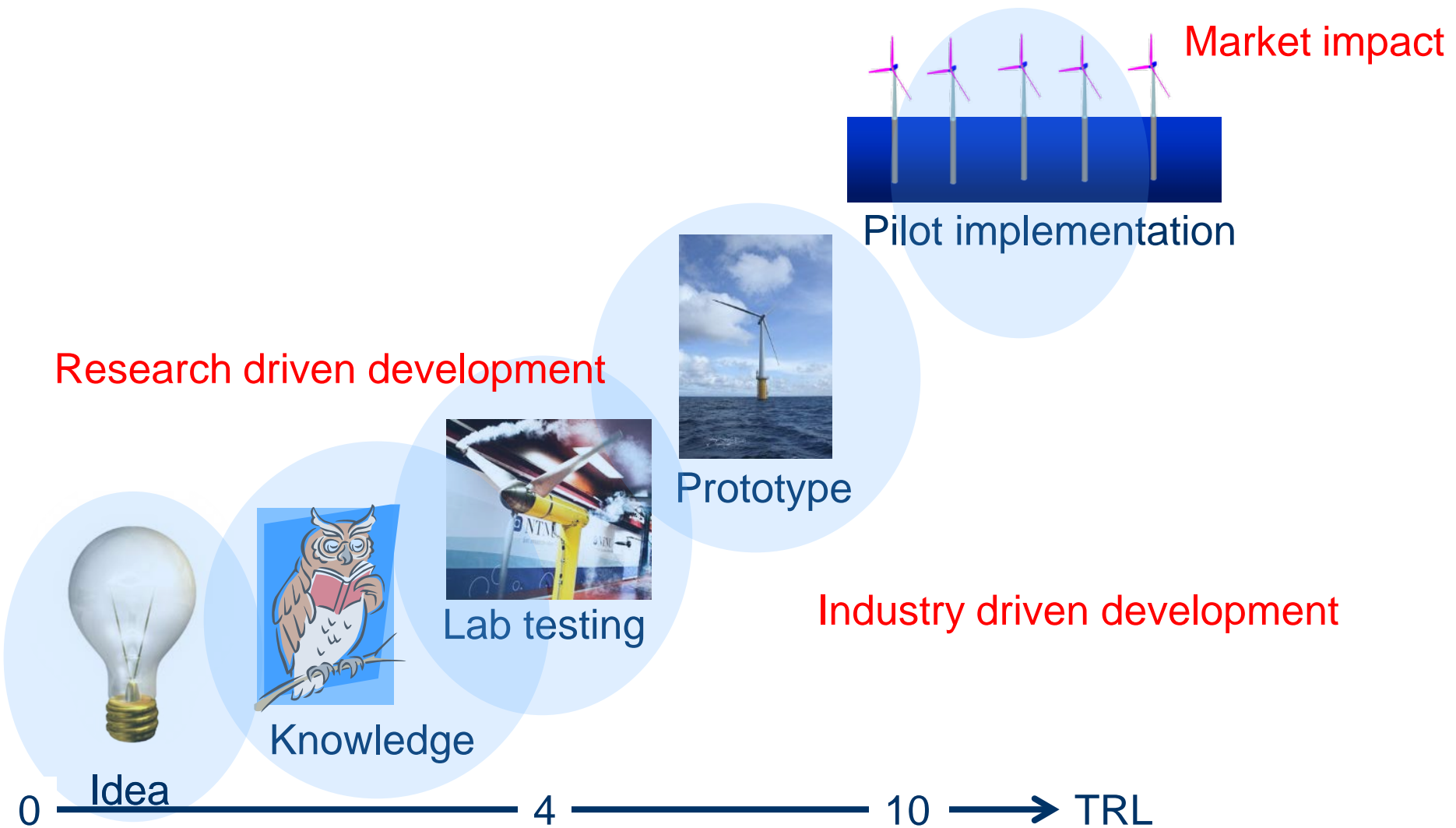
Offshore wind main challenge: Reduce Cost of Energy



EU TP wind KPI in new SRA:

Reduce LCOE by 50% from present levels for similar sites by 2030

From R&D to innovations to cost reductions



HyWind – from Norway to Scotland

Office de la Propriété Intellectuelle du Canada
 Canadian Intellectual Property Office
 An agency of Industry Canada

