

ENERGY

# Floating wind technology

Future development

**Johan Slätte**

24 January 2014

# DNV GL Group



**DNV GL Group**  
Headquarter: Oslo, Norway  
Group President & CEO: Henrik O. Madsen



## Maritime

Headquartered in  
Hamburg, Germany

Appr. 6000 employees

## Oil & Gas

Headquartered in  
Høvik, Norway

Appr. 4500 employees

## Energy

Headquartered in  
Arnhem, Netherlands

Appr. 3000 employees

## Business Assurance

Headquartered in  
Milan, Italy

Appr. 2000 employees

DNV GL Renewables Advisory  
DNV GL Renewables Certification



1. Floating wind energy – DNV GL's work
2. Industry status, pathway to commercialization and costs
3. Visions for a future floating wind industry
  - Demonstration projects and small scale arrays – New applications
  - Cost compression and technology developments
  - What the future may look like
4. Concluding remarks





## 1. Floating wind energy – DNV GL's work

2. Industry status, pathway to commercialization and costs

3. Visions for a future floating wind industry

- Demonstration projects and small scale arrays – New applications
- Cost compression and technology developments
- What the future may look like

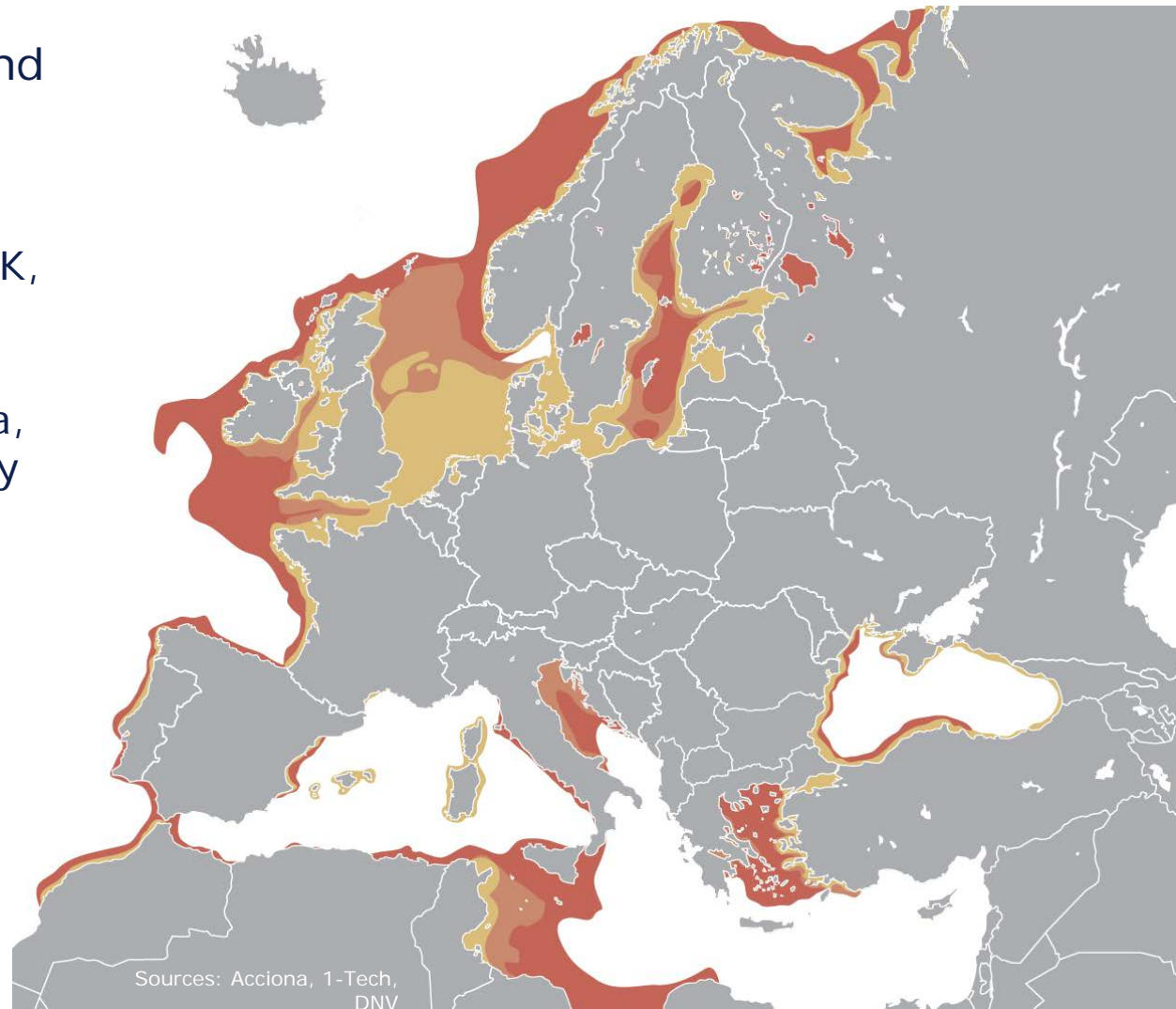
4. Concluding remarks



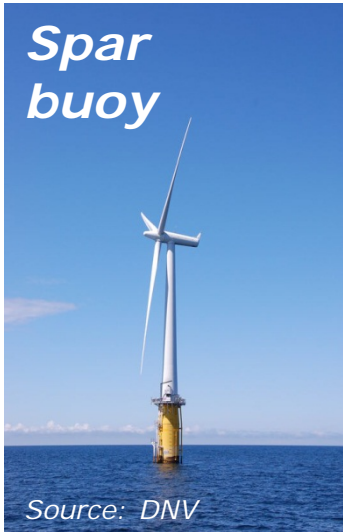
## Vast resources – supreme energy yield sites

Hotspots for floating wind developments:

- In Europe:
  - Towards the Atlantic: UK, Ireland, Spain and Portugal
  - The Northern North Sea, off the coasts of Norway and the UK
- The US
- Japan



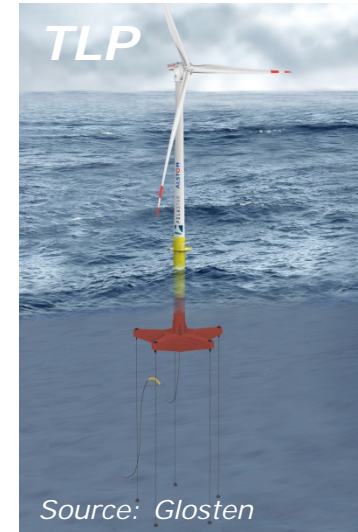
# An emerging industry - An ocean of different concepts



*Hywind*



