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Norwegian Centre of Excellence

The bet for the technological development of offshore wind

as seen from Norway

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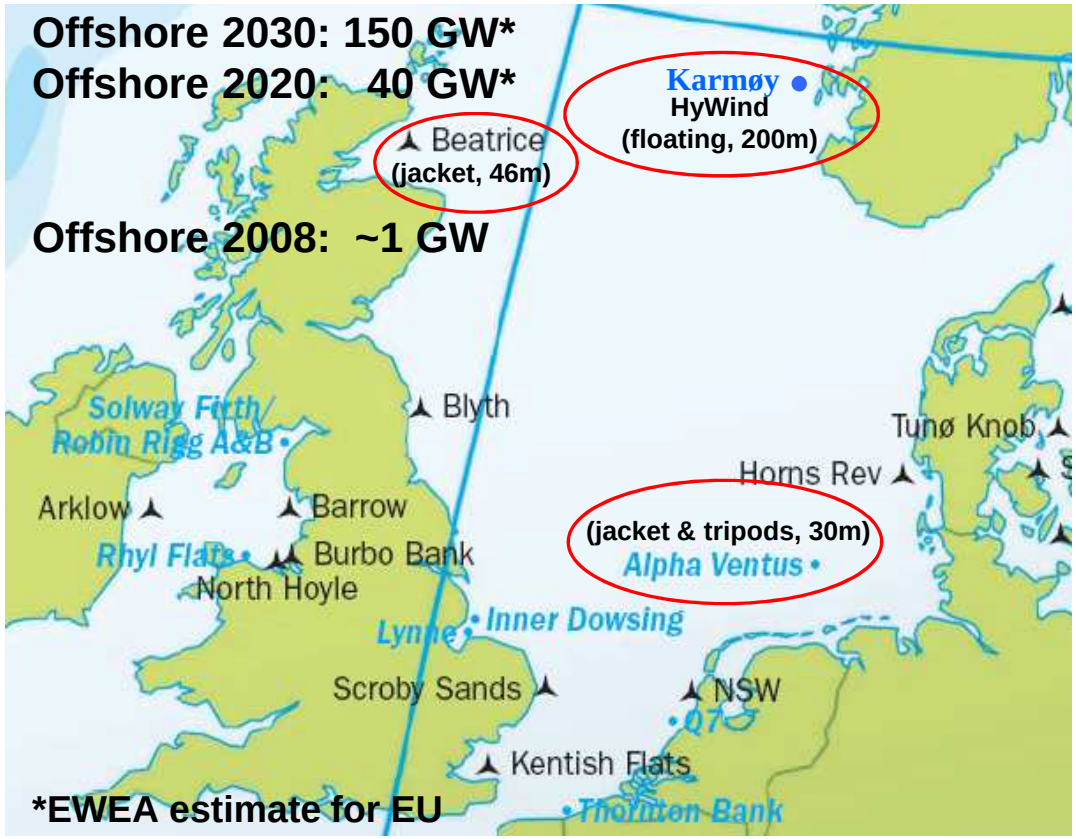
NTNU
Innovation and Creativity

Offshore wind technology needs to be developed



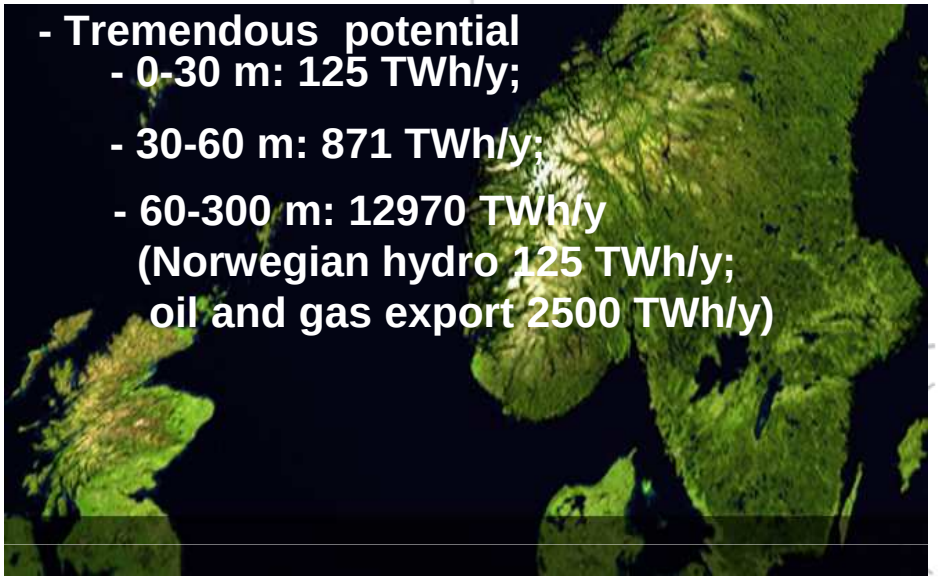
- Huge energy resources
- Development at an early stage
- Installations so far are all close to shore and applying on-shore wind technology
- Challenges related to installation, operation, maintenance and repairs have been underestimated
- Significant potential provided technical development and bringing cost down to a competitive level

