OFFSHORE 2011 AMSTERDAM
ORGANISED BY EWEA

Offshore wind supply chain:

Turbines and Substructures

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Pre event seminar
28 November 2011
Amsterdam

Outline

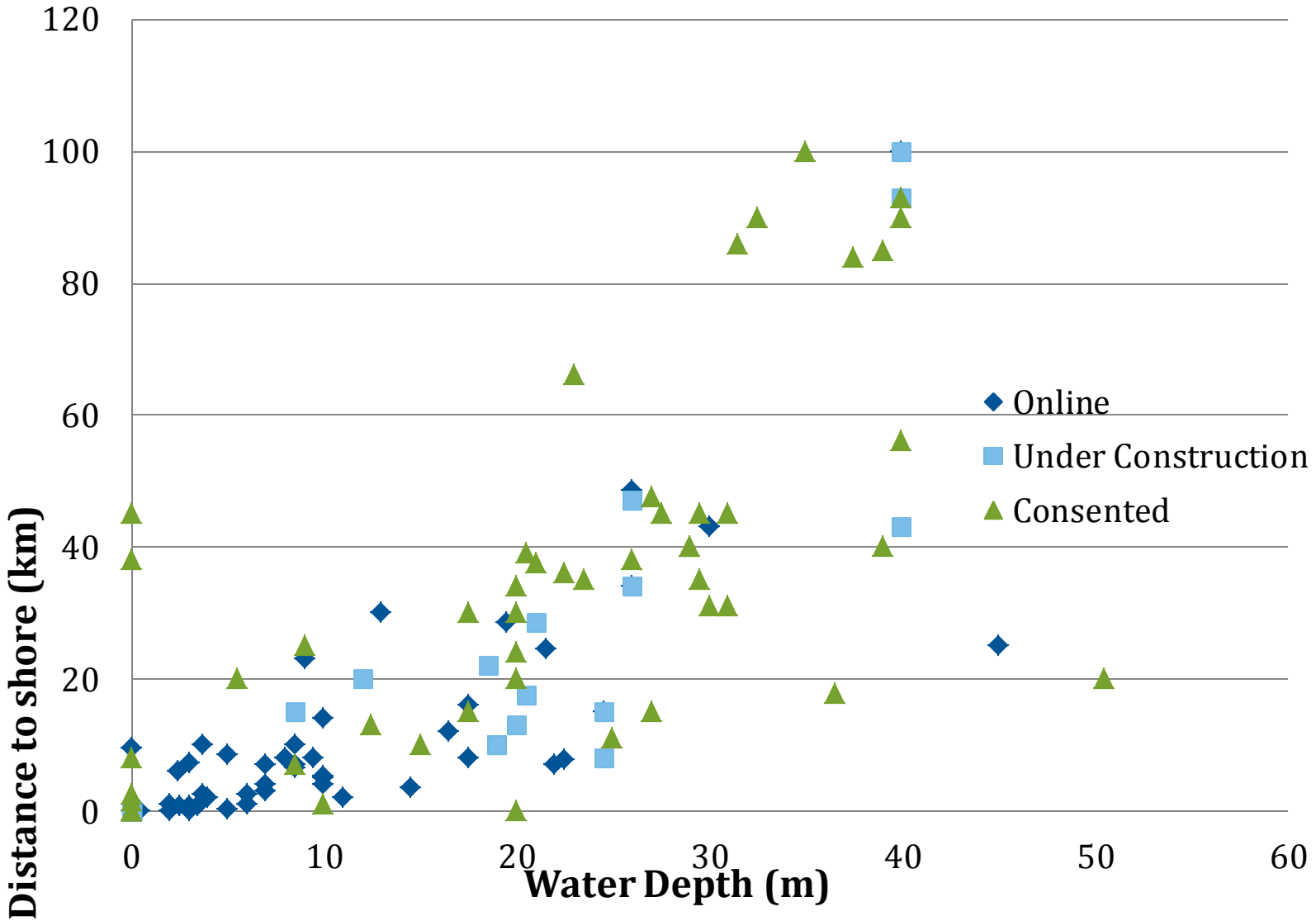
- Introduction
- Offshore wind turbines
- Offshore substructures