*WindFloat*



*PelaStar*



*Kabashima*



*Tri-Floater*



*GICON*

# Time for innovation...and consolidation

DNV GL have closely followed the development of the floating wind industry from its early days;

Core activities by DNV GL:

- Benchmarking studies
- Market analysis
- Technology evaluations
- Guideline and Standard development
- Conceptual design verification
- Prototype certification / Project certification

**Offshore Wind Floating System Demonstrator: Technology comparison**  
**Overview of Technical and Commercial comparison**

2012-04-01 | DRAFT | MANAGING RISK | DNV GL

**Assessment of standards for offshore wind parks**

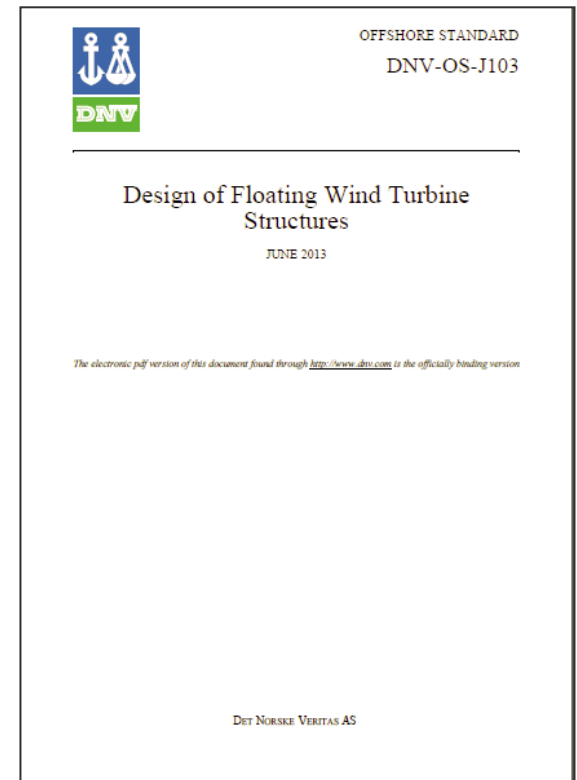
**Offshore Wind Floating System Demonstrator: Market assessment Executive summary**

**Key Markets for Floating Wind Platforms:**

Country	Deep sea wind potential	Market Prospects
UK	Deep sea wind potential is 130 GW	Strong market prospects
Norway	Deep sea wind potential is 140 GW	Good market prospects
Sweden	Deep sea wind potential is 41 GW	Good market prospects
Denmark	Deep sea wind potential is 7 GW	Good market prospects
France	Deep sea wind potential is 50 GW	Good market prospects
Spain	Deep sea wind potential is 80 GW	Strong market prospects
Portugal	Deep sea wind potential is 40 GW	Good market prospects
Italy	Deep sea wind potential may be up to 100 GW	Good market prospects
China	Deep sea wind potential is 40 GW	Strong market prospects
Japan	Deep sea wind potential is 28 GW	Strong market prospects
Korea	Deep sea wind potential is 25 GW	Strong market prospects
US	Deep sea wind potential is 101 GW	Strong market prospects

