

arena

Arena NOW
Arena Vindenergi

Norwegian Offshore Wind Industry and R&D Centres

Arena NOW, Arena Vindenergi, Norcowe, Nowitech

NOWITECH

Norwegian Research Centre for Offshore Wind Technology



norcowe

Norwegian Centre for Offshore Wind Energy



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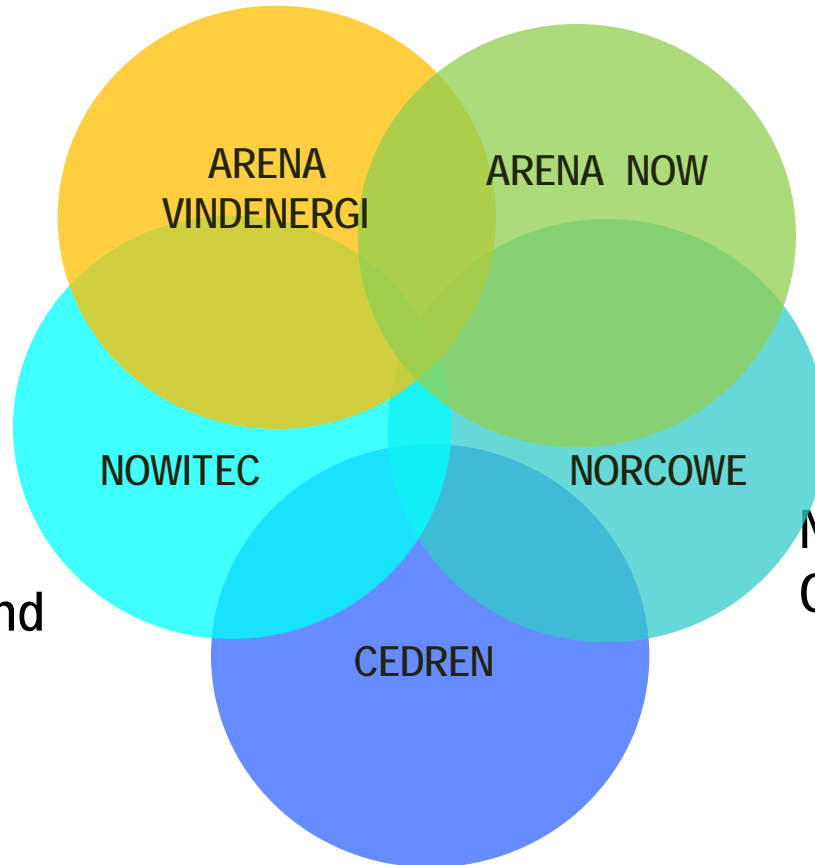
Research and industry clusters in Norway

Offshore Wind Technology

Technology status and references in Norway

A strong cluster on Norwegian offshore wind

Industry network/arena



Norwegian Research
Centre for Offshore Wind
Technology

Norwegian Centre for
Offshore Wind Energy

Centre for Environmental Design of Renewable Energy

NOWITECH in brief

Director: John Olav Giæver Tande, john.tande@sintef.no

- Objective:
Pre-competitive research laying a foundation for industrial value creation and cost-effective offshore wind farms. Emphasis on deep sea (+30 m).
- R&D partners: SINTEF, IFE, NTNU + associates: Risø DTU (DK), NREL & MIT (US), Fraunhofer IWES (DE), University of Strathclyde (UK)
- Industry partners: Statkraft, Statoil, Vestavind Kraft, Dong Energy, Lyse, Statnett, Aker Solutions, SmartMotor, NTE, DNV, Vestas, Fugro Oceanor, Devold AMT, TrønderEnergi + associates: Innovation Norway, Enova, NORWEA, NVE, Energy Norway, Navitas Network
- Work packages:
 1. Numerical design tools (including wind and hydrodynamics)
 2. Energy conversion system (new materials for lightweight blades & generators)
 3. Novel substructures (bottom-fixed and floaters)
 4. Grid connection and system integration
 5. Operation and maintenance
 6. Concept validation, experiments and demonstration
- Total budget (2009-2017): +NOK 320 millions including 25 PhD/post docs

NOWITECH - relevant labs on campus and field facilities

Ocean basin 80x50x10 m



Wind tunnel 11x3x2 m



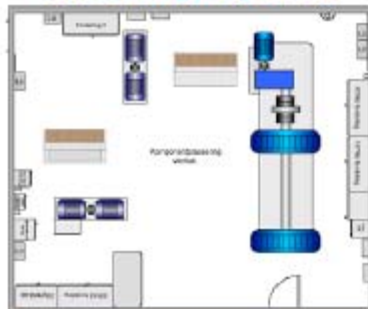
2x45 m + 2x100 m masts



Met-ocean buoys, lidars, etc (to be procured & operated jointly with NORCOWE)