Targets:

- Improve reliability
- Reduce cost per kWh
- Exploit deep sea

Wind power in Norway

- About 20 km off the coast of Norfolk
- Joint venture with Statkraft & Statoil
- 315 MW installed capacity
- Construction starts in 2009, power generation from 2011
- Total investment of NOK 10 BN

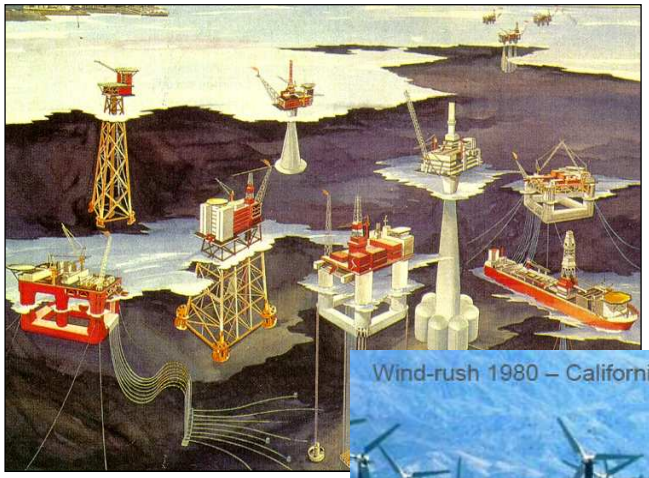


- Wind power industry

  Limited land-based & offshore turbines

- Offshore oil & gas industry, ship transport, aquaculture..

Transfer of technology:



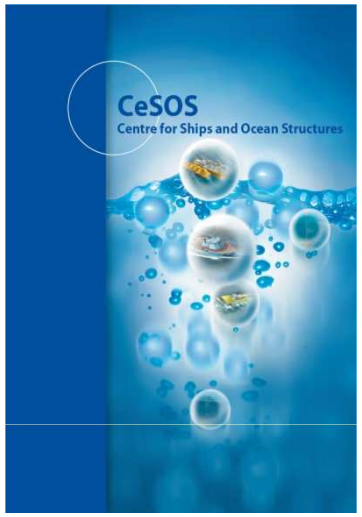
Differences from other marine structures

Number of units – one of a kind versus mass production.

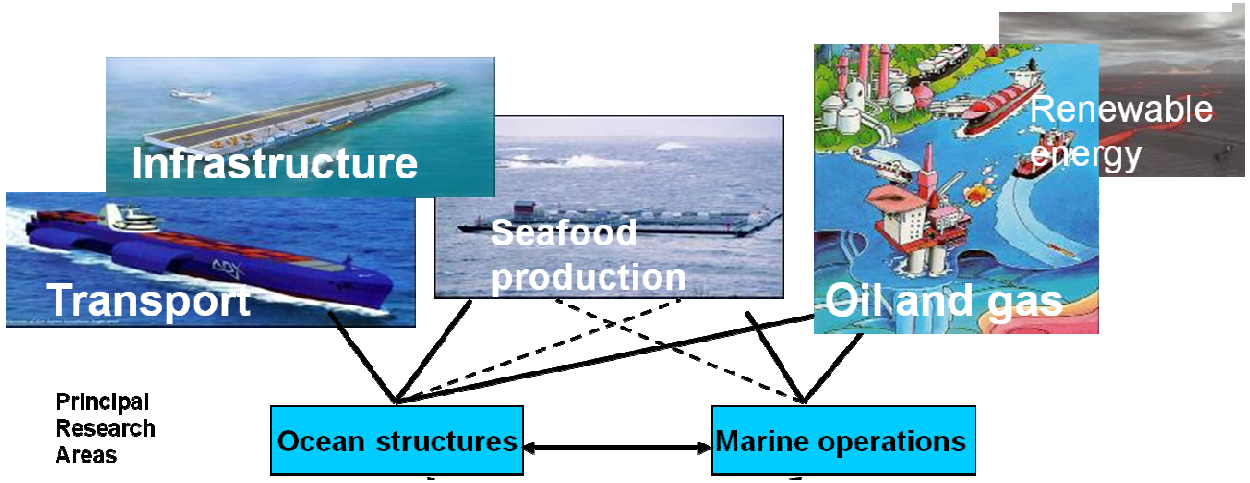
- **Return are more sensitive to O&M costs (access)**
- **Safety issues - No hydro carbon and people on board**
- **Marginal business**