## Standard development; DNV-OS-J103

- DNV-OS-J103 Design of Floating Wind Turbine Structures was published in June 2013
- Can be downloaded for free on [www.dnv.com](http://www.dnv.com)
- Developed through a Joint Industry Project (JIP) during 2011 – 2013
- Industry hearing April 2013
- Participants:
  - Statoil
  - Nippon Steel & Sumitomo Metal Corporation
  - Sasebo Heavy Industries
  - STX
  - Navantia
  - Gamesa
  - Iberdrola
  - Alstom
  - Glosten Associates
  - Principle Power





## Contents of DNV-OS-J103 – Technical issues covered

- Safety philosophy and design principles
- Site conditions, loads and response
- Materials and corrosion protection
- Structural design
- Design of anchor foundations
- Floating stability
- Station keeping
- Control system
- Mechanical system
- Transport and installation
- In-service inspection, maintenance and monitoring
- Cable design (structural)
- Guidance for coupled analysis (appendix)



Source: Japan Times

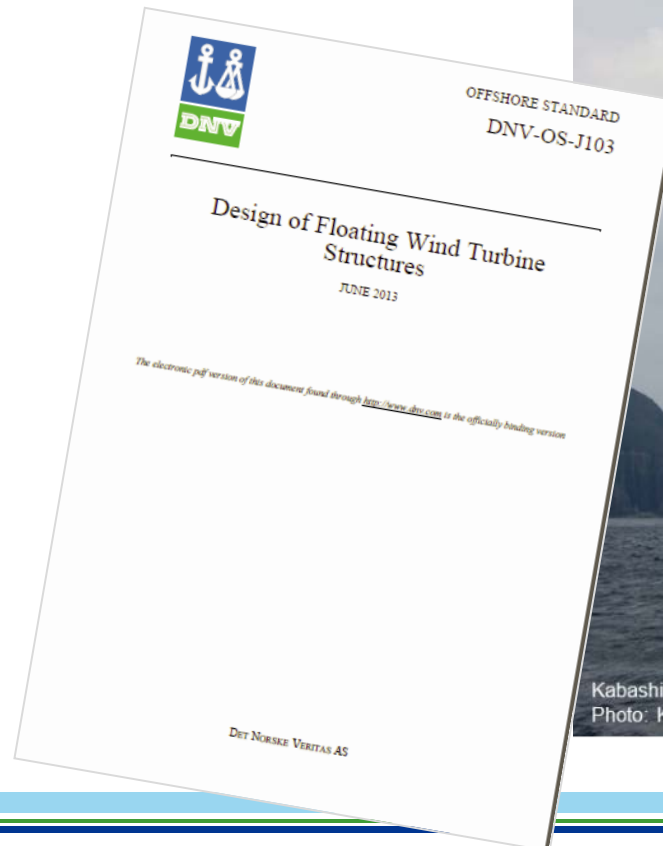
Image: Japan Times

*Mitsui*

# Why is a standard for floaters important?

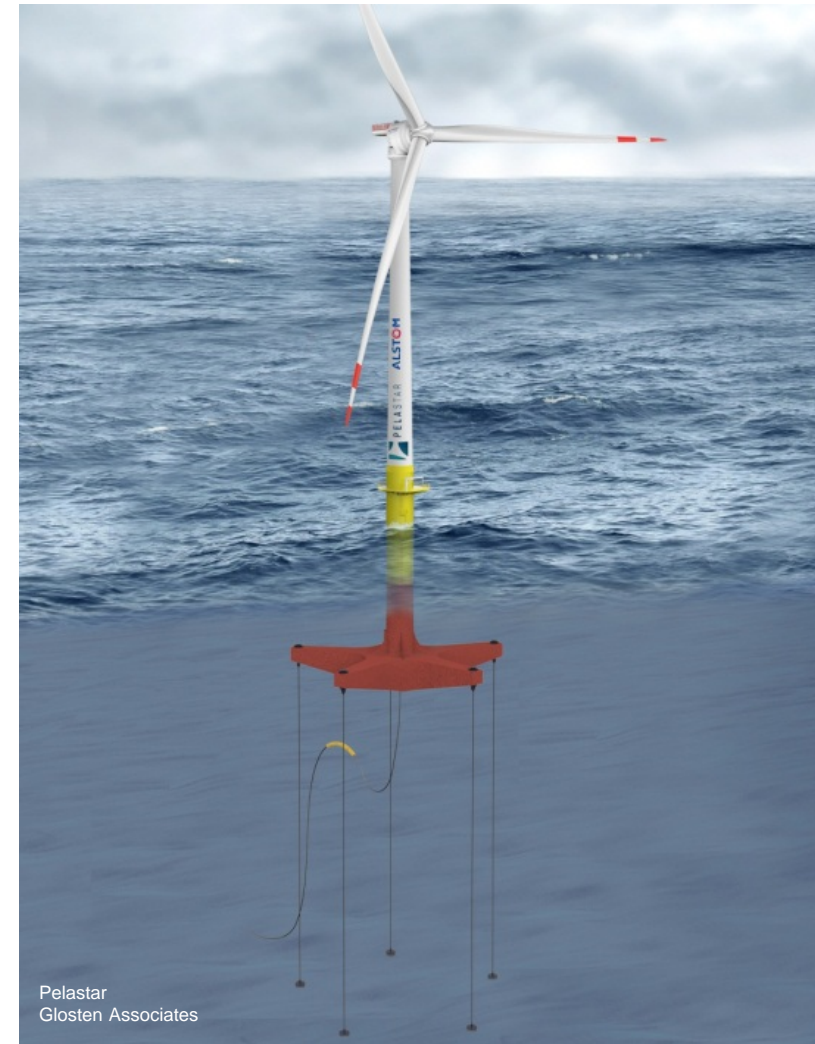
- Expert / industry consensus on design principles
- Capturing industry experience
- Economically optimized designs through rules considering the unique aspects of floating wind turbines