CA 2627148 C 201208897
 (135) **2 627 148**
BREVET CANADIEN
CANADIAN PATENT
 (13) C

(86) Date de dépôt PCT/PCT Filing Date: 2006/10/30
 (87) Date de publication PCT/PCT Publication Date: 2007/05/10
 (41) Date de délivrance/Issue Date: 2012/08/07
 (85) Entrée phase nationale/National Entry: 2008/04/24
 (86) N° demande PCT/PCT Application No.: NO 2006/000385
 (87) N° publication PCT/PCT Publication No.: 2007/05/03/31
 (30) Priorité/Priority: 2005/11/01 (NO20055118)

(51) Cl. Int. (Int. Cl.): F03D 7/60 (2006.01); F20F 1/00 (2006.01)
 (72) Inventeur(s)/Inventors: NIELSEN, FRIM, GUINAR, NO; SKAARE, BJORN, NO; TANGE, JOHN OLAV GAEVER, NO; NORDHEIM, IAN, NO; UNJEN, KJETIL, NO
 (73) Propriétaire/Owner: STATOIL HYDRO ASA, NO
 (74) Agent: PETHERSTONHAUGH & CO.

(54) Titre - PROCÉDE D'AMORTISSEMENT DES VIBRATIONS DE LA TOUR DANS UNE INSTALLATION D'ÉOLIENNE
 (54) Title - A METHOD FOR DAMPING TOWER VIBRATIONS IN A WIND TURBINE INSTALLATION



Karmøy 2009



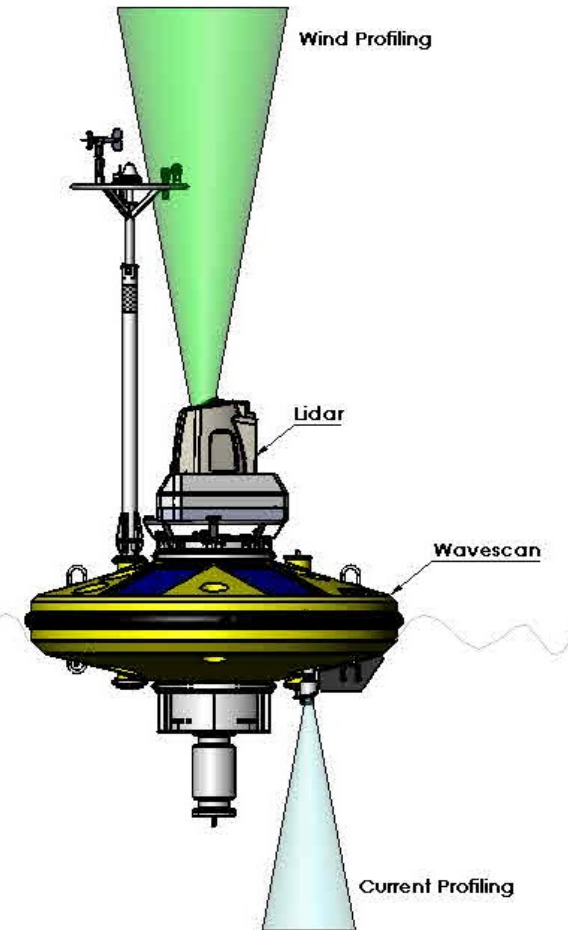
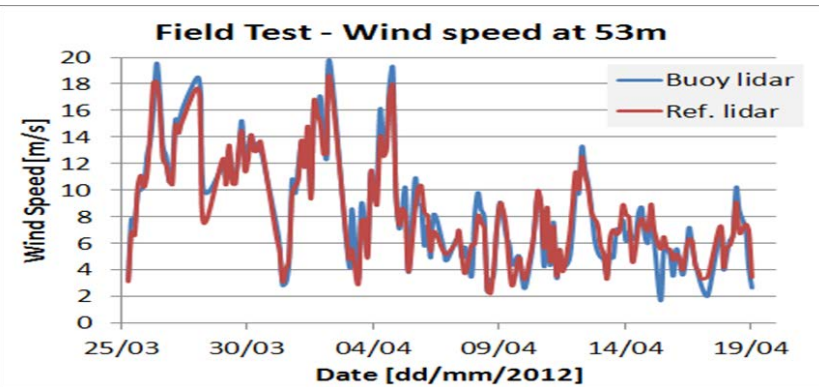
Scotland 2017



SINTEF/
MARINTEK 2005

SEAWATCH Wind Lidar Buoy

- ▶ Cost efficient and flexible compared to offshore met mast
- ▶ Measure wind profiles (300 m), wave height and direction, ocean current profiles, met-ocean parameters
- ▶ Result of NOWITECH "spin-off" joint industry project by Fugro OCEANOR with Norwegian universities, research institutes and Statoil.