Re. Energy Sys Lab



Material testing



HyWind 2,3 MW floating wind turbine (owned & operated by StatoilHydro)



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

0.2 MW

0.9 MW

2.3 MW



Photo / Visualisation: InterPares AS

NORCOWE – in brief

- Vision
 - Combine Norwegian offshore technology and Danish wind energy competence
 - Innovative and cost effective solutions for deep waters and demanding offshore environmental conditions
- Partners
 - Research: CMR (host), Uni Research, UiB, UiS, UiA, Aalborg univ.
 - Industry: Statkraft, Statoil, Vestavind Offshore, Lyse Produksjon, Agder Energi, Aker MH, Origo Engineering, Norwind, National Oilwell Norway
- Budget
 - 240 MNOK over 8 years



NORCOWE research areas

1. Wind and ocean
2. Offshore wind technology and innovative concepts
3. Marine operations and maintenance
4. Optimisation of wind farms
5. Common topics
 - Education
 - Security
 - Environment
 - Test facilities and infrastructure



Industrial Clusters

- Two industrial clusters focusing on offshore wind are under development in Norway
- One is developing with Bergen/Stavanger (west Norway) as a centre, the other one is developing with Verdal/Trondheim (mid-Norway) as a centre
- More than 100 companies are connected to these two clusters
- Both initiatives awarded governmental funding for cluster development
- Cooperation between the clusters for the development of demonstration sites for offshore wind



Wind energy cluster Mid-Norway

"Building Norway's Bremerhaven"



Key facts mid-Norway cluster

Wind energy cluster:

About 40 industry companies, energy suppliers and R&D institution with interests in the market for offshore wind

Objective: To be a key industrial area in the European market for offshore wind

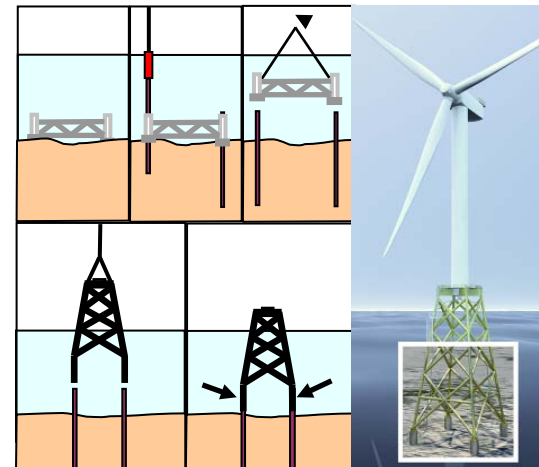
Mid-Norway:

3 counties: Nord-Trøndelag , Sør-Trøndelag and Møre og Romsdal

Trondheim; regional capital with 170.000 inhabitants

The Norwegian University of Technology and Science

Strong industry within oil & gas, cleantech and agriculture



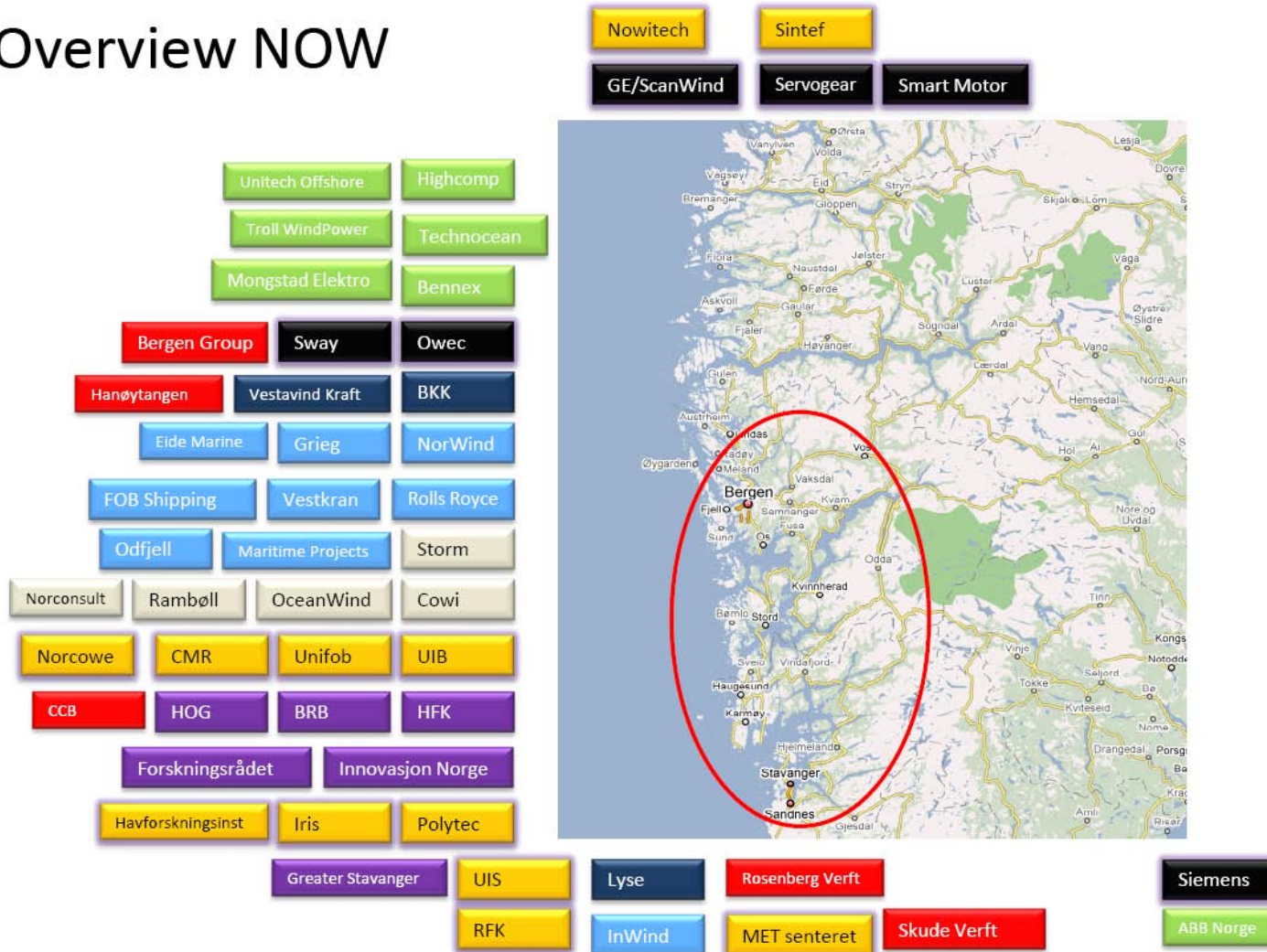
Arena Norwegian offshore wind (NOW) in west Norway



Industrial cluster of suppliers and operators located in the west of Norway working together to develop and deliver complete offshore wind farm solutions

Arena NOW – Bergen/Stavanger

Overview NOW



- | | | |
|--------------------------------|----------------------------------|-------------------------------|
| ■ Foundations / WTG components | ■ Marine Operations / shipping | ■ Ulility / Operatør |
| ■ Yard / base facilities | ■ Equipment / technical services | □ Consulting / Other services |
| ■ R&D and education | ■ Public services | |

Arena NOW – an experienced cluster for realising next generation offshore wind solutions