Introduction

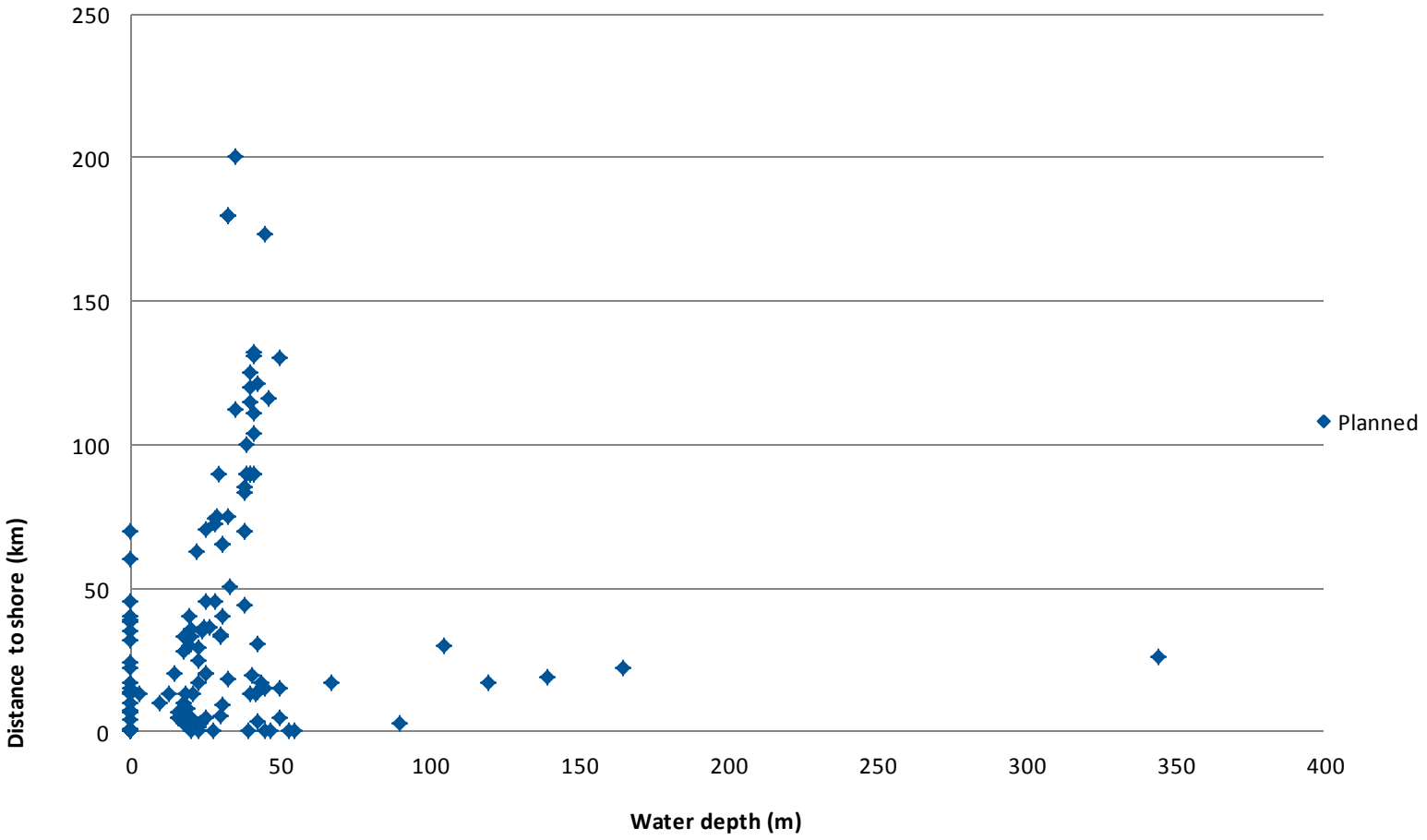
First six months of 2011:

- 101 offshore wind turbines grid connected → 5 wind farms → 348MW.
- Total installed capacity end June 2011: 3,294 MW
- 16 offshore wind farms under construction:
  - 129 foundations fully installed
  - 108 offshore wind turbines erected (not grid connected)
- 4.5% higher growth than last year – same period
- Fewer turbines to achieve higher growth → larger machines
- Expected annual installations for end 2011 above 1 GW