Research and development

Industry & NTNU SINTEF IFE



Safe, sustainable and economical utilis



NOWITECH

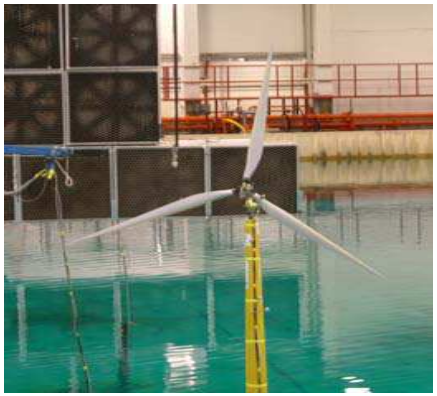
Norwegian Research Centre for Offshore Wind Technology

Objective: Pre-competitive research laying a foundation for industrial value creation and cost-effective offshore wind farms – in deep water

- annual budget MNOK 45

Relevant laboratories and field test facilities

Ocean basin 80x50x10 m

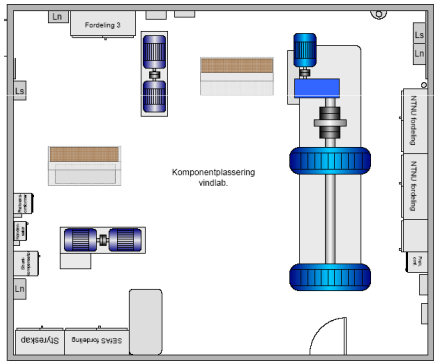


Wind tunnel 11x3x2 m

2x45 m + 2x100 m masts

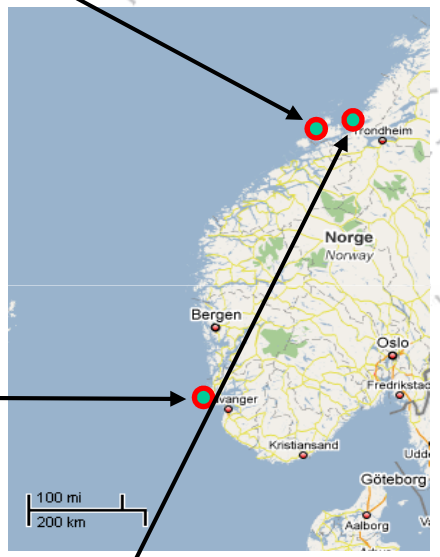
Met-ocean buoys, lidars, etc (to be procured & operated jointly with NORCOWE)

Renewable Energy Sys Lab



Material testing

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



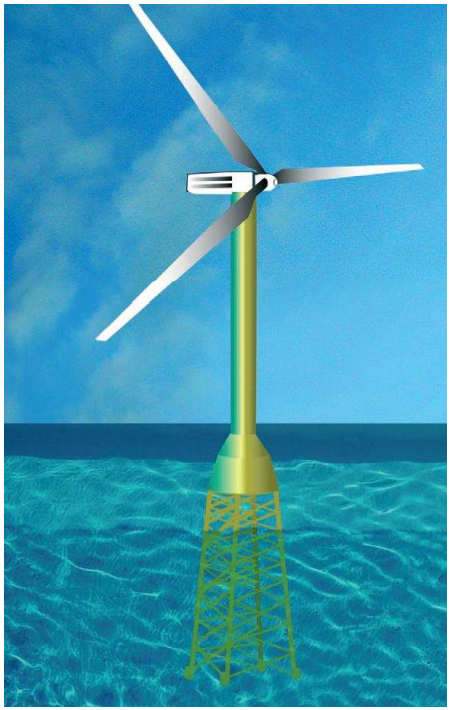
Test station for wind turbines – VIVA AS
Average wind speed 8.4 m/s @ 50 m agl

Photo / Visualisation: InterPares AS

Offshore Wind Power Concepts

“Standard” mono-pile (0-30 m)

Turbine w/jacket (30–60 m)



Floating turbine (100 m -)