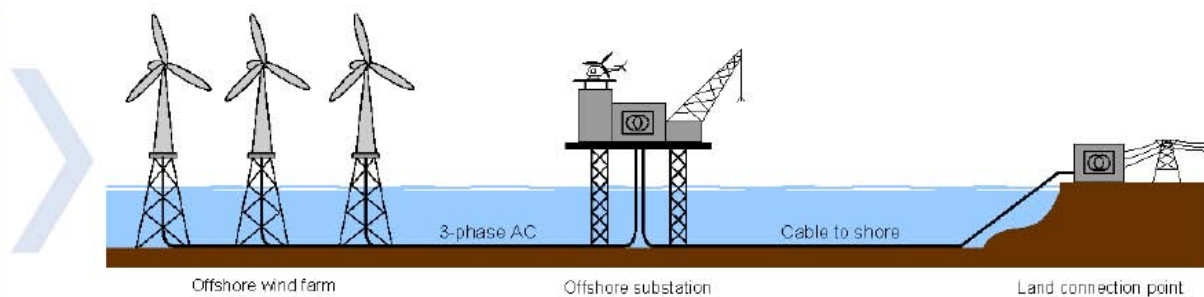
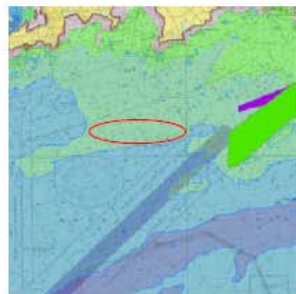
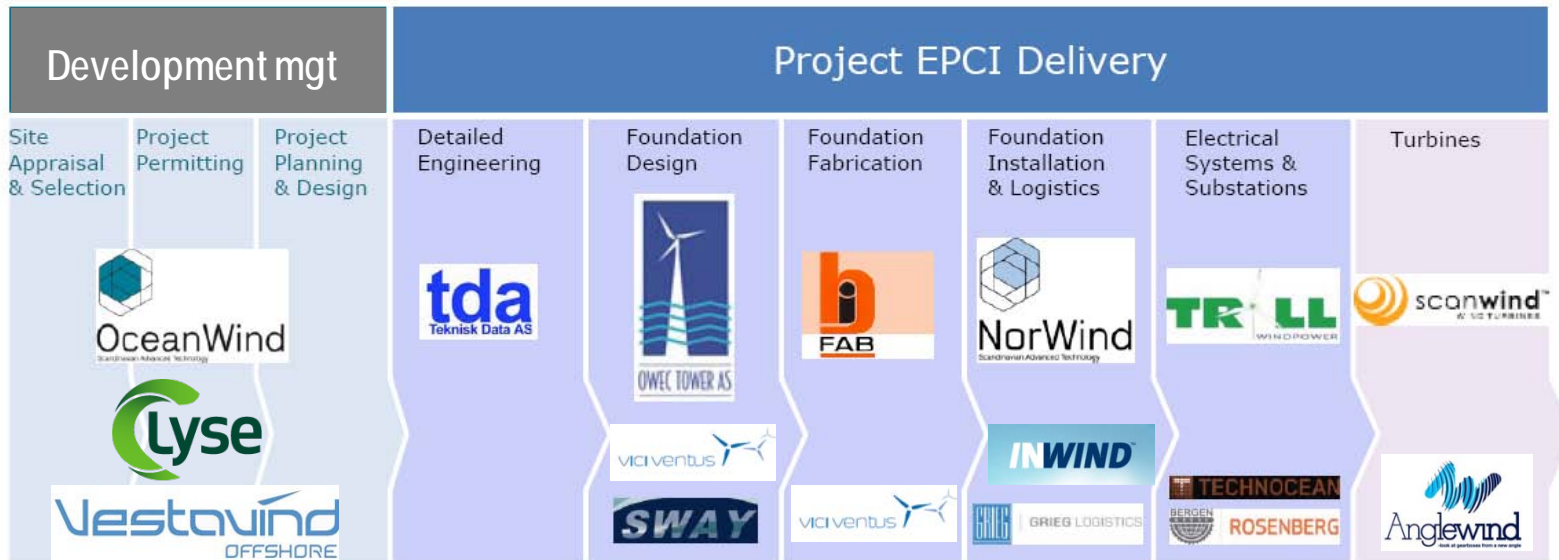


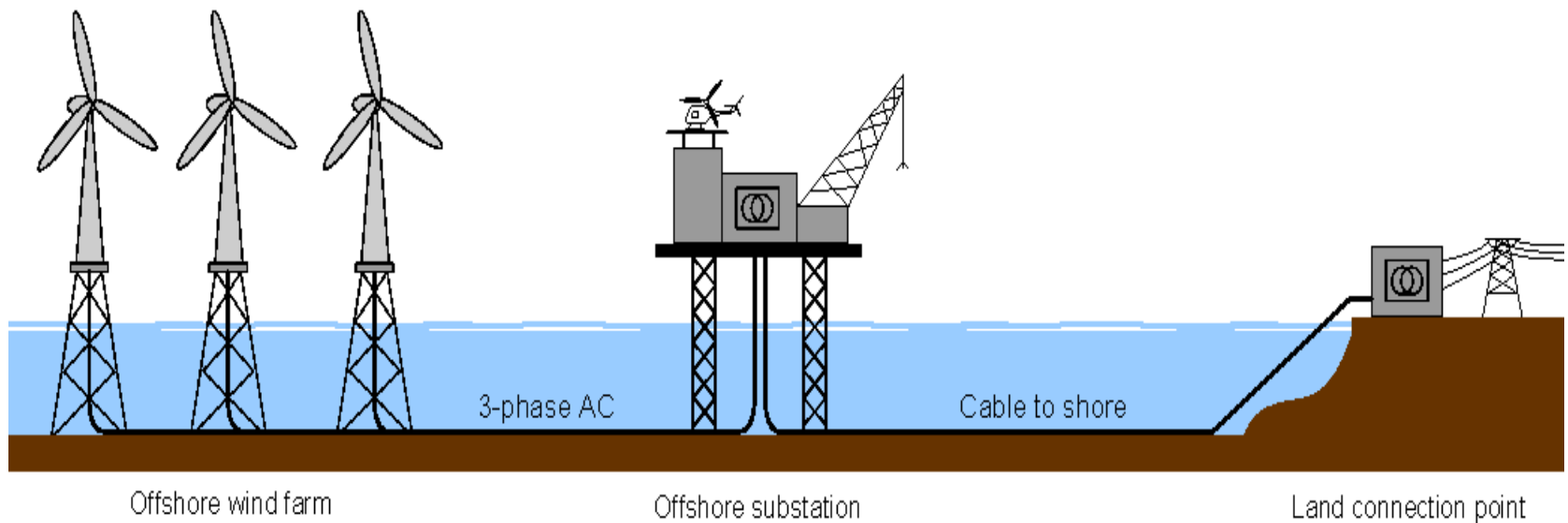
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Offshore Wind Technology - overview