*DNV-OS-J103 Design of Floating Wind Turbine Structures, published in June 2013*

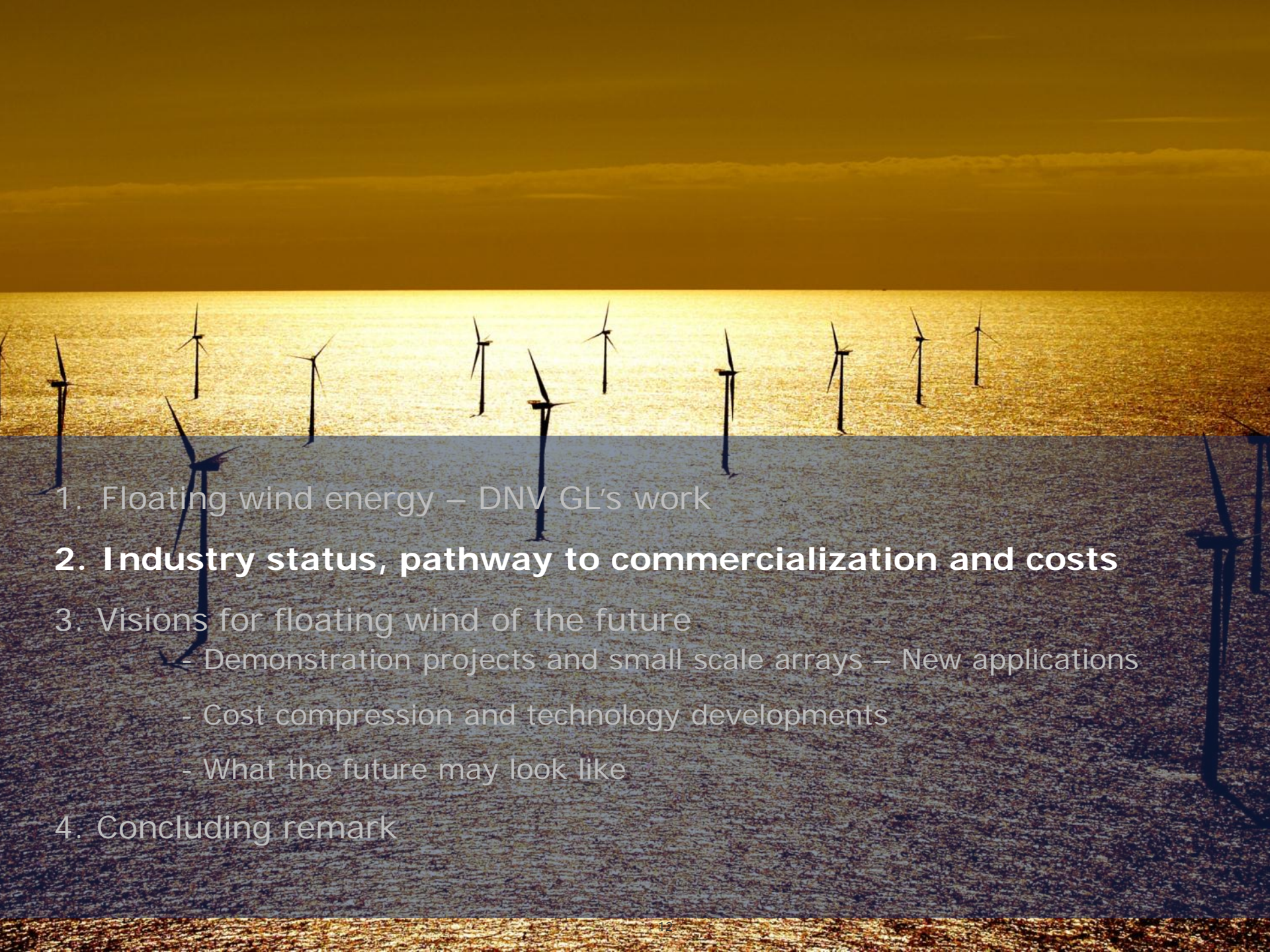


# Application of the standard - Pelastar TLP demonstration project

- Floating wind turbine demonstration project in UK
- Funded by Energy Technology Institute (ETI)
- Glosten Associates' Pelastar TLP design has been selected
- The TLP will support Alstom's 6 MW Haliade turbine
- DNV performs certification of the design against the new standard, DNV-OS-J103
- The project is currently in Front End Engineering Design (FEED) phase
- Planned installation 2015/2016







1. Floating wind energy – DNV GL's work

**2. Industry status, pathway to commercialization and costs**

3. Visions for floating wind of the future

- Demonstration projects and small scale arrays – New applications
- Cost compression and technology developments
- What the future may look like

4. Concluding remark



# Floating wind technology – A rapid development

**RECHARGE**

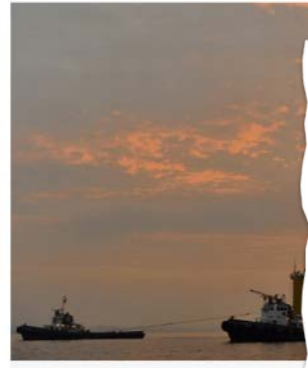
News Wind CIVICA 2012 Solar

all In depth analysis opinion europe&afica americas asia&australia technology policy&more

## World's first floater turbine inaugurated in North Sea

**2009: The first full scale prototype deployed outside Karmøy, Norway**

## Semi-submersible wind turbine is floating into the future



By Darius Snieckus Póvoa de Varzim Wednesday, November 25 2012  
Updated: Sunday, November 25 2012

Portuguese energy group EDP and US partner have applied for EU funding to help build a 25MW offshore array, following a flawless eight-month trial of the world's first semi-submersible wind turbine.