Going deeper and further…



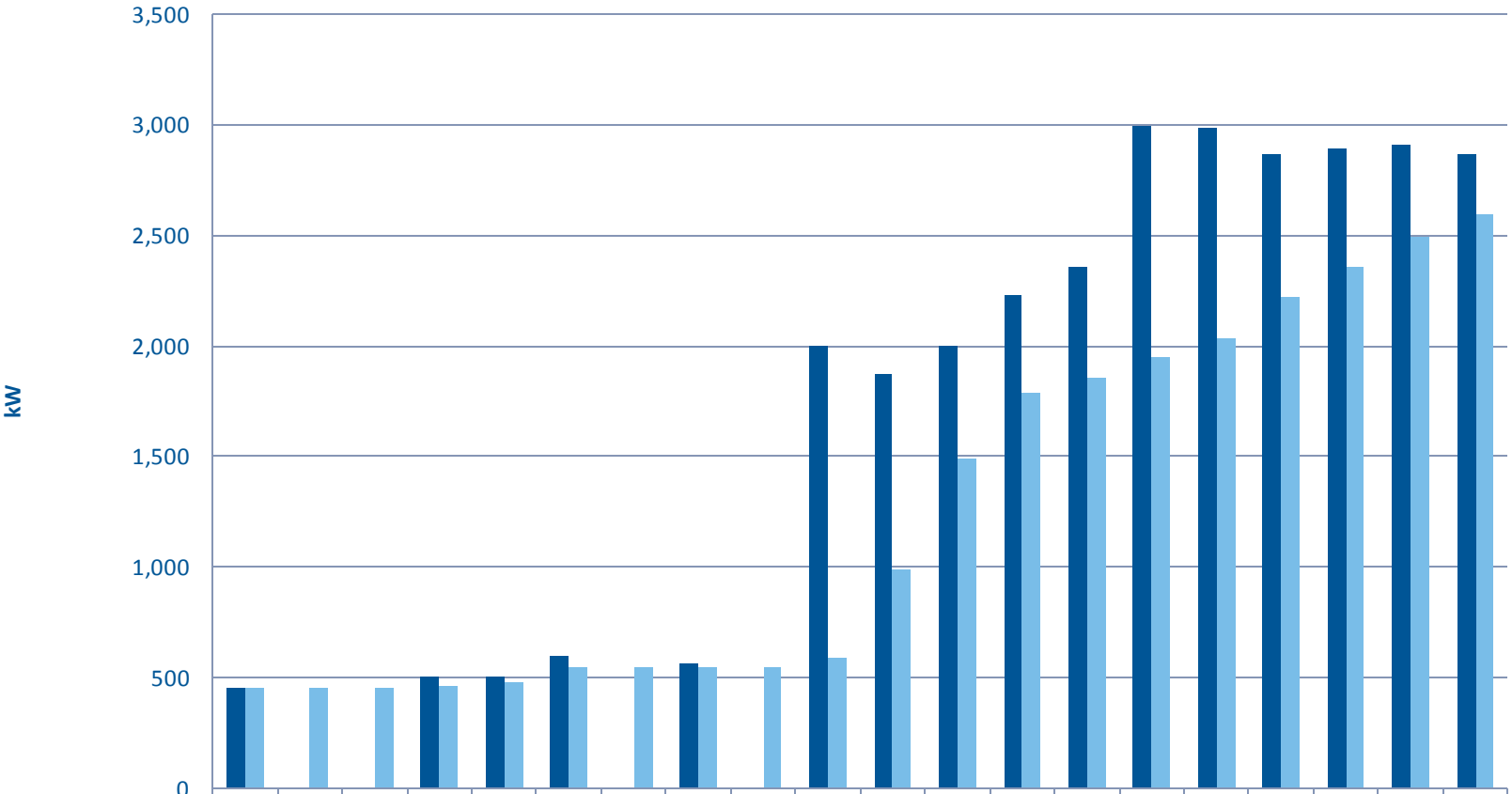
Going deeper and further…



Offshore report to come…

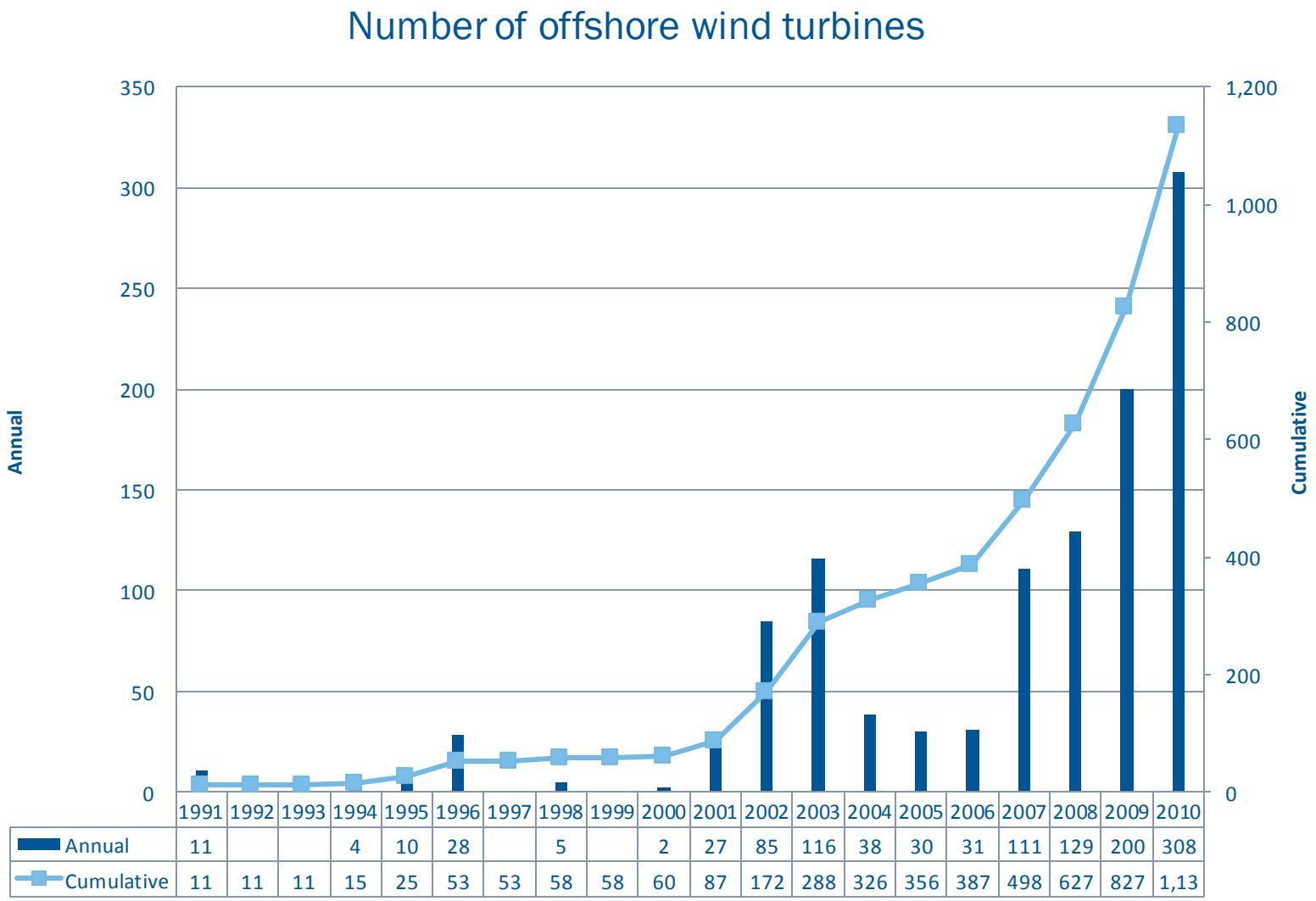
Offshore wind turbines

Average size of offshore wind turbines



	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Annual (kW)	450	0	0	500	500	600	0	560	0	2,000	1,870	2,000	2,234	2,361	3,000	2,984	2,868	2,895	2,909	2,866
Cumulative (kW)	450	450	450	463	478	542	542	544	544	593	989	1,489	1,789	1,856	1,952	2,035	2,221	2,359	2,492	2,594

Offshore wind turbines



	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Annual	11			4	10	28		5		2	27	85	116	38	30	31	111	129	200	308
Cumulative	11	11	11	15	25	53	53	58	58	60	87	172	288	326	356	387	498	627	827	1,13

Offshore wind turbines – different from onshore?