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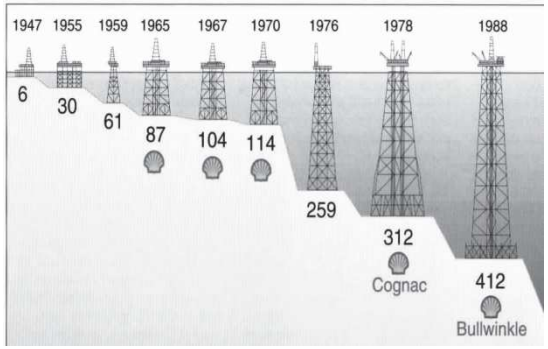
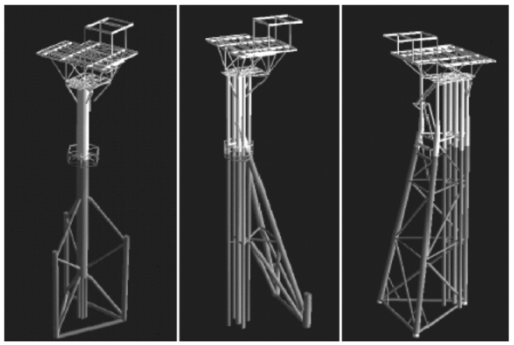
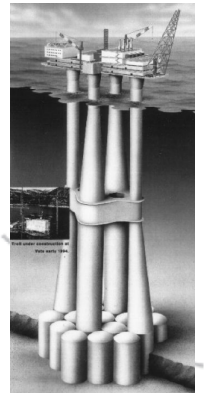
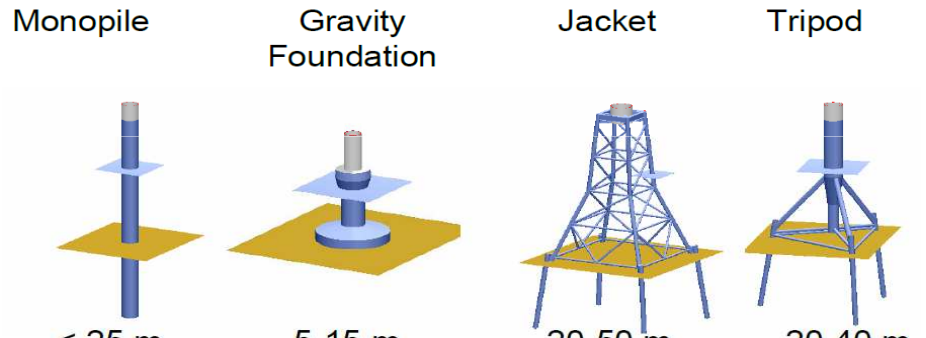
Bottom supported turbines







Example minimal platform concepts



Thorntonbank

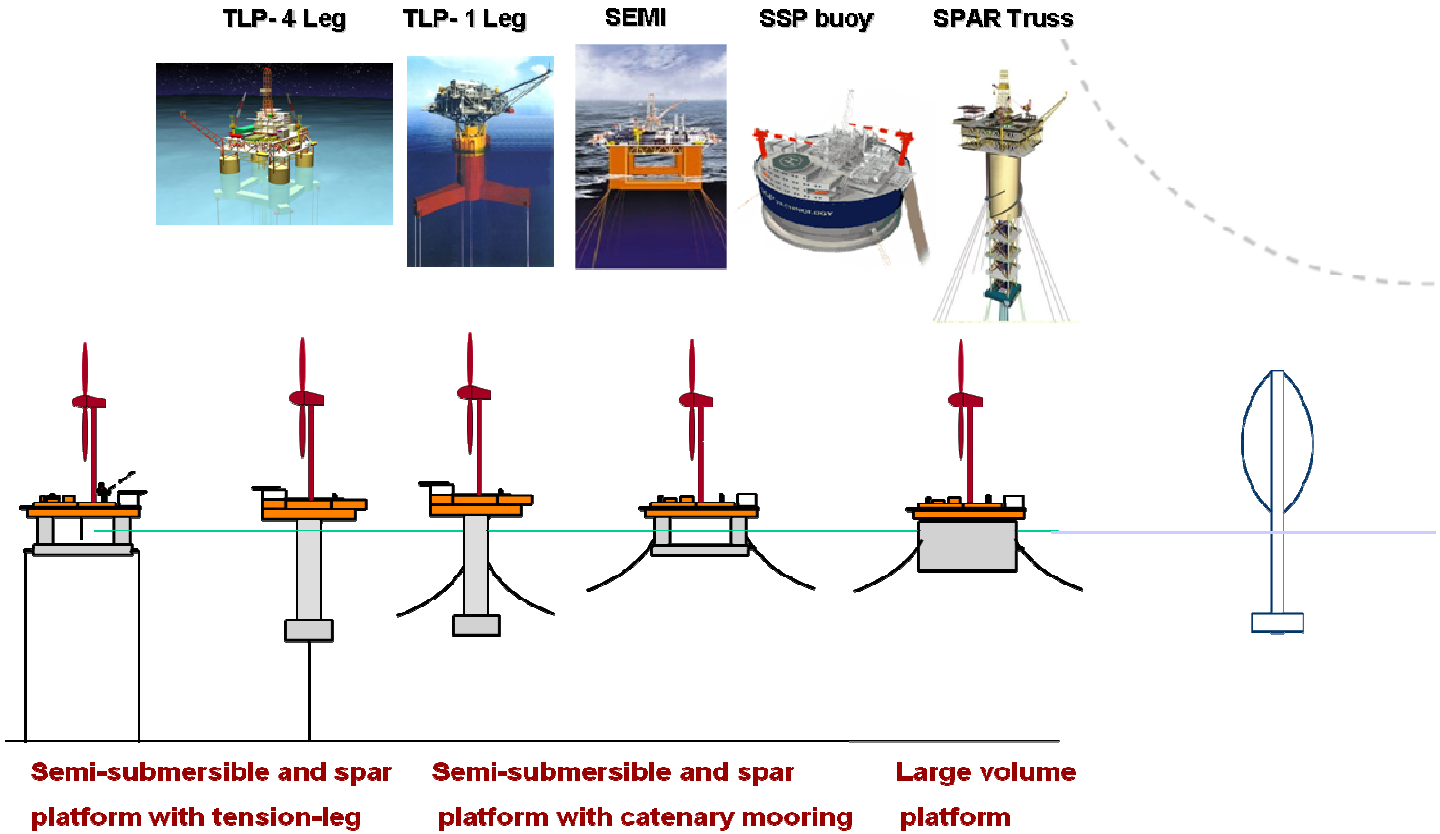
Beatrice (Owec Tower)