WindFloat 1 (WF1) has flowed more than 1.7GWh of electricity in 43 metres of water, 5km off Aguçadoura, north of Póvoa de Varzim, Portugal, last autumn. The 1,200-tonne floating concept, which carries a 2.0MW turbine, rode out storms that buffeted it with gusts to 15 metres during its first winter offshore.

The €20m (\$25m) WF1 was built by the WindPlus joint venture between Portuguese shipbuilder A Silva Matos (ASM), venture capitalist and ASM shareholders. The floater is seen as a game-changer in the offshore wind sector.

"We have demonstrated and proven the WindFloat technology. The entire system was fabricated using domestic materials and components. The WindFloat has delivered an energy profile that is competitive with onshore wind farms."

## IN DEPTH: Floating forwards in wind



The Gamesa-Ideol floater

By Darius Snieckus Wednesday, February 13 2013  
Updated: Friday, February 15 2013

**Europe is planting its flag on the floating wind sector with its largest-ever deep-water turbine demonstrator.**

The €36m (\$48.7m) pilot aims to have two distinct prototypes riding the swell off Spain by 2015.

FloatGen, an EU-funded consortium, expects to have engineering wrapped up this year on the concepts:

- a 2MW unit developed around Gamesa's G8X turbine mounted on a "surface floating" concrete platform designed by France's Ideol;
- and a 3MW prototype based on an Acciona AW-3000, with a semi-submersible to be designed by Spanish shipbuilder Navantia and offshore construction specialist Olav Olsen of Norway.

The four-year project is on the fast track. The world's gustiest offshore region, off the UK, will need 6GWh per year from floaters to reach a targeted capacity of more than 245GW by 2050, harnessing 70% of the country's deep-water wind resource.

