

Floating Supports for Offshore Wind: Small Structures – Big Challenges

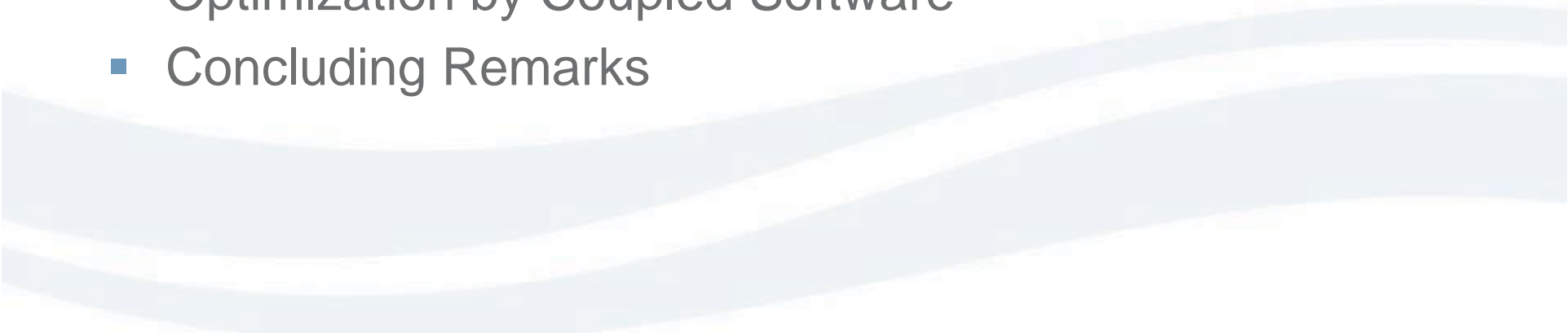


Wim de Boom

Rotterdam, 20 June 2011

Presentation Lay-out

Floating Supports for Offshore Wind: Small Structures – Big Challenges

- Introduction
 - Market Prospects for Floating Wind
 - Tri-Floater Design
 - Optimization by Coupled Software
 - Concluding Remarks
- 

Introduction to GustoMSC

GustoMSC is part of the SBM Offshore Group

Activities:

- Floating Production Systems
- Exploration and Construction Vessels



Maersk Deliverer



Oleg Strashnov – Seaway Heavy Lifting

GustoMSC and Offshore Wind

Jack-up vessels for offshore wind turbine installation



Seaworker by courtesy of A2Sea team



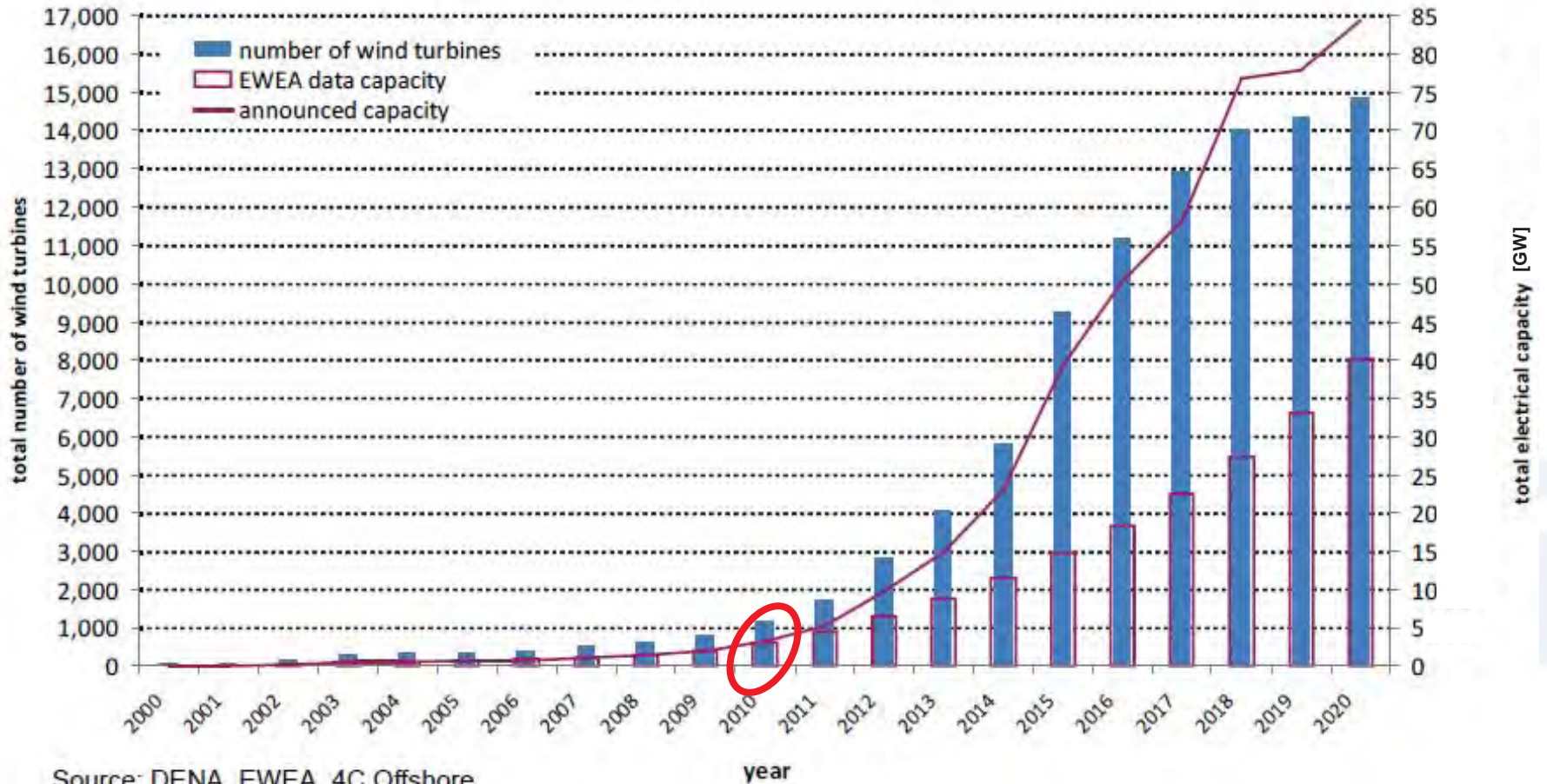
NG 9000C

Facts and Figures EU Power Generation

	Situation End 2010		
Total Power Generating Capacity	874,023 MW		
Of which Wind Power	84,074 MW	(=9.6%)	
Of which Offshore	2,964 MW	(=0.3%)	(=3.5%)