- Larger
  - Larger blades – higher energy capture – less noise constrains – less visual disruption (further from shore)
  - Weight consideration
  - Loads consideration
  - Different operational environment

→ Dedicated designs for offshore wind turbines

Main technical trends
Purpose: Accommodate the offshore wind turbines' evolution

"LARGER" = Increasing energy capture

- Diameters: clear trend to overpass the 120 meters → going up to almost 160 – 170 meters
- Rated power of wind turbines: above 3MW with clear move towards larger machines up to even 10 MW

Two ways of increasing the energy capture :

Enlarged Rotors ⟶ m^2 ↑

Enlarged Generators ⟶ MW ↑

Specific area

$$\frac{m^2}{MW}$$

Main technical trends

Purpose: Accommodate the offshore wind turbines' evolution

Larger means heavier?

- Lighter generators
- Direct drive permanent magnet generators
- Sophisticated hybrid systems

Main technical trends
Purpose: Accommodate the offshore wind turbines' evolution

Main objective:

Decreasing the cost of energy from offshore wind power:

→ producing more electricity with larger machines
→ improving transport and installation of components

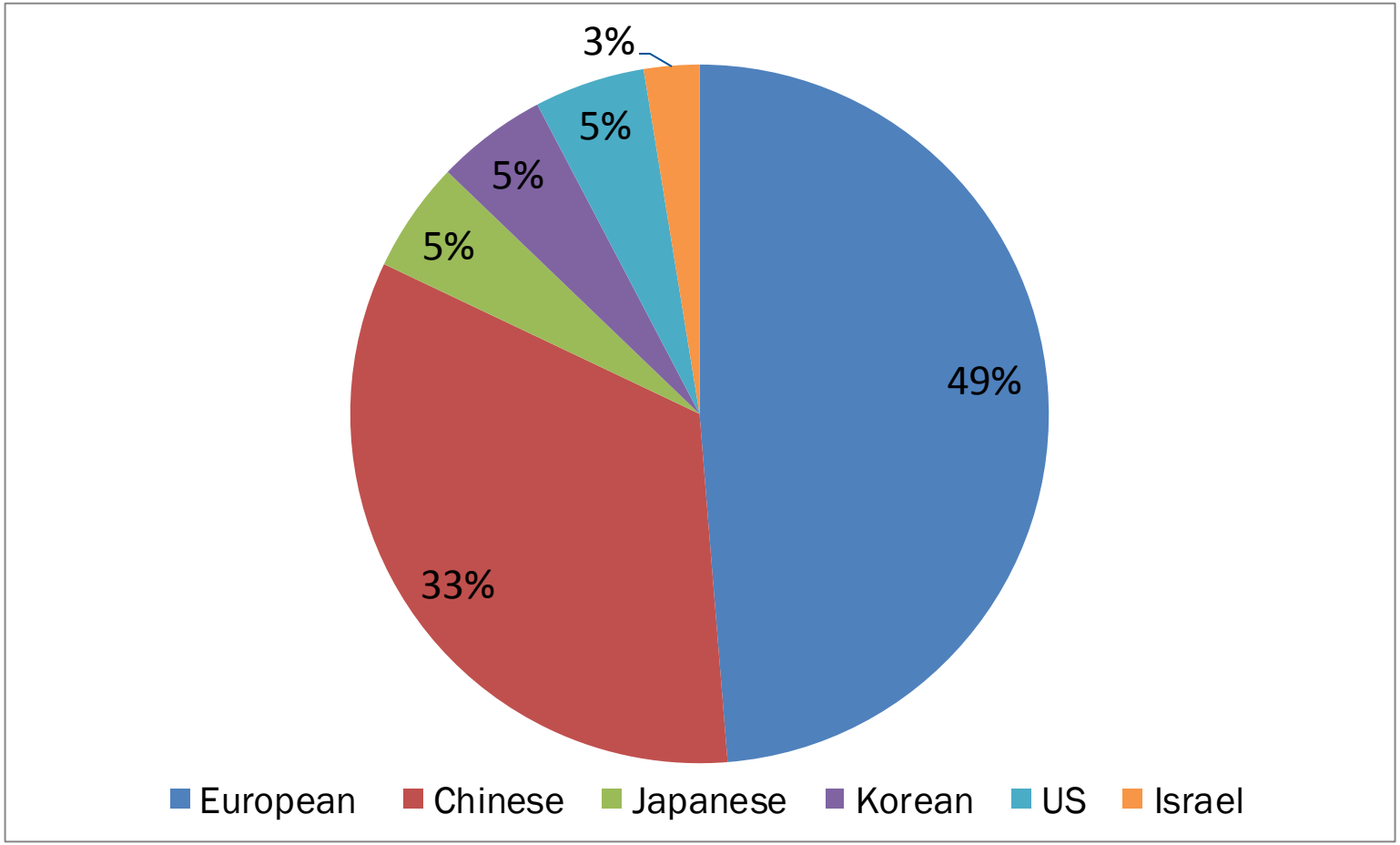
Impact on the supply chain

- Driving force to develop the supply chain accordingly

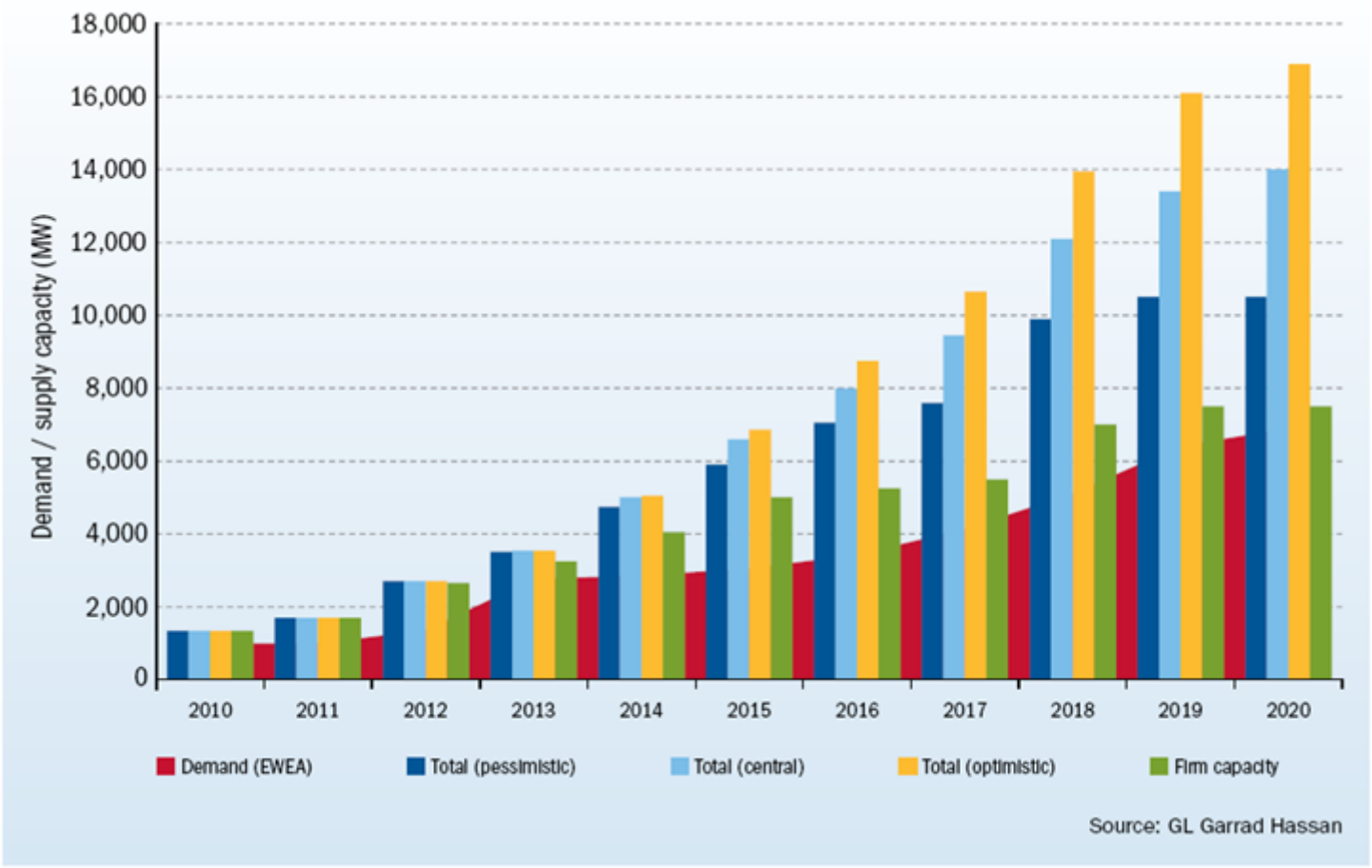
Wind turbine components	Barriers to entry	Logistical issues	Integration possibility
Towers	Low	Medium	Low
Blades	High	Medium	Medium
Drive train	Medium	Low	Low
Casting and forgings	Medium	Low	Low

Demand and supply of offshore wind turbines

52 new offshore wind turbine models announced by
39 manufacturers



Demand and supply of offshore wind turbines



Oversupply = higher “competition”= lower cost

Offshore wind substructures

Moving from land to sea → Moving from onshore foundation to **offshore substructures**

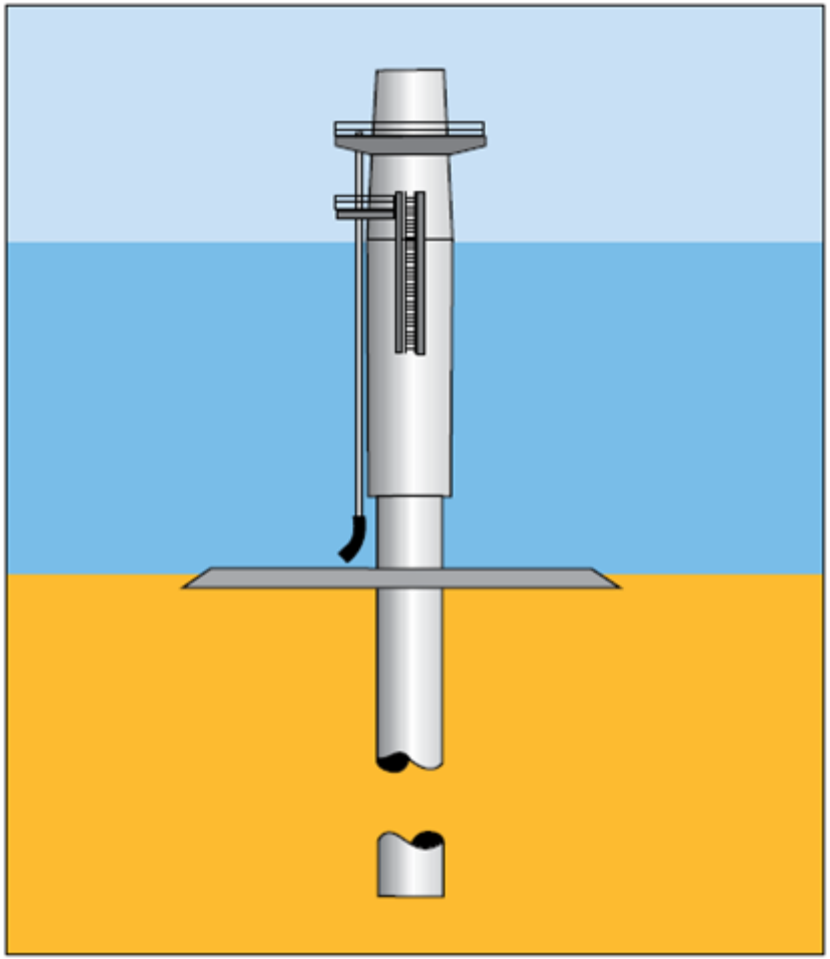
Suitable technology to "carry" the offshore wind turbines and substations