Wind Turbine Generators (WTGs)

Typical WTG data:

- Rotor diameter 100-130 metres
- Nacelle weight 200-400 tons
- Height above water level 100 metres
- Power output 5 MW



The Alpha Ventus offshore wind farm: Repower 5M on top of OWEC Tower jacket foundations in the foreground & Areva Multibrid 5M on top of Aker Verdal tripods in the background.

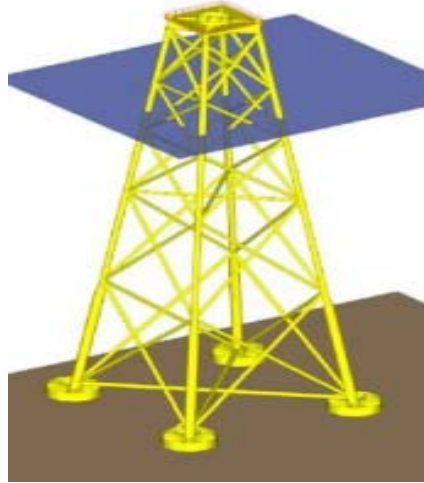
Offshore Access Systems & Offshore Substations



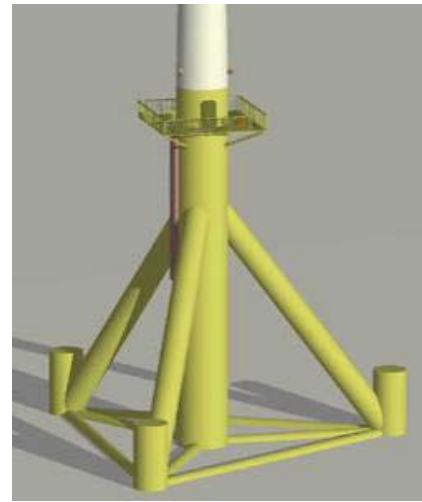
WTG Foundations – current technology



Monopiles



Jackets



Tripods



Gravity based

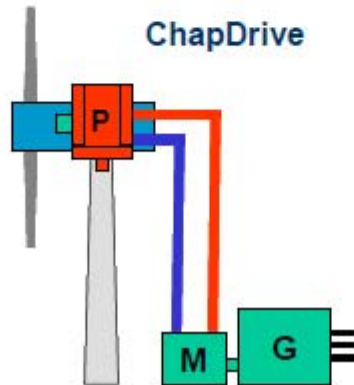
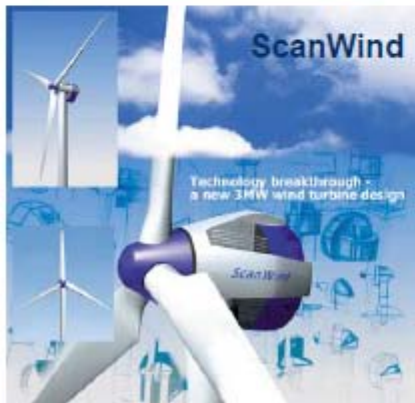
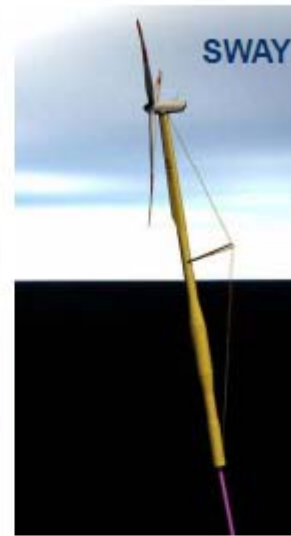
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Norway is developing offshore wind technology



Bottom-fixed foundations - a current solution/reference!