Progress of the offshore wind industry has been slowed by the economic crisis,

## Japan moves forward with floating wind turbine ambitions



By Glynis.../Flickr

**SHARE STORY**

[Tweet](#)

[Share](#)

[Rekomendera](#) 0

[Contact Us](#)

**RELATED**

US and UK to join forces on floating offshore development

Mitsubishi and Fuji name for Fukushima offshore wind farm

Japan looks to floating offshore wind to boost stricken coast

**SHARE STORY**

[Tweet](#)

[Share](#) 18

[Recommen](#) 0

[Contact Us](#)

**RELATED**

Hywind clears Maine hurdle

Glosten, Michigan group seeks DOE funding for PelaStar

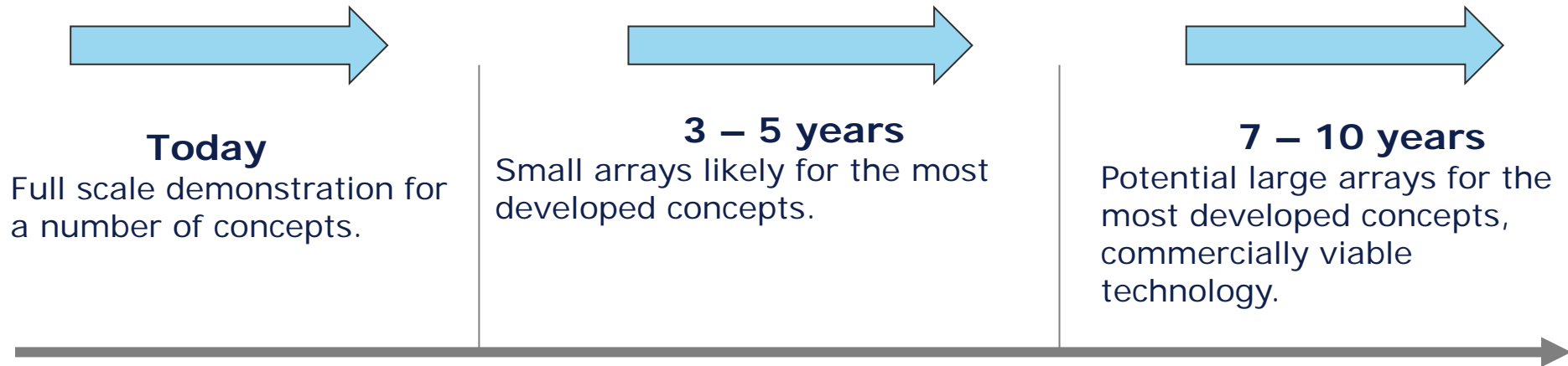
Semi-submersible wind turbine is floating into the future

# Typical development phases for new technologies

There are several natural steps in the development of a new technology:

1. Proof of concept in the lab
2. Concept development and scale testing
3. Prototype demonstration
4. Commercial demonstration and system development

TRL (Technology readiness level) scale can be used to describe the development process.

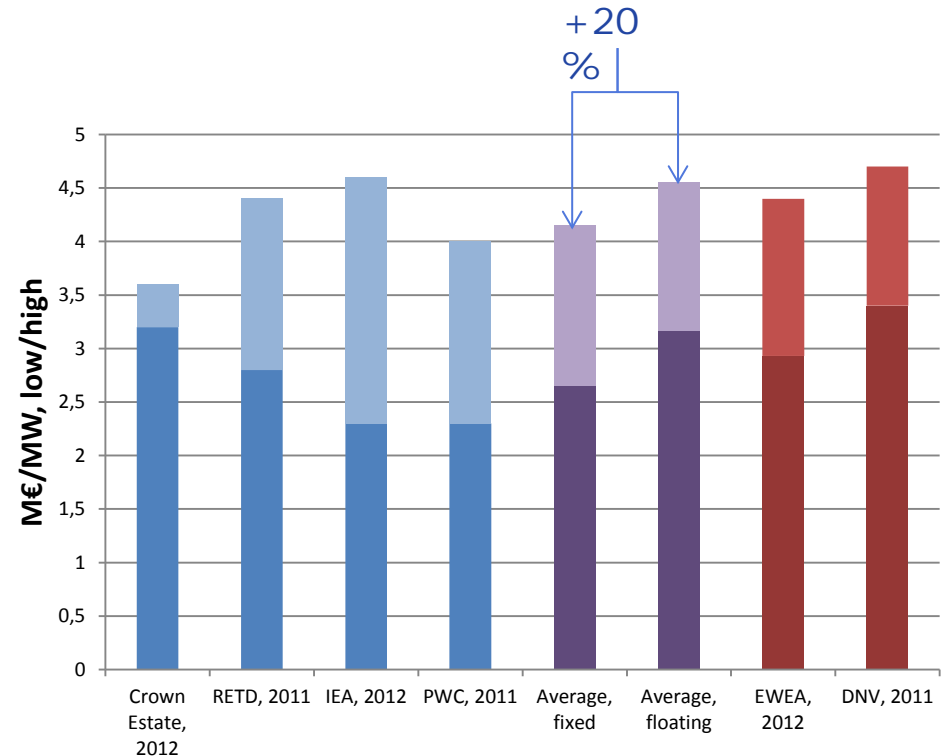




# CAPEX estimations – floating vs. bottom fixed turbines

*Floating wind turbine CAPEX is estimated to be **approximately 20 % higher** for than bottom-fixed wind energy.*