Main considerations determining the type of substructure:

- Water depth
- Soil condition
- Cost
- Turbine characteristics
- Commercial Risk

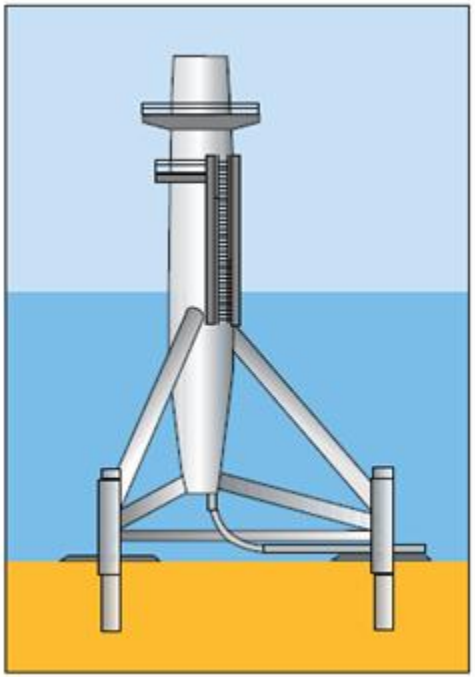
Offshore wind substructures

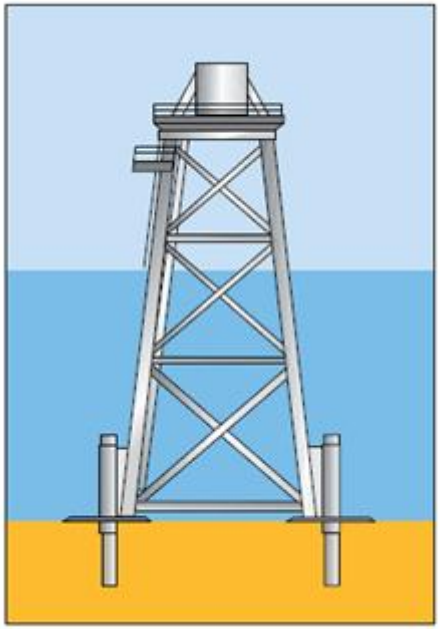
Monopiles

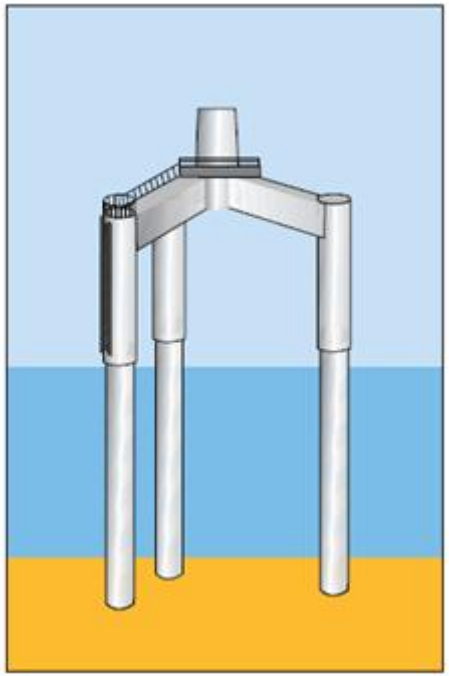


Offshore wind substructures

Space frame
- Tripod
- Tri-pile
- Jacket

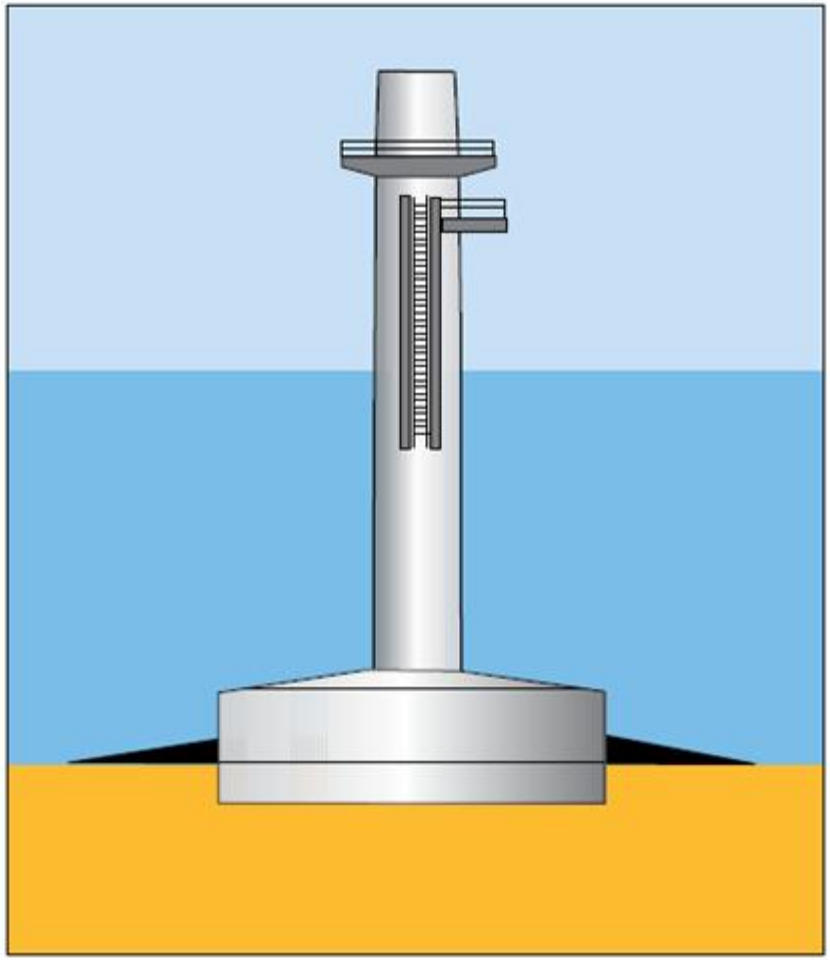






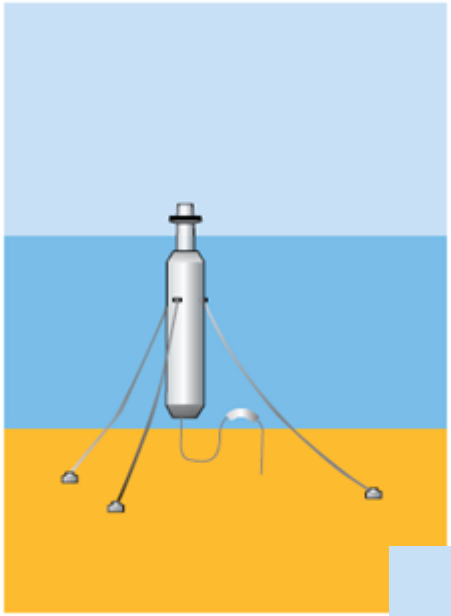
Offshore wind substructures

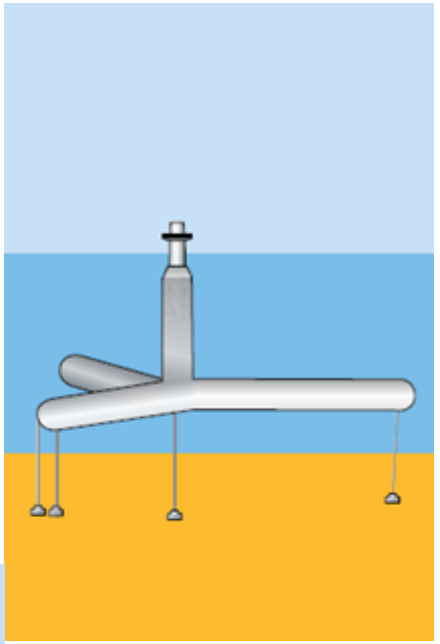
Gravity based

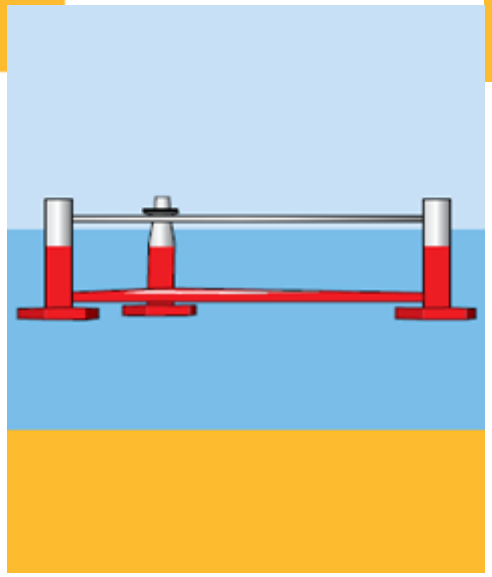


Offshore wind substructures

Floating
- Spar
- Tensioned – leg
- Jacket







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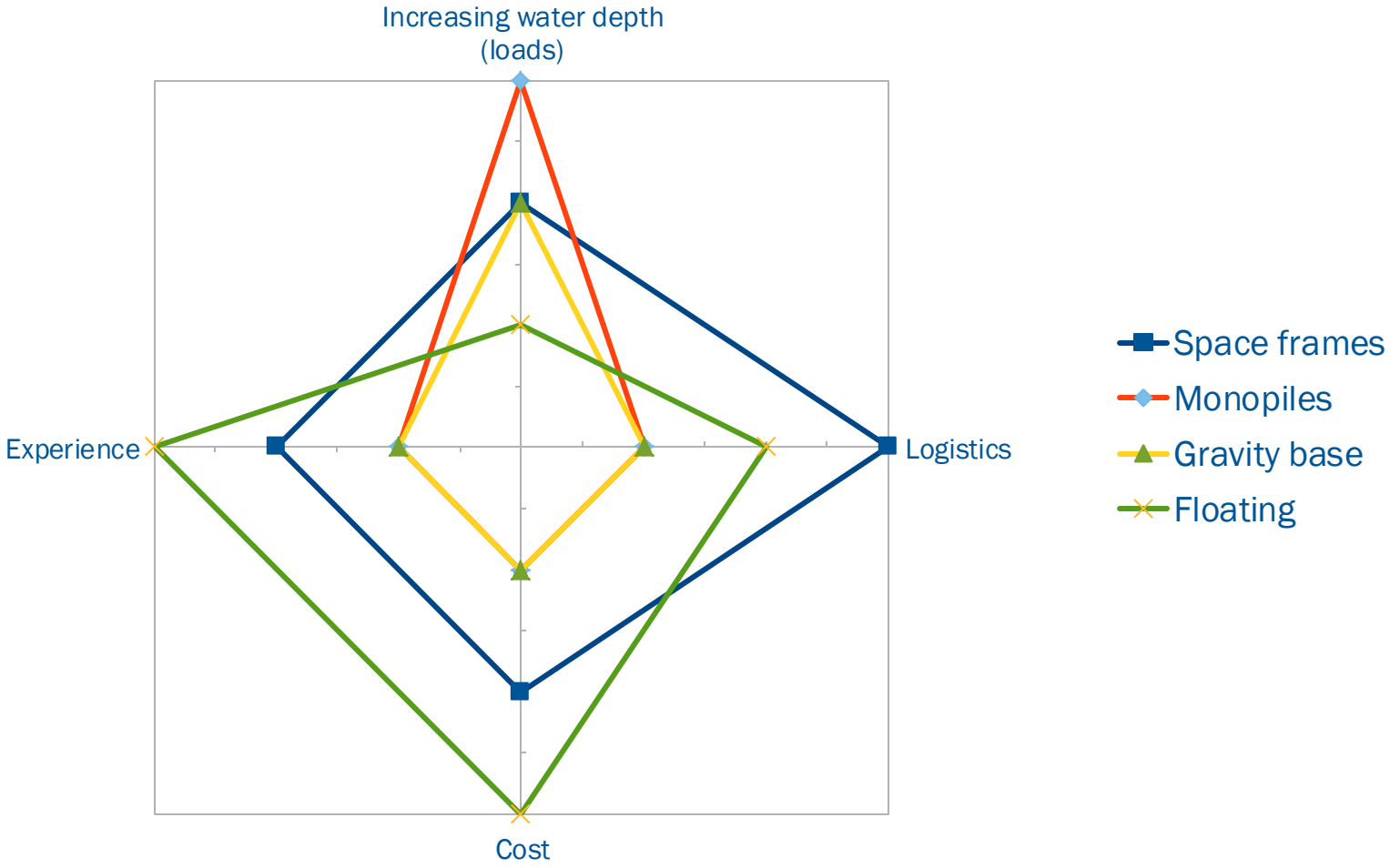