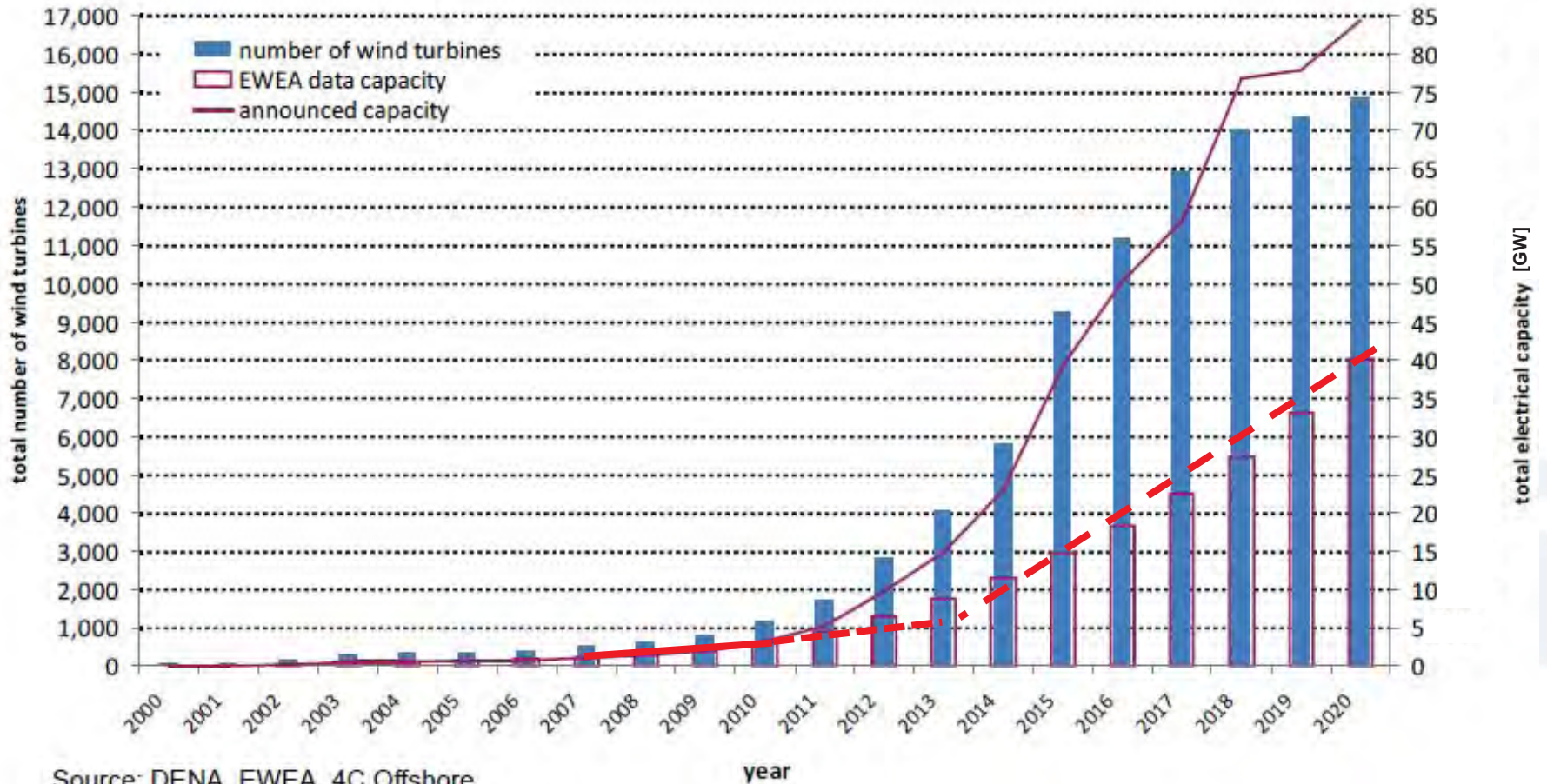
	New in 2010		
Total Power Generating Capacity	55,326 MW		
Of which Renewable power	22,645 MW	(=40.9%)	
Of which Wind Power	9,259 MW	(=16.7%)	
Of which Offshore	883 MW	(=1.6%)	(=9.5%)