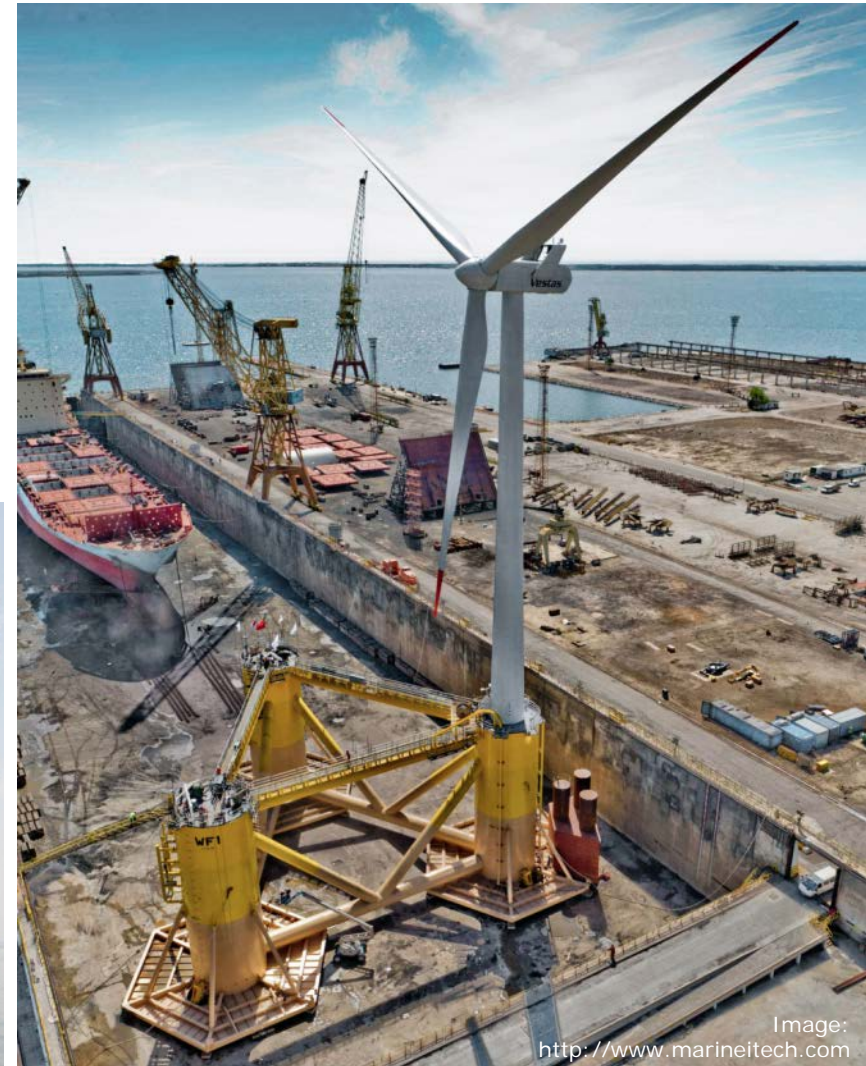
DNV (2012) The Crown Estate – UK Market Potential and Technology Assessment for floating offshore wind power



*Considering potential for a higher energy yield as well as an OPEX at least equal with bottom fixed wind turbines, the cost of energy gap could be considered even smaller*

## Higher energy yield and an efficient supply chain

- Mass production
- No specialized vessels
- Minimum offshore operations







1. Floating wind energy – DNV GL's work

2. Industry status, pathway to commercialization and costs

### **3. Visions for floating wind**

- Demonstration projects and small scale arrays – New applications
- Cost compression and technology developments
- What may the future look like

4. Concluding remark



## Era of demonstration projects and small scale arrays

---

### Demonstration projects/small arrays

- **Hywind**
  
- **WindFloat**
  
- **Fukushima project**  
Phase 1, 2013:
  - Floating substation
  - 2 MW semi-submersible substructurePhase 2, 2015:
  - Two 7 MW turbines on semi-sub and spar solution respectively
  