Alpha Ventus (Aker Verdal)

- Alternative tower design, structural material, downwind /upwind rotor)
- foundation technology
- design for mass production and easy installation
- transport and installation (complete installation in-shore and then float- out)

Floating Wind Turbines

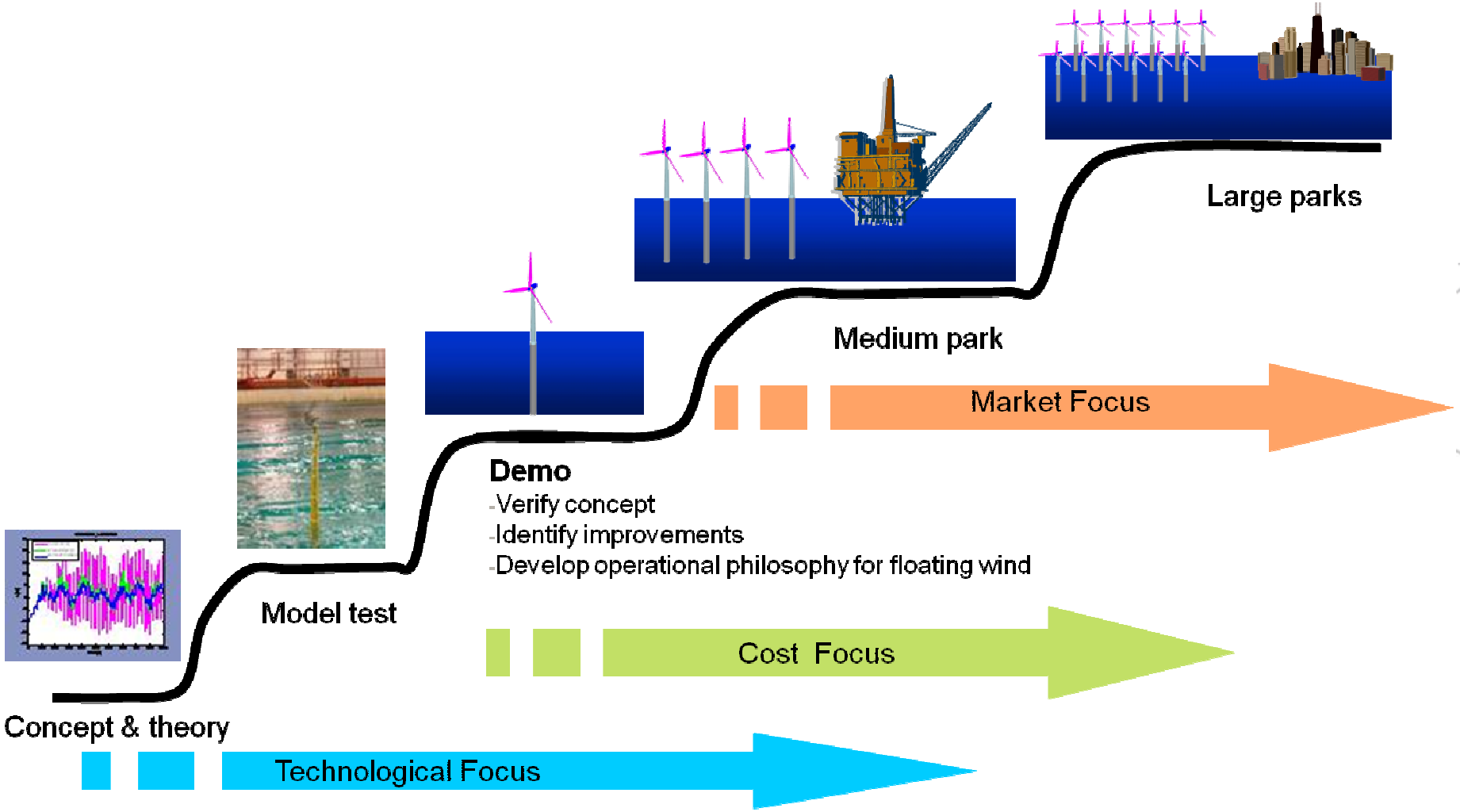
vs offshore production systems for oil and gas