Projections for Offshore Wind in EU



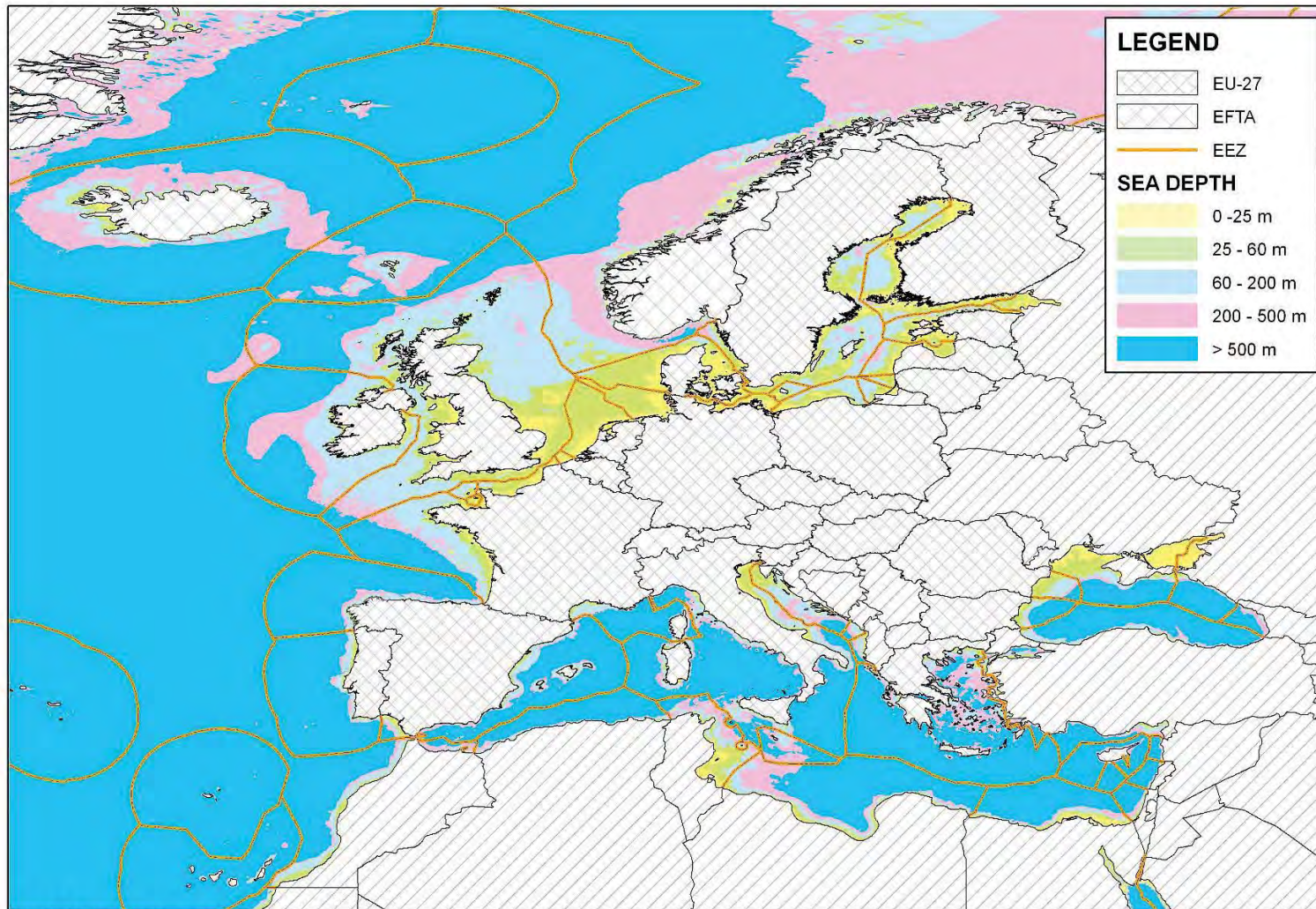
Source: DENA, EWEA, 4C Offshore

Projections for Offshore Wind in EU



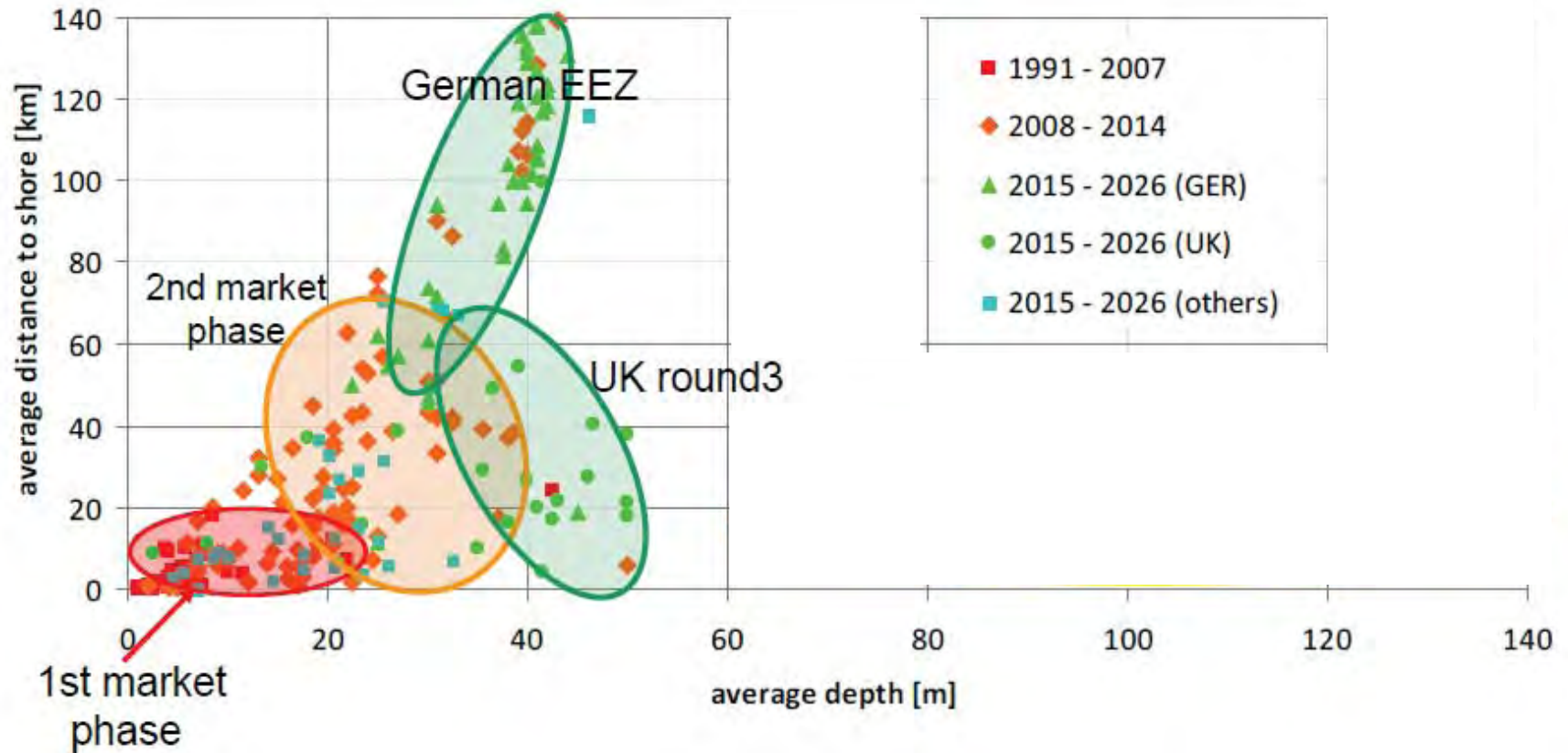
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Prospects Floating Wind in EU

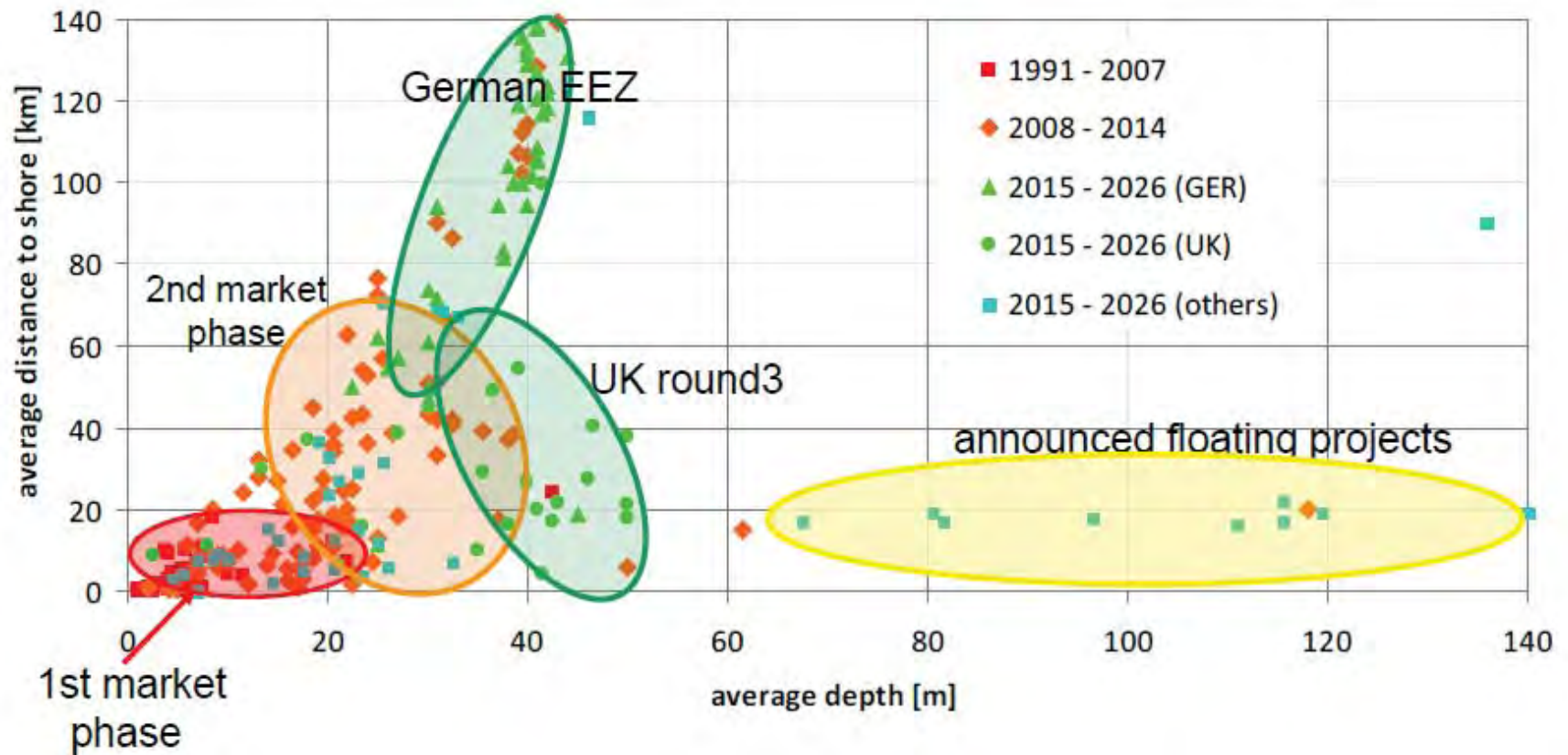


WGS 84 WORLD REFERENCE SYSTEM

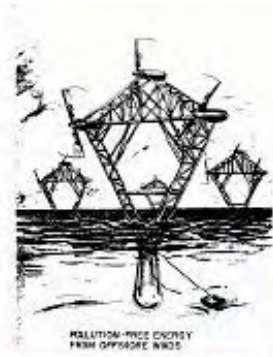
Projects Identified – WD and Distance to Shore