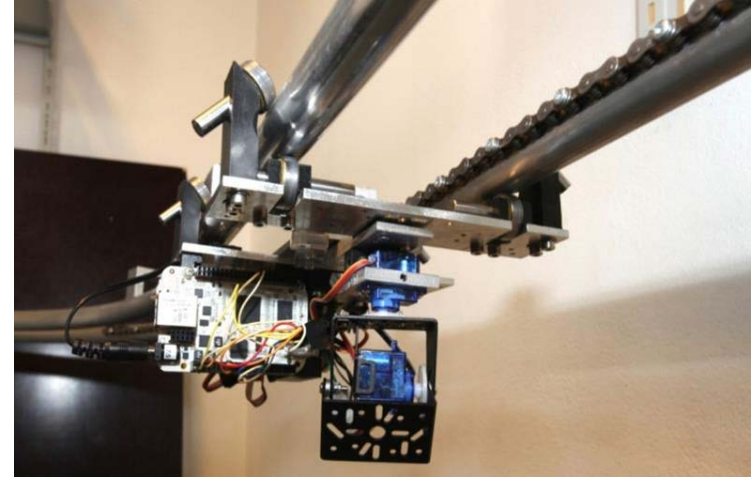
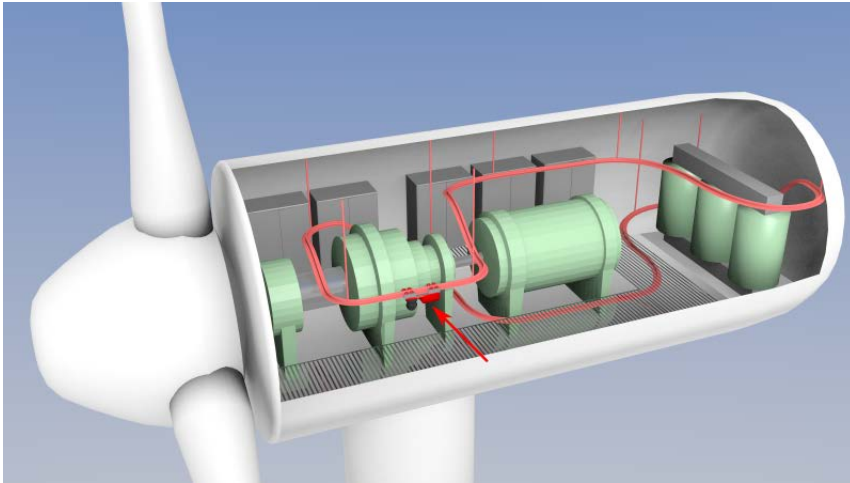