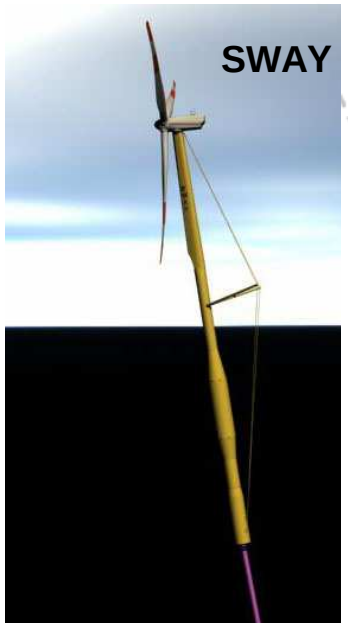
Variation of concepts

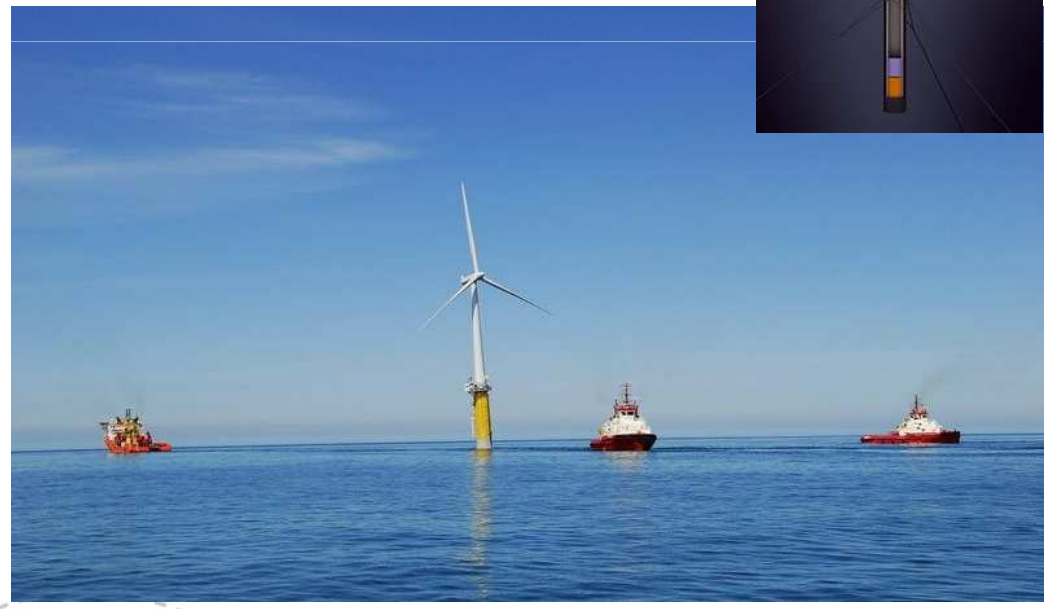
- Support principle
- HA Upwind / downwind turbine,VAT
- Number of blades
- Tower construction
- Number of units on a floater