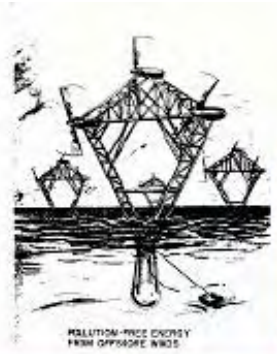
Projects Identified – WD and Distance to Shore



Floating Wind Concepts



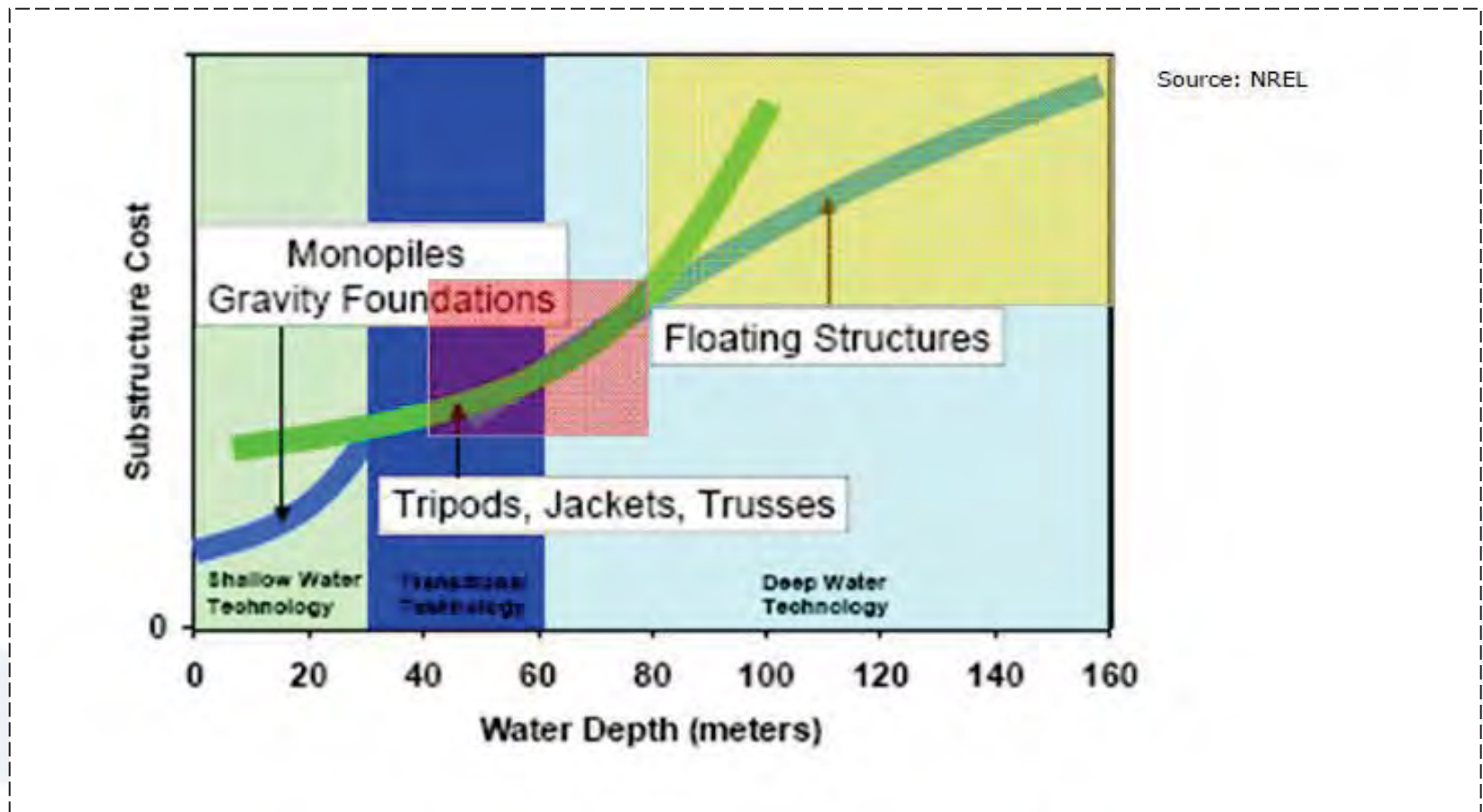
Floating Wind Concepts



Floating Wind Concepts



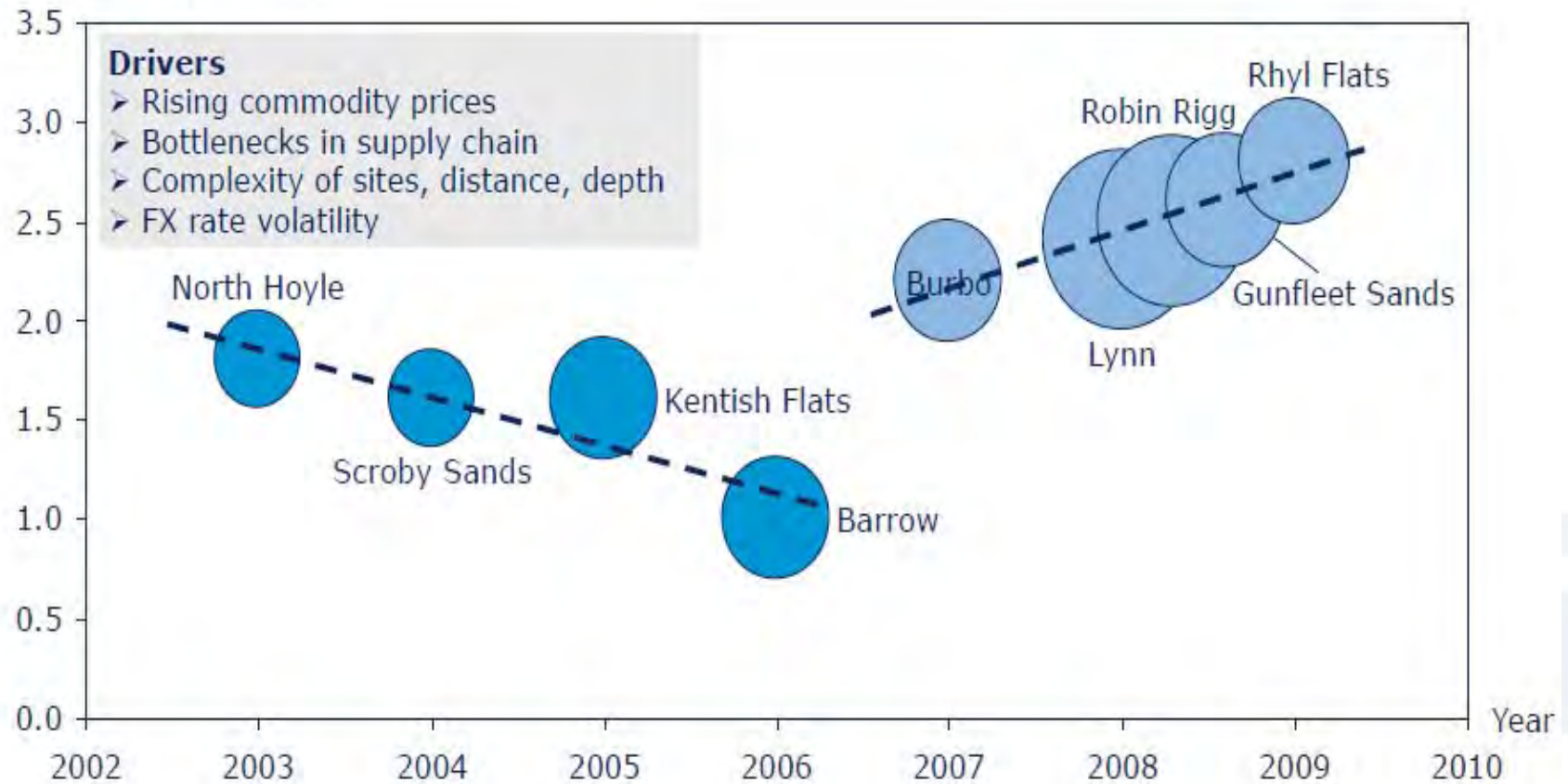
Cost Development



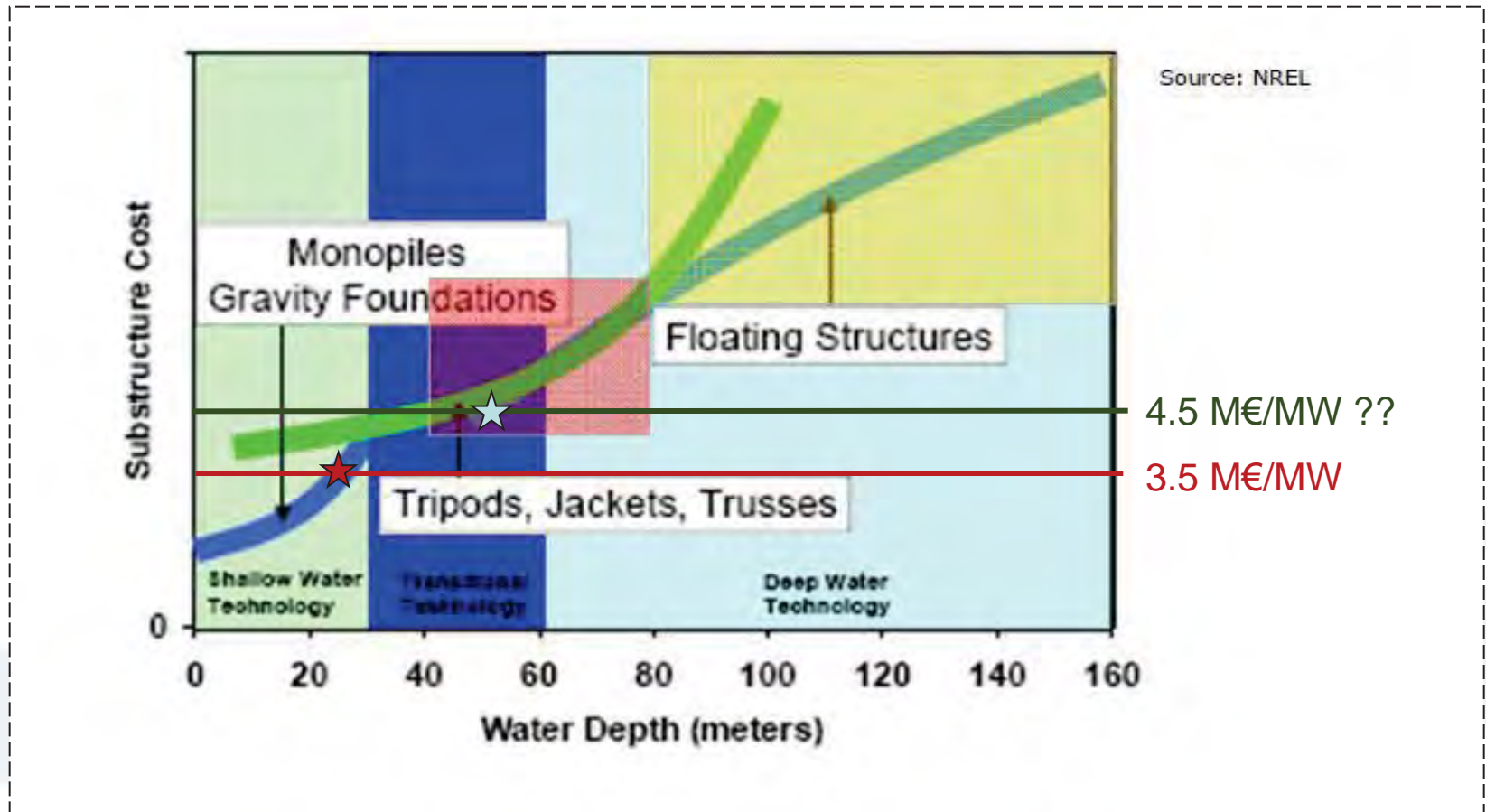
This is a well known graph, but which numbers should show along the vertical axis?

Cost Development Bottom Founded WT

Cost per MW installed (€/MW)



Cost Development



Political Support

Subsidized Research Projects

Year	Description	Parties	Funding	From
2005	Hydro-Aero Elastic simulation platform	Risø DTU	0.360 M€	Danish Government
2005	Hywind	Statoil a.o.	7.5 M€	Enova
2009	Deep Water Innovative Wind Energy Technology (DIWET)	Blue H, BEA, SLP a.o.	Approx. 5 M€	UK ETI
2008	EOLIA	Acciona Energia, a.o.	16.7 M€	Spanish CDTI
2009	DeepCWind	Univ. of Maine, a.o.	61 M\$	US Department of Energy a.o.
2009	Windfloat	Principle Power	1.9 M\$	Federal DOE grants
2010	Floating Offshore Research Turbine	CMR Research Norway	5.7 M€	The Research Council of Norway
2010	DeepWind VAWT prototype	Risø DTU a.o.	3 M€	EU FP7
2010	HiPRwind	Frauenhofer IWES	11 M€	EU FP7
2010	SWAY	Sway	17.5 M€	Enova
2010	Vertiwind VAWT	Technip, Nenuphar, a.o.	7 M€	ADEME
2010	Floating Wind Offshore Structures	GustoMSC, ECN, MARIN	0.370 M€	Dutch government

170 M\$

“Drijfwind” (Dutch for Floating Wind)

Study executed in 2001-2002 (i.e. 10 years ago)

Partners

- Energy research Centre Netherlands (ECN)
- TNO
- MARIN
- Lagerwey
- Delft University of Technology
- **GustoMSC**



Parametric study into potential concepts for floating support of a windturbine.

Presented at European Wind Energy Conference 2003, Madrid, Spain.