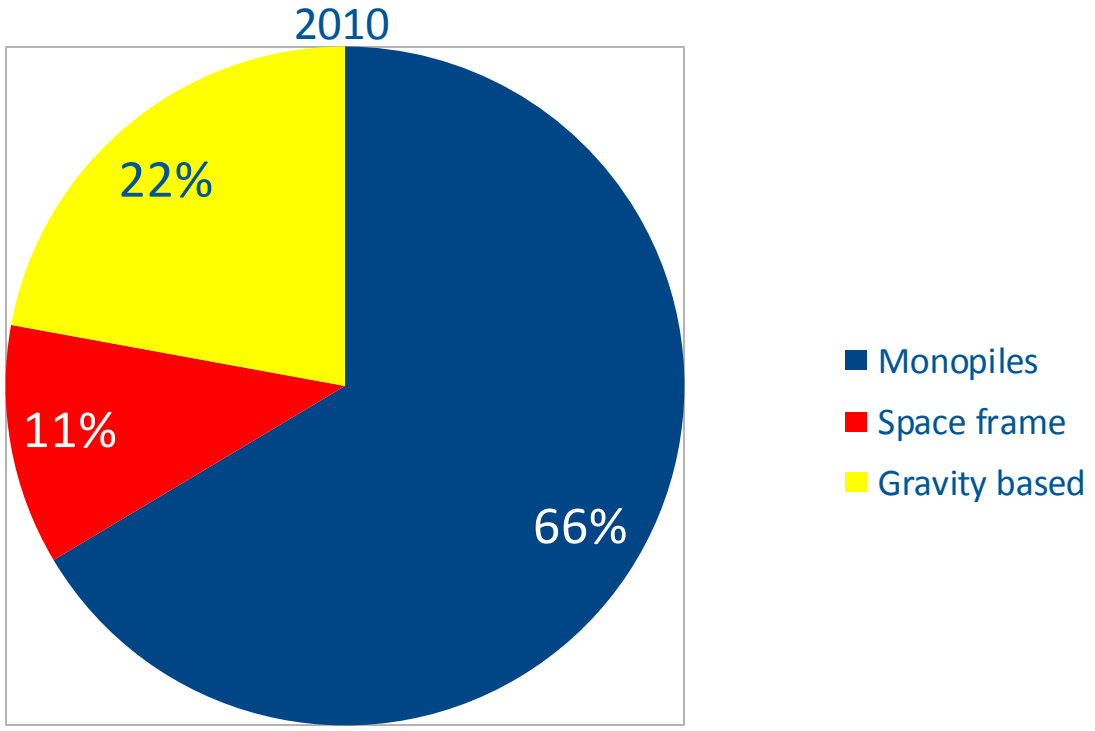


Offshore wind substructures



Moving to deeper waters and with bigger turbines → Use of space framed, improved monopiles as well as **floating**

Company	Project name	Floating turbine	Floating platform (substructure only)	Wind and Wave comb.	Turbine capacity	Deployment date	Region
Statoil	Hywind	X			2.3 MW	2009	Norway
Sway	Karmoy	X			5MW	2013	Norway
Technip	Vertiwind	X				2013	France
Nass and wind	Winflo		X		2.5MW	2012	France
Catalonia institute for Energy research	ZÈFIR Floating Med Wind Plant		X		8X4MW		Spain
EU project	HiPRwind		X			2016	Europe
Gamesa	Azimut	X			15MW	2020	Spain
Principle Power	Windfloat		X		2MW	2011	Portugal
Hexicon	Hexicon platform			X	54MW		Sweden
Ideol	Floating foundation		X				France
Nautica Windpower	Advanced Floating Turbine	X			n/a	2015	US
EU project	Deepwind	X			n/a	2015	Europe

Conclusions

Strong development of offshore wind power

- Moving to deeper waters further from shore
- Great impact on the supply chain
- New offshore dedicated wind turbines, higher rated capacity, increased energy capture
- Different types of substructures for different types of projects
- Logistical issues to be addressed to allow healthy deployment of the sector

More information?

Join us in the official launch of the Offshore Report:

Wind in Our Sails – "The coming of Europe's offshore wind energy industry"

OPENING SESSION

Tuesday, 29 November 2011, 10:00 - 12:00
Room: AUDITORIUM (open to all participants)

Thank you for your attention

Discussion