From idea to commercial concept



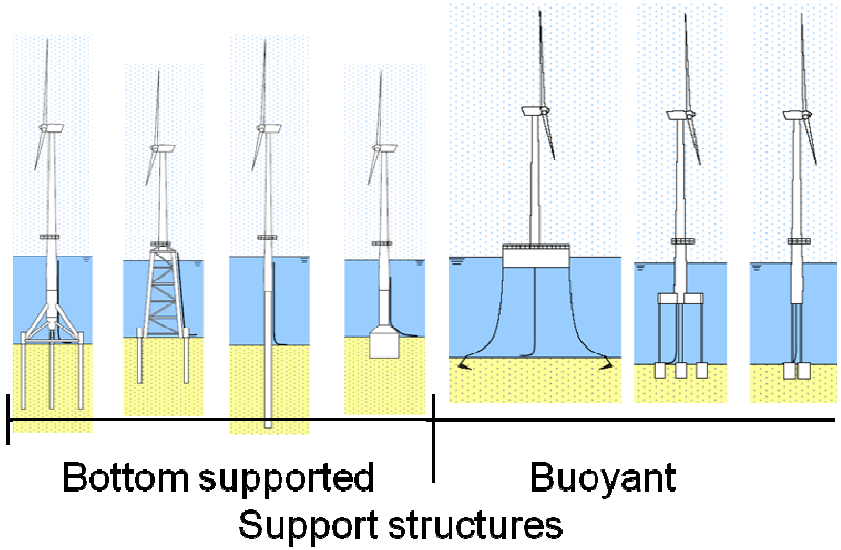
Ongoing projects on floating wind turbines in Norway





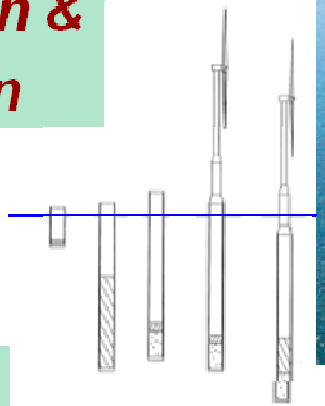
- HyWind 2,3 MW test in operation Sept. 2009
- Still a long way to go before large scale commercial deployment of floating wind turbines

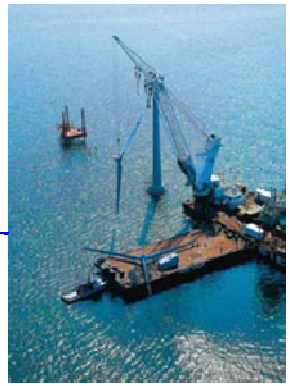
Life Cycle Planning of Offshore Renewable Energy Facilities