Tri-Floater



Small Structures – Big Challenges

GustoMSC DSS-21



100 m



Small Structures – Big Challenges



100 m



Dimensions

Semi L.O.A. = 117 m

Length deck box = 77.5 m

Tri-floater width = approx. 80 m

Typical Steel Weights

Semi 15000 t

Tri-floater approx. 1800 t

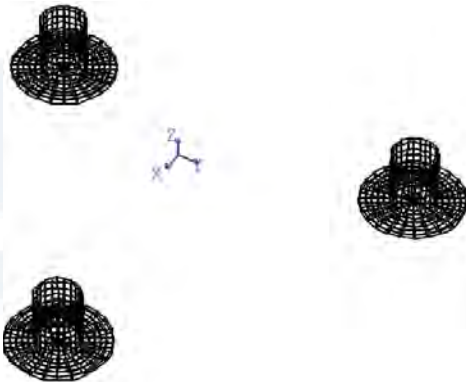
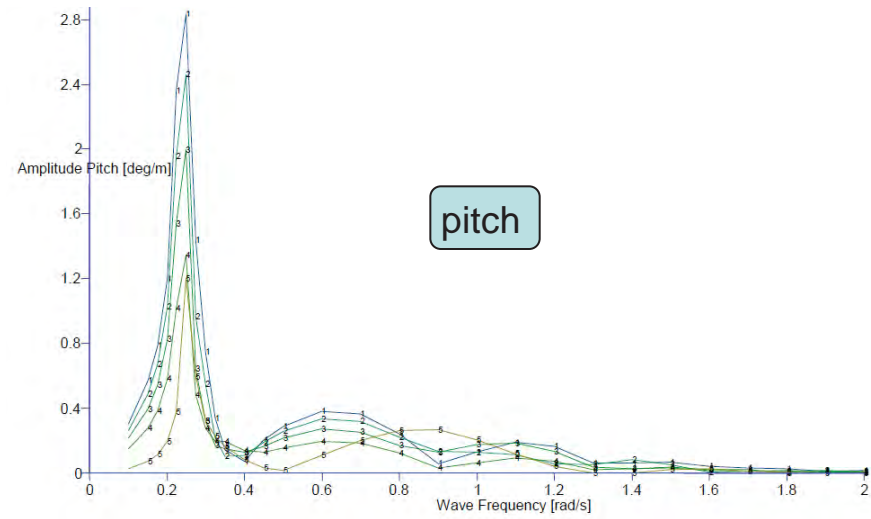
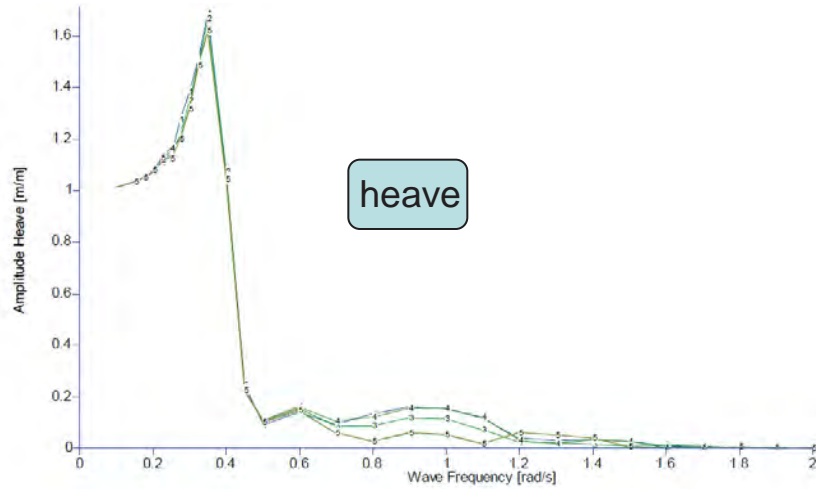
Say 8 tri-floaters from one semi

Small Structures – Big Challenges



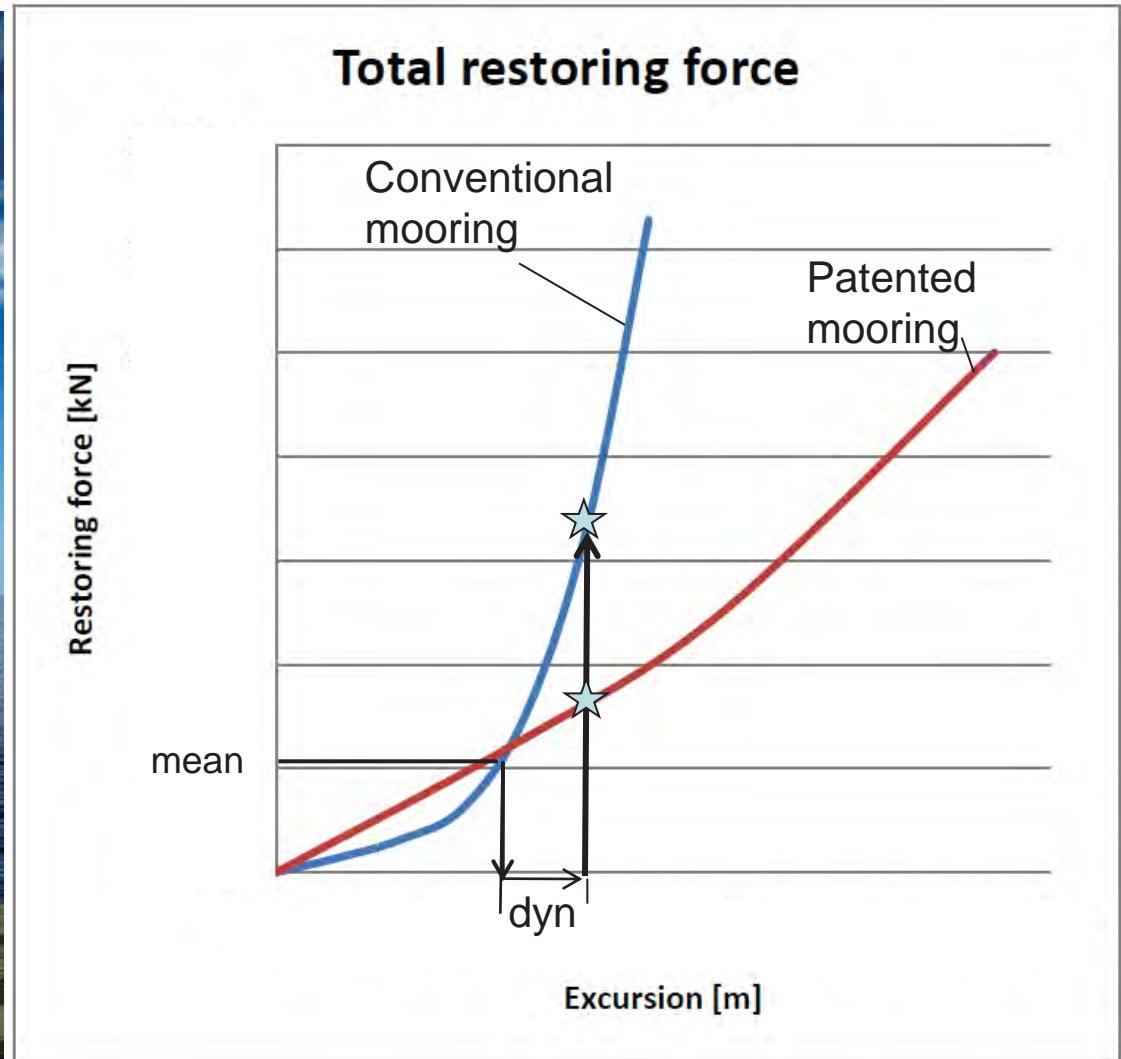
5 units >> steel for 40 tri-floaters
A wind park of only 200 MW

Design for motions



Natural periods	
Heave	16.5 s
Pitch	28 s

Mooring/cable connection



Maintenance

- Regular/Planned maintenance:
 - Access
- Emergency repair, requiring heavy lifts:
 - Lifting operations next to a floating body : very stringent weather constraints.
 - Disconnect and tow-away to harbour is an option



Rules and Regulations

- Bureau Veritas, Guidance Note NI 572 DT R00 E, Classification and Certification of Floating Offshore Wind Turbines, November 2010.

Loads as per IEC 61400 and Offshore Rules

Design Platform and Mooring system based on the Offshore Rules

- ABS: Guide for Building and Classing Offshore Wind Turbine Installations, December 2010.