NorWind/BiFab/OWEC Tower

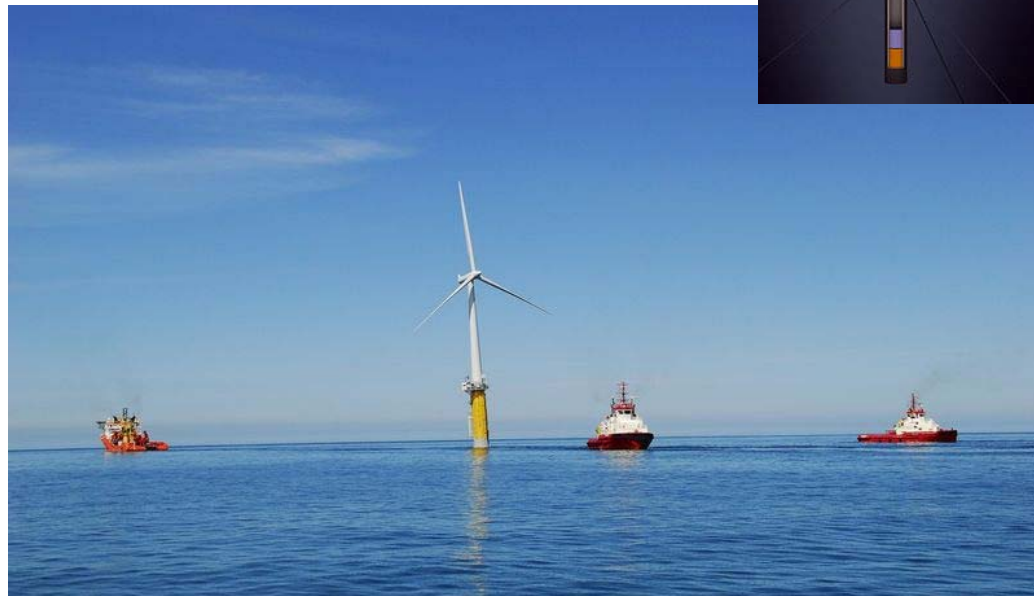
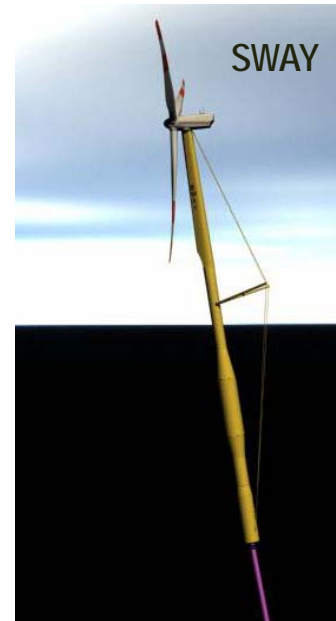


Aker Verdal



Vici Ventus

Floating wind turbines - a solution for the future!



- ▶ HyWind 2,3 MW test in operation Sept. 2009
- ▶ Still a long way to go before large scale commercial deployment of floating wind turbines

Offshore substation

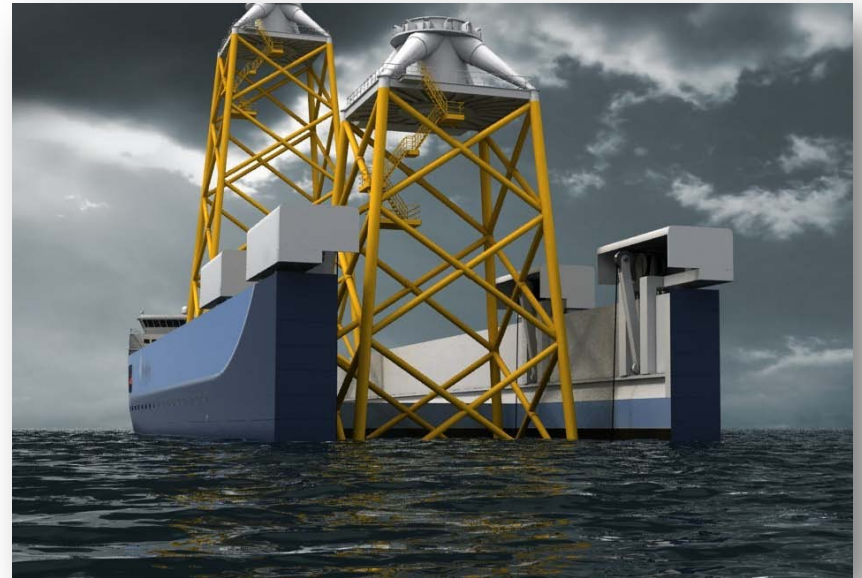
- A modular system with several advantages:
 - It makes planning easier and saves time
 - The equipment can be ordered in early stage
 - Necessary analyses can be done in advance
 - Flexible design – easy to expand