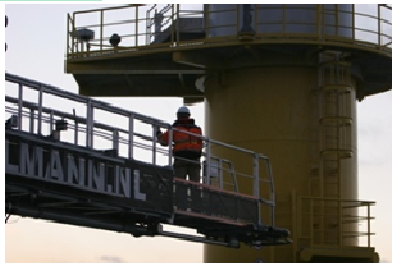
Design

Fabrication & Installation





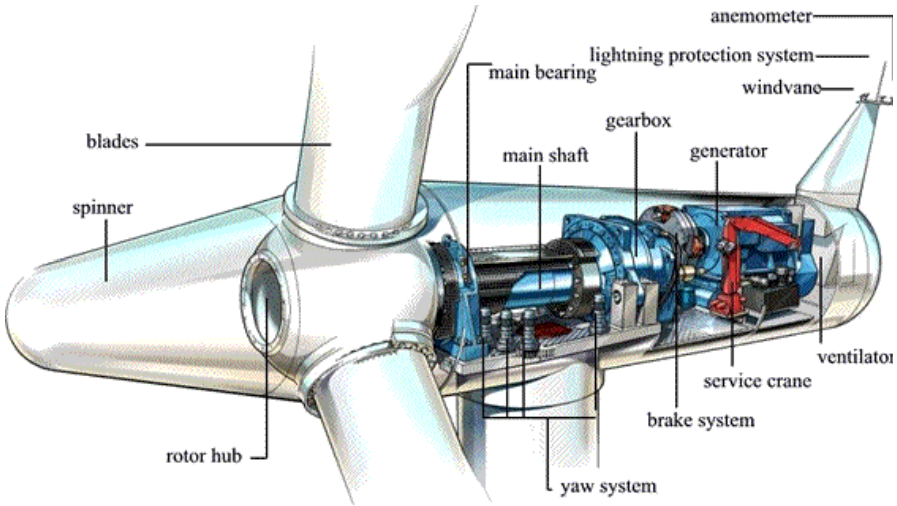
Operation



+ Installation of the mooring system

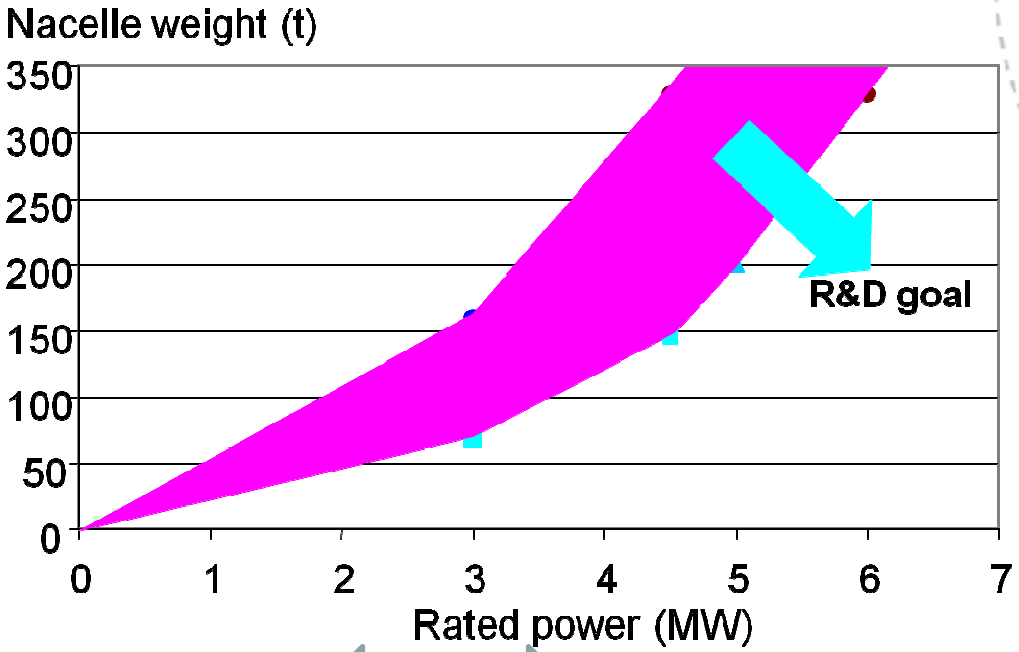
Development of the power train
“Same looks - different insides”

Fixed or variable speed w/gear box



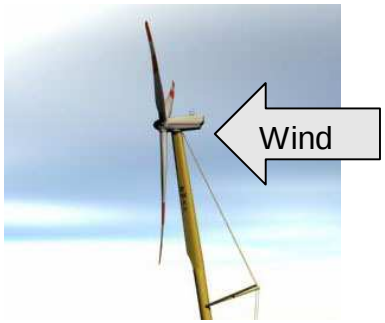
Direct drive variable speed

Some alternative ways to reduce top weight

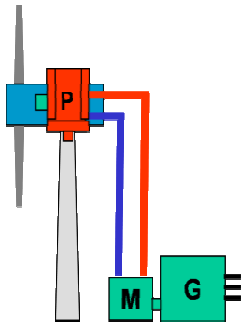


Use
- **new materials and**
- **new designs**

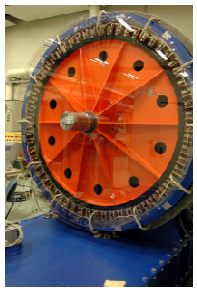
Commercial power today



Downwind turbine



Hydraulic transmission



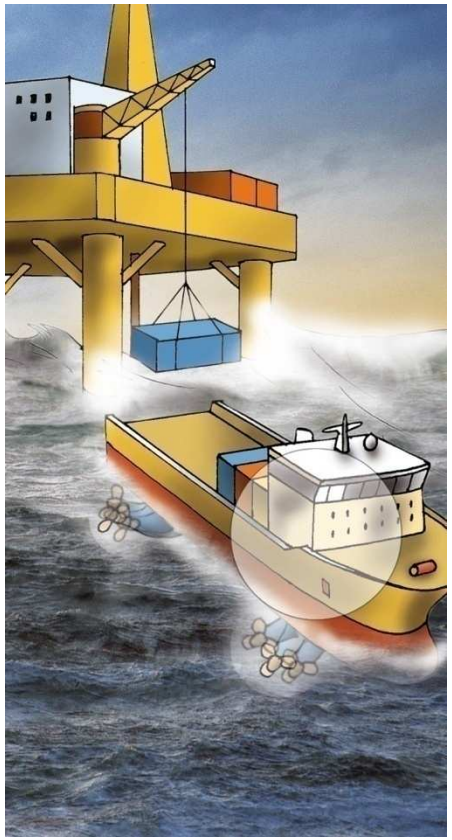
Smart generators

Marine operations

- installation

- service, maintenance

Wave Height, H_{lim}	Percentage of time $H < H_{lim}$	
	Winter	Summer
1 m	2	15-20
2 m	15-25	60-75
3 m	35-45	90-95



Access to
large offshore units

Access to small units
- wind turbines, wave- and current power units

Concluding remarks

- A huge untapped potential for offshore wind power
- Remarkable results have already been achieved by the industry and R & D organisations
- Technology is still at an early stage (model test/demo level)
  - a significant improvement potential exists
- Joint R & D efforts are required
  (we in Nowitech… expect to contribute..
  and important issue being transfer of
  knowledge from offshore oil and gas exploitation……)