Thermally sprayed silicon carbide coating



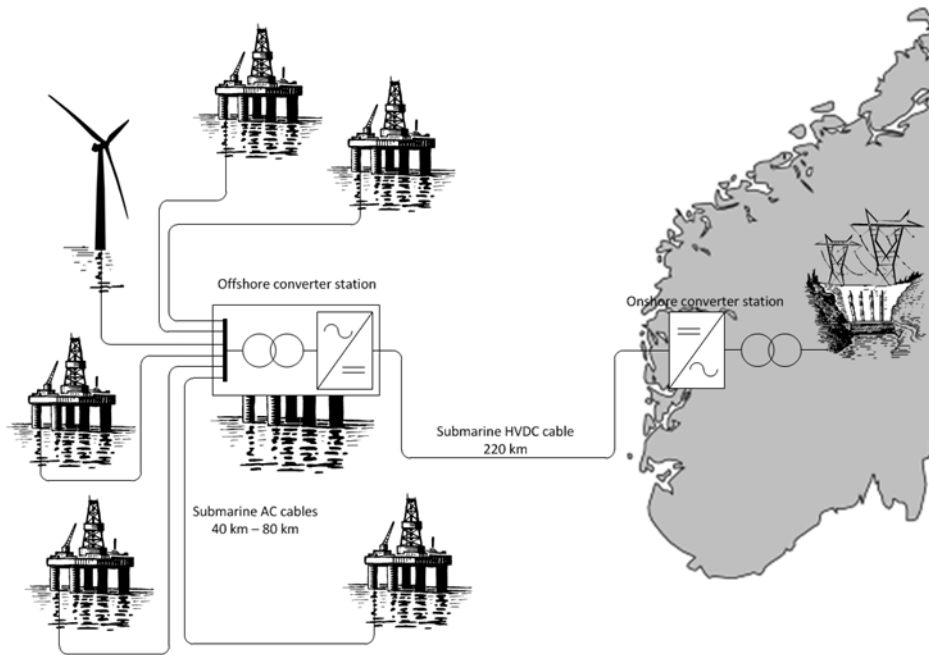
- ✓ Patented process result of NOWITECH PhD work.
- ✓ Being developed as a commercial product through the new spinout company Seram Coatings AS.
- ✓ The process provides for an extremely hard, wear-resistant, low friction ceramic coating that can be applied to rotating machinery like main bearings in large direct drive wind turbines; ultimately increasing lifetime and reducing cost for maintenance.

Remote presence



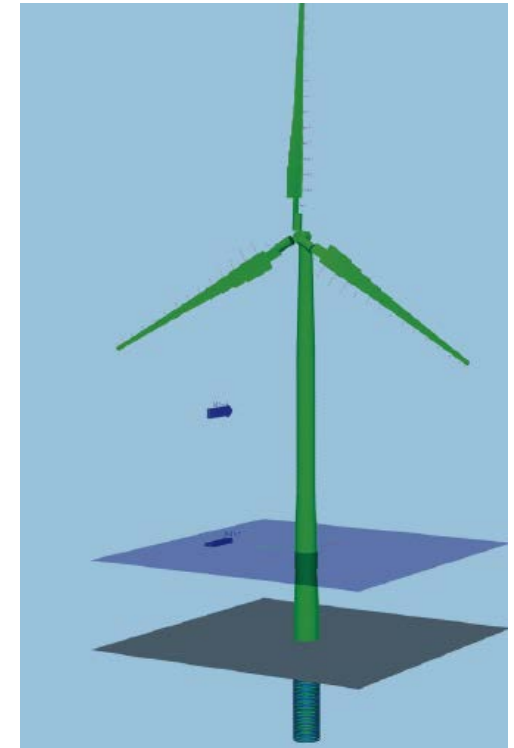
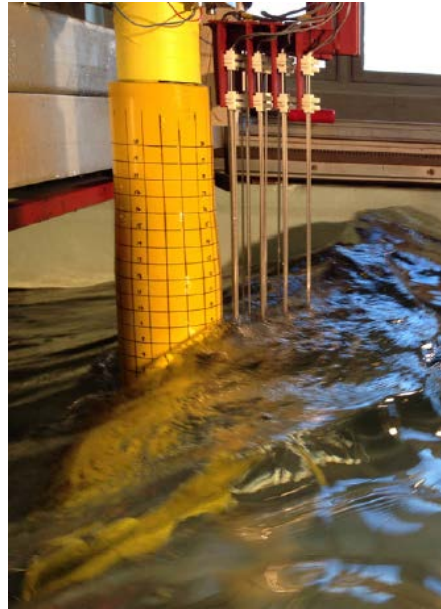
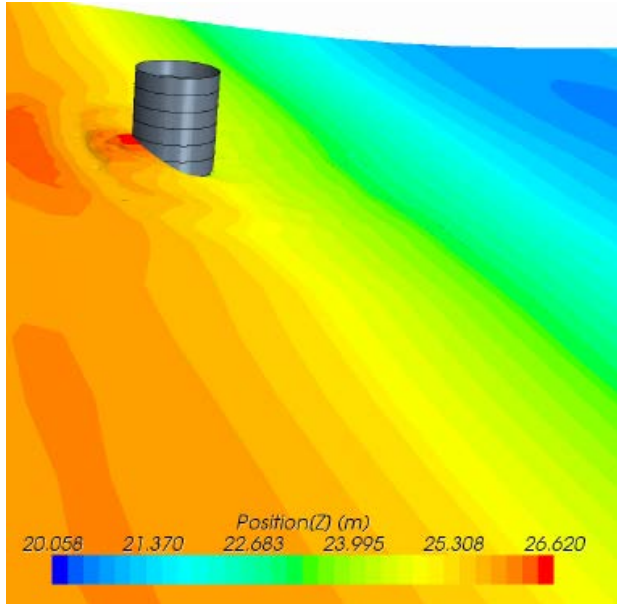
- ✓ **Technology developed in part through NOWITECH PhD work**
- ✓ **Remote presence through a small robot on a track in the nacelle equipped with camera / heat sensitive, various probes, microphone etc. reducing offshore work by service personnel, downtime and costs**
- ✓ **Technology is commercialized by Norsk Automatisering**