Special purpose installation vessels being developed

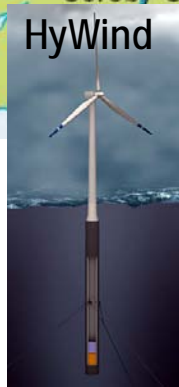
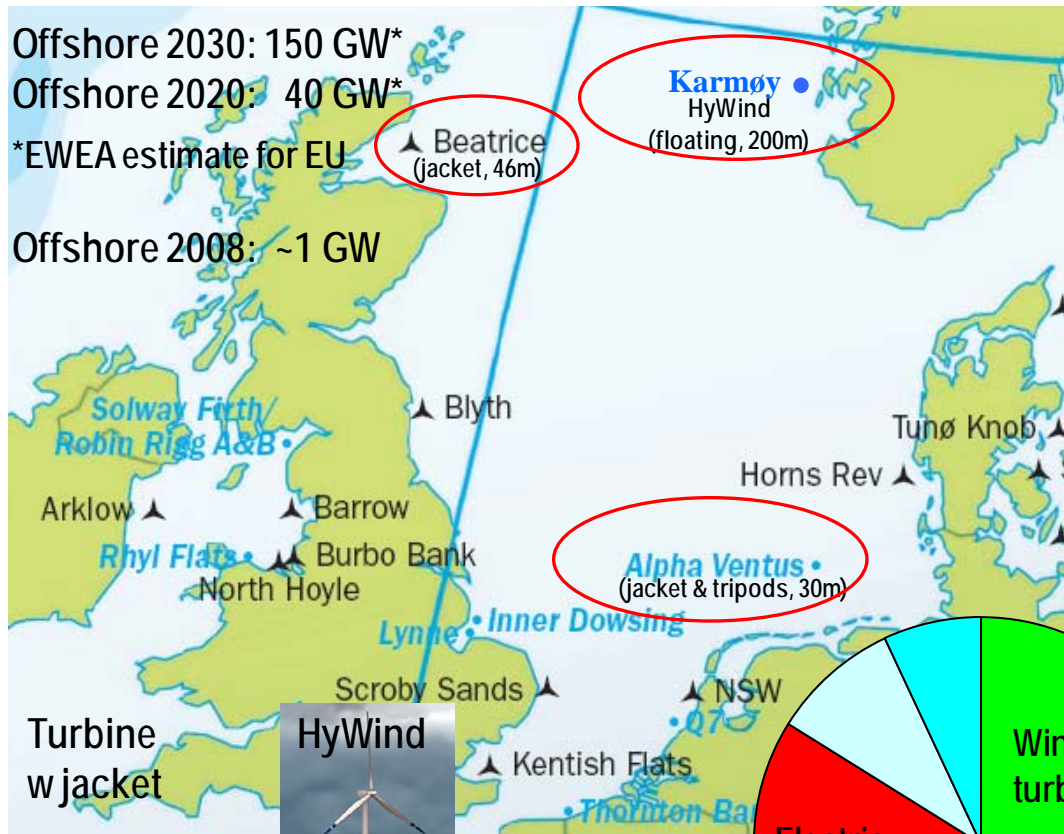


Master Marine – under construction for Sheringham Shoal work

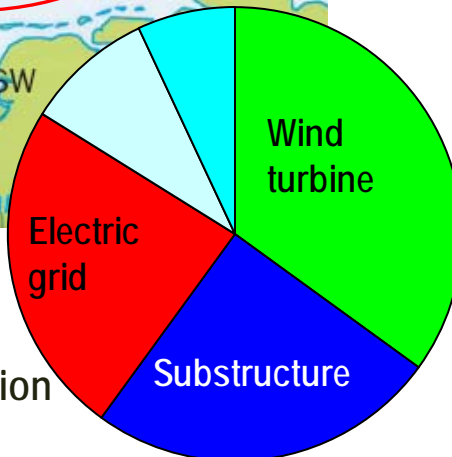


NorWind - patent pending

Offshore wind projects installed including Norwegian suppliers and operators

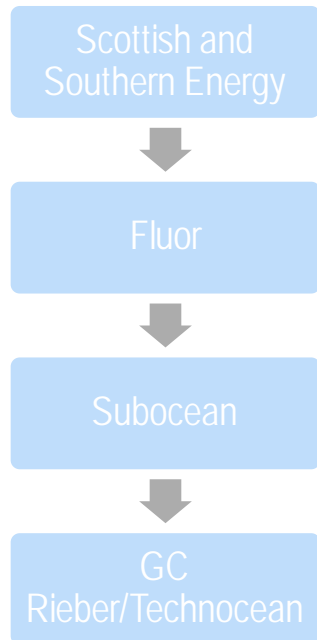


CAPEX distribution OWF (DTI study)