- **Kabashima project:** 2 MW spar buoy installed fall 2013
  
- PelaStar (2016), IDEOL, GICON, Tri-Floater, VertiWind.....more to come

- **Hywind Scotland (30 MW)**

- **WindFloat (27 MW)**

- **Japan initiatives, UK initiatives, US initiatives**

**Are there situations where power from floating wind turbines could be a cost effective solution already today?**

# A potential future demonstration project?

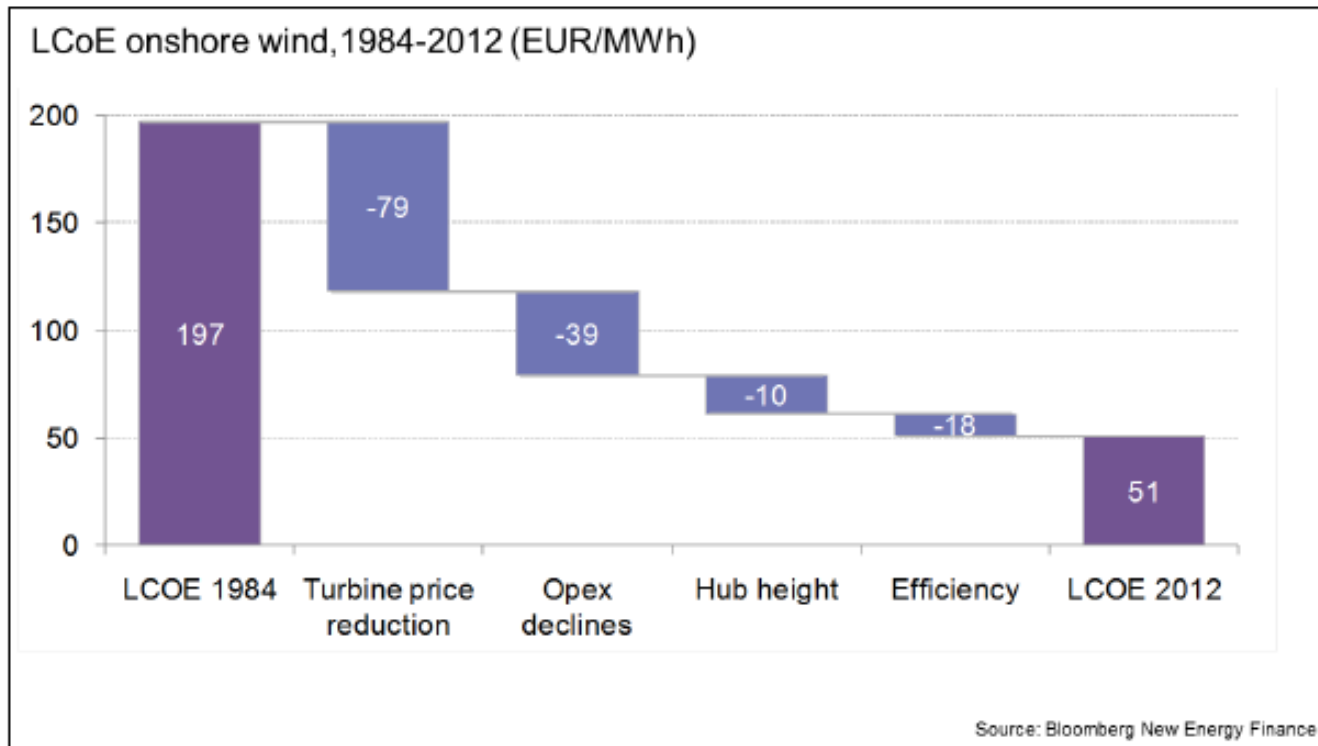
## Integration of offshore wind and Oil & Gas activities on the NCS

---

- High-level assessment of using floating wind turbines to power subsea water injection pumps, replacing gas turbines on the host platform.
- Cost drivers: Long step-out distances between host platform & injection well, platform conversion costs, fuel costs for running gas turbines, emission costs on the NCS
- Recent successes with raw-seawater injection (Tyrihans) and new subsea water treatment systems under development
- *High-level indicators of economic and technical performance show an interesting window of opportunity for applications that can tolerate unprocessed seawater for injection in oil fields and also other configurations are possible*

## The onshore experience

- Total cost compressions of close to 75% are indicated during a 28 year period.
- Onshore wind is a mature industry compared to offshore wind, however, IEA have estimated that the cost of generating energy will continue to decrease with another 26% up until 2050 and their corresponding assessment for offshore wind implies a reduction in the cost of generating energy of 52%. Both analyses accounting for increasing capacity factors.



Historical developments in LCoE for onshore wind. Source: Bloomberg New Energy Finance



## Concluding remarks

---

### Demonstration projects:

- Design optimization and R&D efforts are obvious focus areas
- Technologies are being proven, the first small arrays on the way and commercialisation can be within the next few years
- Need not only to show the technical feasibility but also the ability to reduce costs
  - large potential for cost reductions
- New applications are possible – Integration with other offshore interests
- Stable, long-term policies are needed to create investor confidence
- DNV GL have strong belief in the floating wind industry focuses on its further development, assisting the industry through verification, certification, technology assessment and market studies!

# Thank you

**Johan Slätte**

Johan.Slaette@dnvgl.com

+47-917 38 338

[www.dnvgl.com](http://www.dnvgl.com)

**SAFER, SMARTER, GREENER**