Offshore wind supply to oil and gas platforms



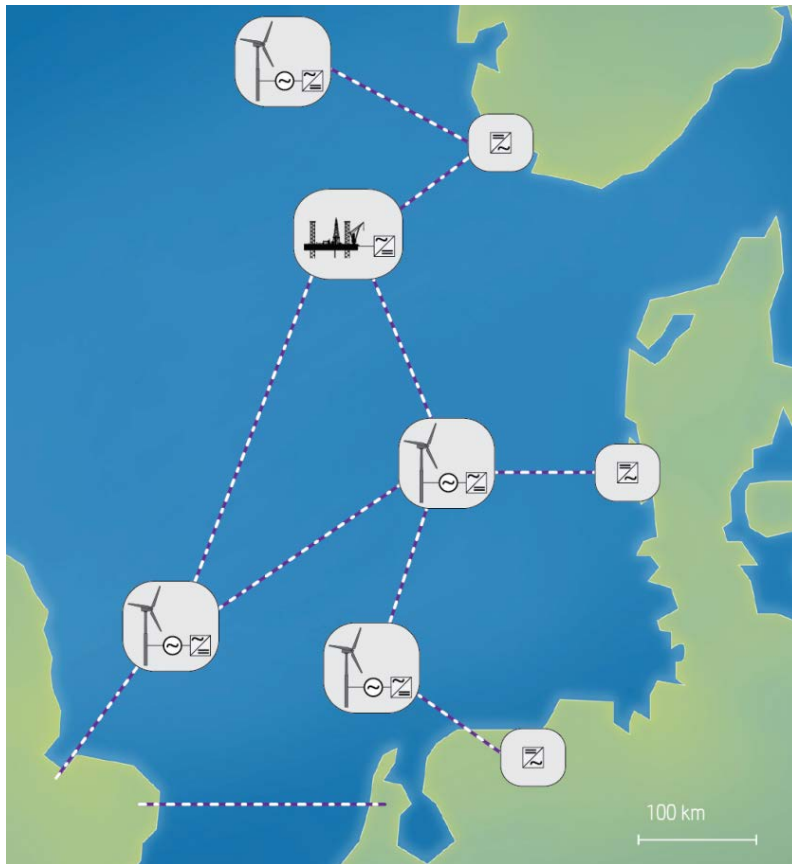
- ▶ NOWITECH result by SINTEF Energi
- ▶ Verified technical and operational questions through detailed numerical simulations
- ▶ Concept provides for reduced CO₂ emission from oil and gas production and better utilization of the grid connection

Savings costs with knowledge, models and labs



De-risking monopile for Dudgeon 402 MW Offshore Wind Farm
MARINTEK using CFD, lab experiments and FE SIMA analysis