- ▶ Huge potential: 150 GW expected by 2030 in EU
- ▶ Offshore wind is vital for battling climate change, development of industry and contributing to security of supply
- ▶ Development at an early stage – only 3 full scale tests on +30 m water depth realized by 2009
- ▶ Strong motivation for offshore wind R&D -technology needs to be developed to reduce costs per kWh

Real case: Greater Gabbard cable installation



Subocean charters Polar Prince for Greater Gabbard job



Trenching and Cable Lay Operations

- Ploughing – passive system, high demands on vessel, high fuel consumption
 - Passive system, high vessel requirements
 - High fuel consumption
 - Limited manoeuvrability
 - Alternative systems higher day rates and higher personnel requirements



- The Polar Prince, is outfitted with a cable lay spread and cable plough to lay and bury the 33 kVA lines in around 20 metres of water, as well as survey and remotely operated vehicle spreads.
- Two-year charter, with three one-year options. Subocean says the contract represents £30m.
- Polar Prince also slated for cable lay assignment on the Vattenfall Thanet wind farm project.

Real case: Alpha Ventus – the first offshore wind project based upon pre-piling of jacket foundations

- NorWind conducted engineering, procurement, construction and installation (EPCI) of 6 jacket foundations to first offshore project in Germany
- Contract value of approx. Euro 32 mill.
- Client was a consortium of Vattenfall, Eon and EWE (DOTI)

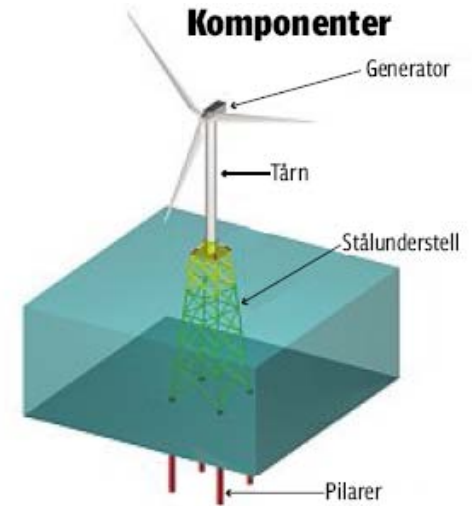
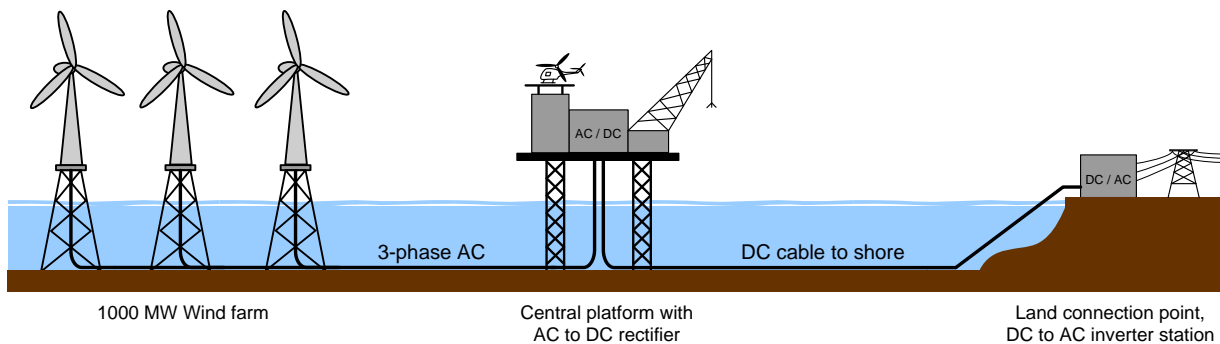


Pilot offshore wind farm in Norway

The need to develop a pilot offshore wind farm in Norway is being argued for towards Norwegian politicians from the Norwegian industry clusters and R&D Centres.

Such a pilot is a key requisite to qualify Norwegian technology towards the large offshore wind markets in the UK and Germany.

A pilot offshore wind farm must include the development of a full scale system as well as testing out various components of offshore wind technology.



Conclusion

- Remarkable results are already achieved by Norwegian companies for offshore wind projects in deep waters
- Technology and industry still in an early phase
- Large potential for technology and industry development in order to bring cost down to a competitive level
- A huge untapped wind resource potential for offshore wind in Norway and rest of the world
- The Norwegian offshore wind clusters are well-positioned to play an active role within this new, emerging industry
- There is a need to develop a pilot offshore wind farm in Norway in order to qualify Norwegian industry for the large world-wide market
- NORCOWE and NOWITECH play significant roles in providing new knowledge as basis for industrial development of cost-effective offshore wind farms at deep sea