Guide is not intended for application to Floating Offshore Wind Turbine Installations

- DNV: Rules in development through a Joint Industry Project

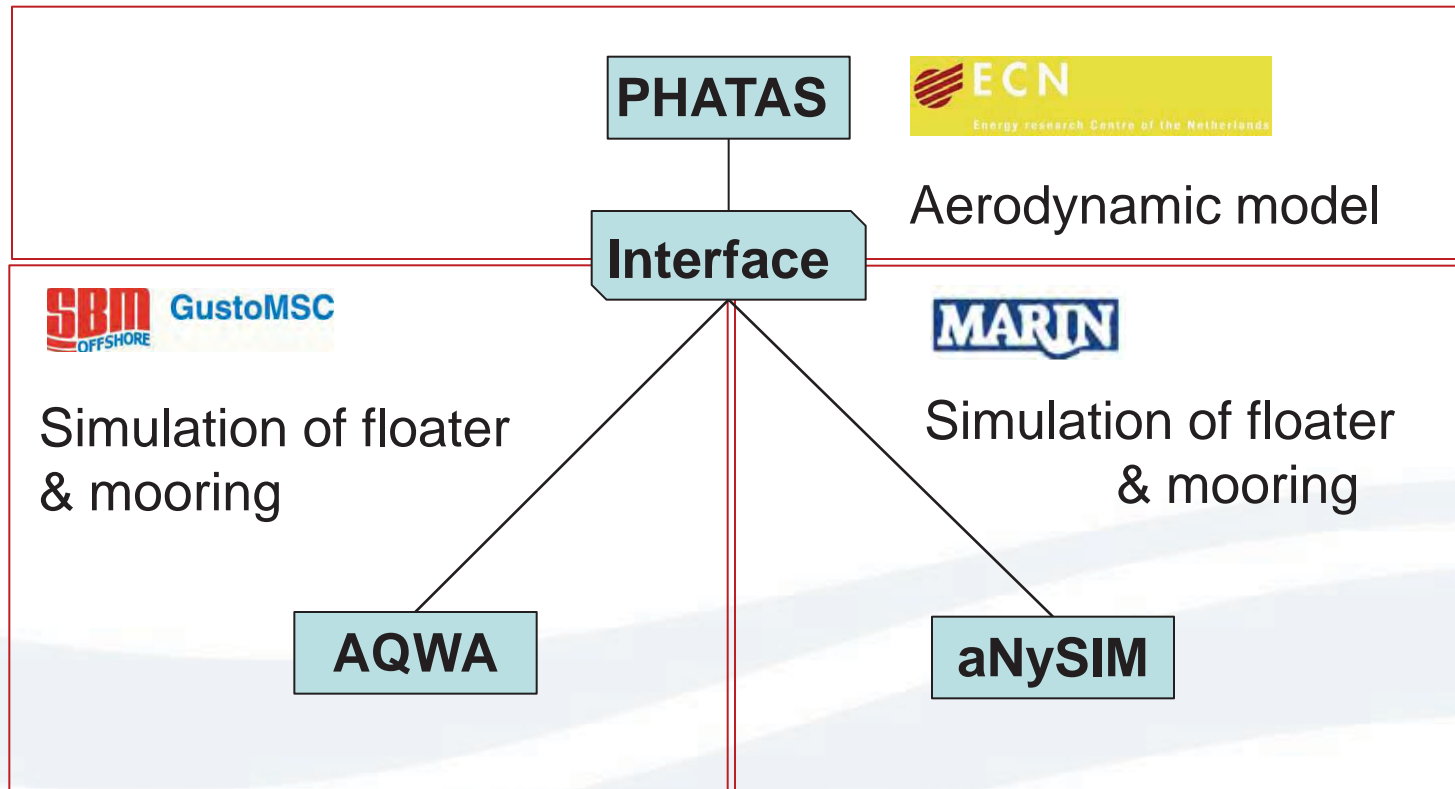
Economy of Scale



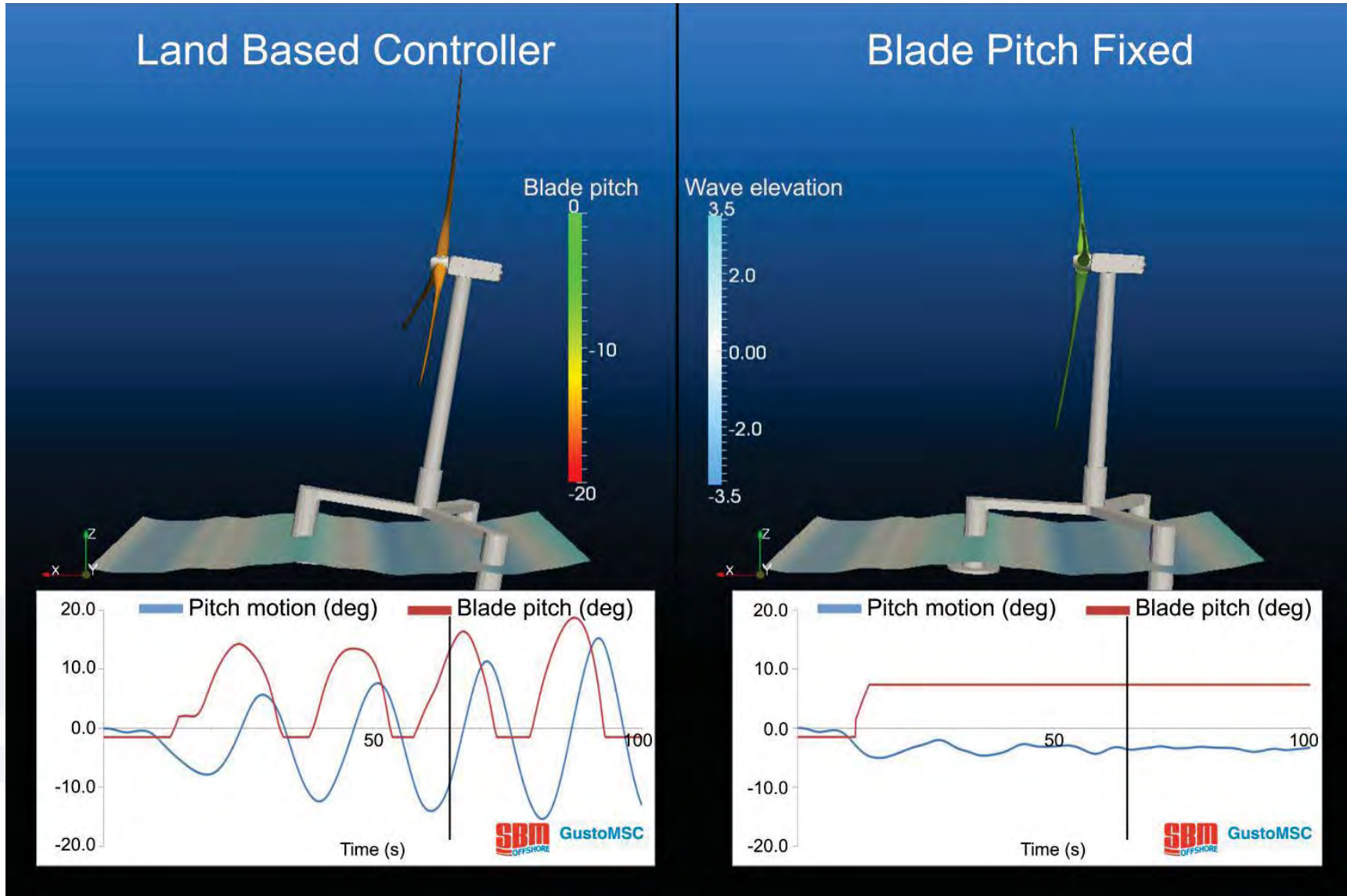
	Turbine	5 MW	10 MW	20 MW
Diameter of rotor*	[m]	126	178	252
Steel weight of tri-floater	[t]	1800	4600	10300
Steel weight of tri-floater over turbine power	[t/MW]	360	460	515