Developing the future offshore grid



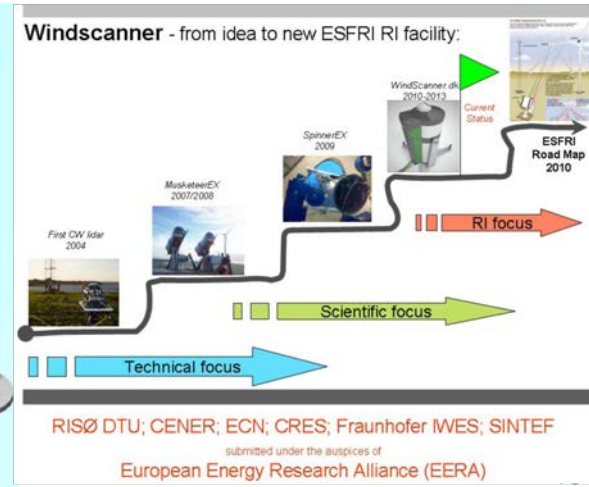
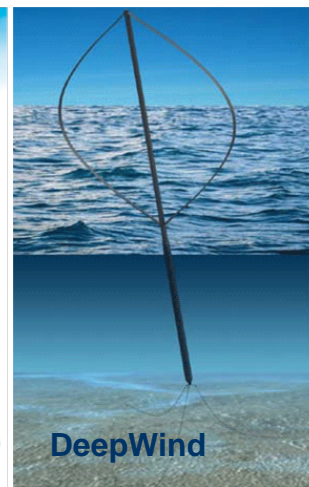
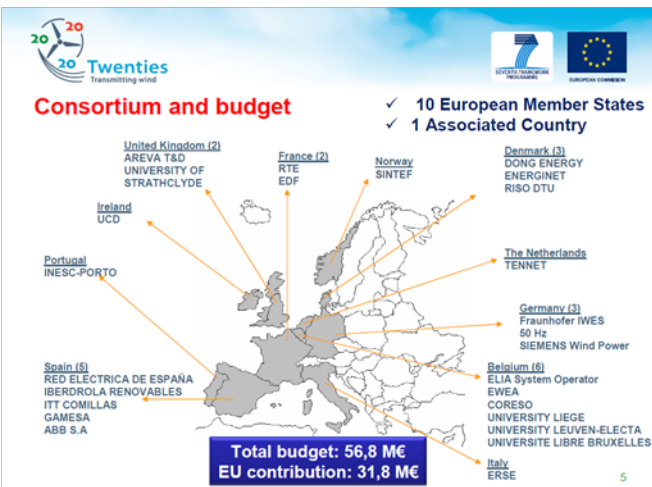
- ▶ Operation and control
- ▶ Converter interoperability
- ▶ System stability
- ▶ Fault handling
- ▶ System services
- ▶ Security of supply
- ▶ New market solutions



Validating new HVDC technology in BestPaths (EU FP7)

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-), Lifes50+ (2015-)



NOWITECH achievements



Successful innovations



Excellence in research



Strong educational program

A new FME on offshore wind is in preparation

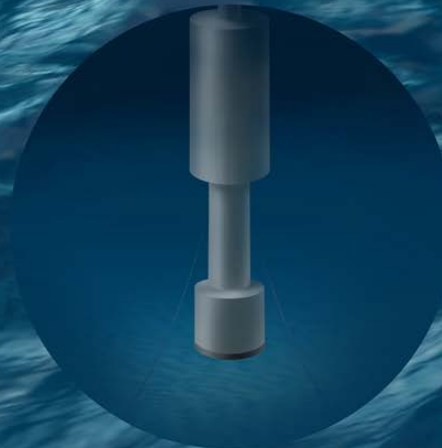
FME title	Centre for Offshore Wind Energy Research (COWIND)
Host institute	SINTEF Energi AS
Contact person	John Olav Tande, +47 9136 8188, john.tande@sintef.no
Partners	Research: CMR, MARINTEK, met.no, NTNU, SINTEF, UiA, UiB Industry / user partners (TBC): Statoil, Statkraft, Kongsberg, DNV GL, Dong, Fedem, Acona, Vestas, Gamesa, Vattenfall, StormGeo

- ▶ Annual budget: 60 MNOK with 50 % from RCN, 25 % from user partners and 25 % from research partners
- ▶ Application deadline 25 November 2015.
- ▶ Start-up in 2016/2017, pending on funding. Duration 8 years.
- ▶ **Industry parties are invited to join a Industry Reference Group for the further dialogue on the development of the new FME.**

We make it possible!

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

- Numerical tools and sub-structures
- O&M and materials
- Grid and wind farms



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Norwegian Research Centre for Offshore Wind Technology