*source: Upwind

Coupling Floater - Turbine

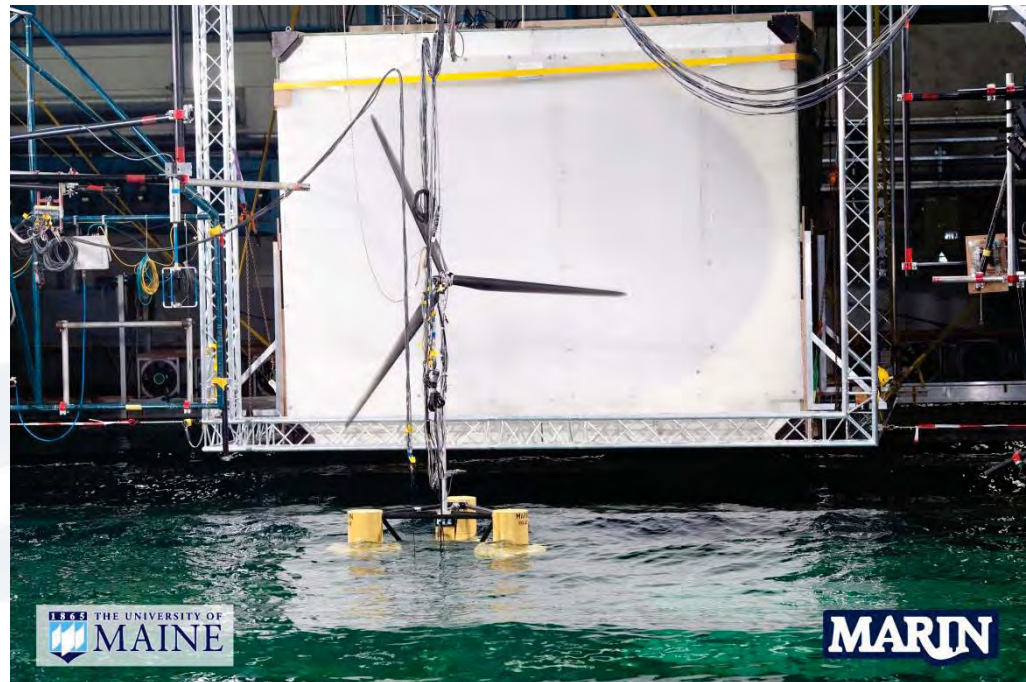


Movie



Verification/Validation

- OC4 (IEA Wind Task 30): Comparison of Dynamic Computer Codes and Models for Offshore Wind Energy
Work Package 2 (phase VI)- Semi-submersible
Management: NREL and Fraunhofer IWES
- DeepCwind – Management: University of Maine
Execution of model tests at MARIN



Threat for breakthrough of Floating Wind

**Robust design-
Offshore standard**

**High stability-
Maximum redundancy
in mooring**

Too expensive

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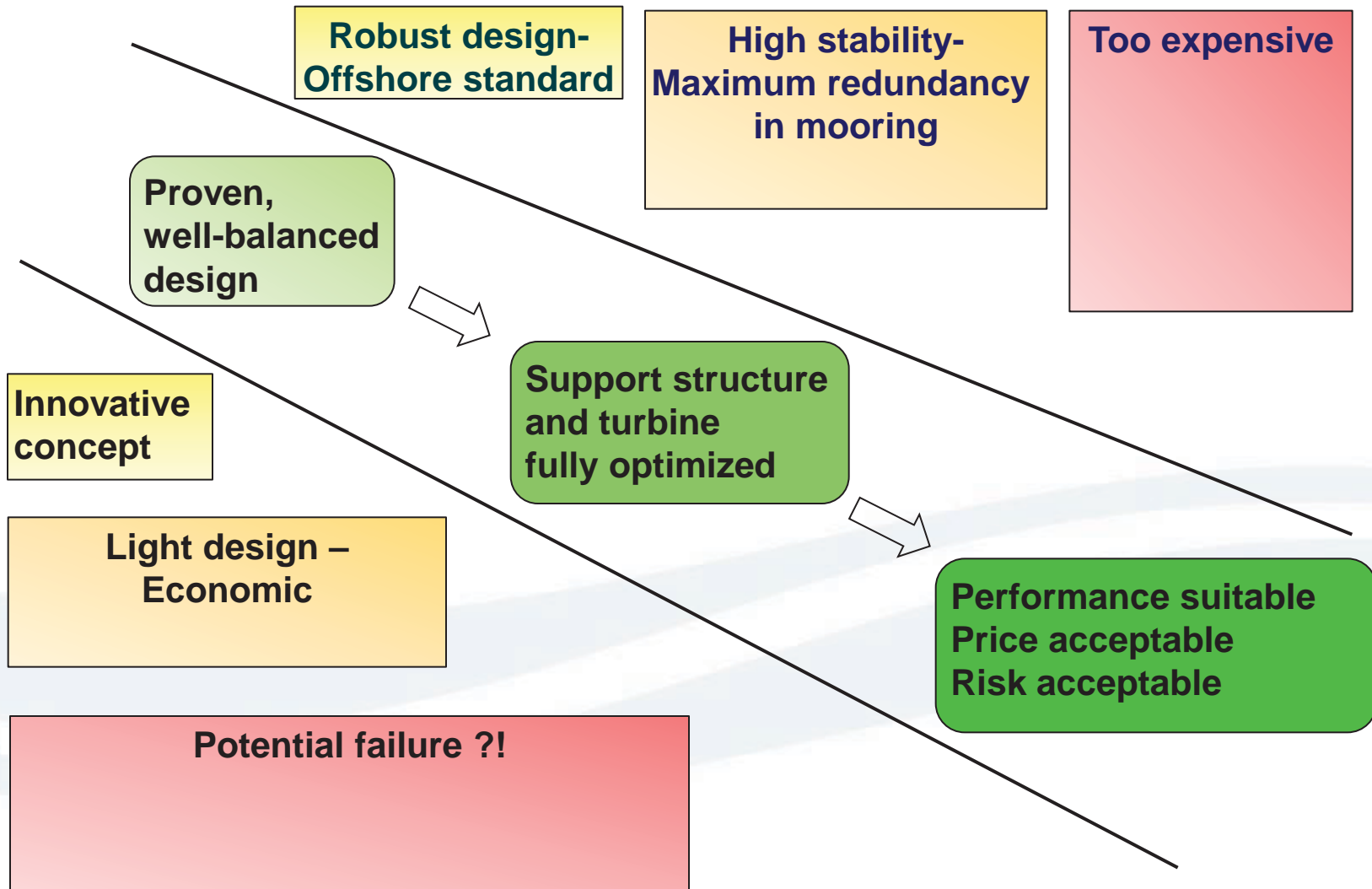
Too expensive

**Innovative
concept**

**Light design –
Economic**

Potential failure ?!

Narrow Path to the Future



Concluding Remarks

“Floating Wind” offers stimulating technical challenges:

- Design rationalization
- Integrated approach to dynamic systems
- Mooring & cable configuration
- Maintenance
- Common sense about applicable Regulations

Future Outlook:

Floating wind does not represent the “low hanging fruit” for offshore wind power, but political support is encouraging.

Thank you for your attention

I thank my colleagues Joop Mikx,
Jan van Kessel and Mauk Tilanus
for their contributions

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