STIFTUNG
OFFSHORE
WINDENERGIE

The Future for Offshore Wind – Potentials and Prerequisites for Future Deployment

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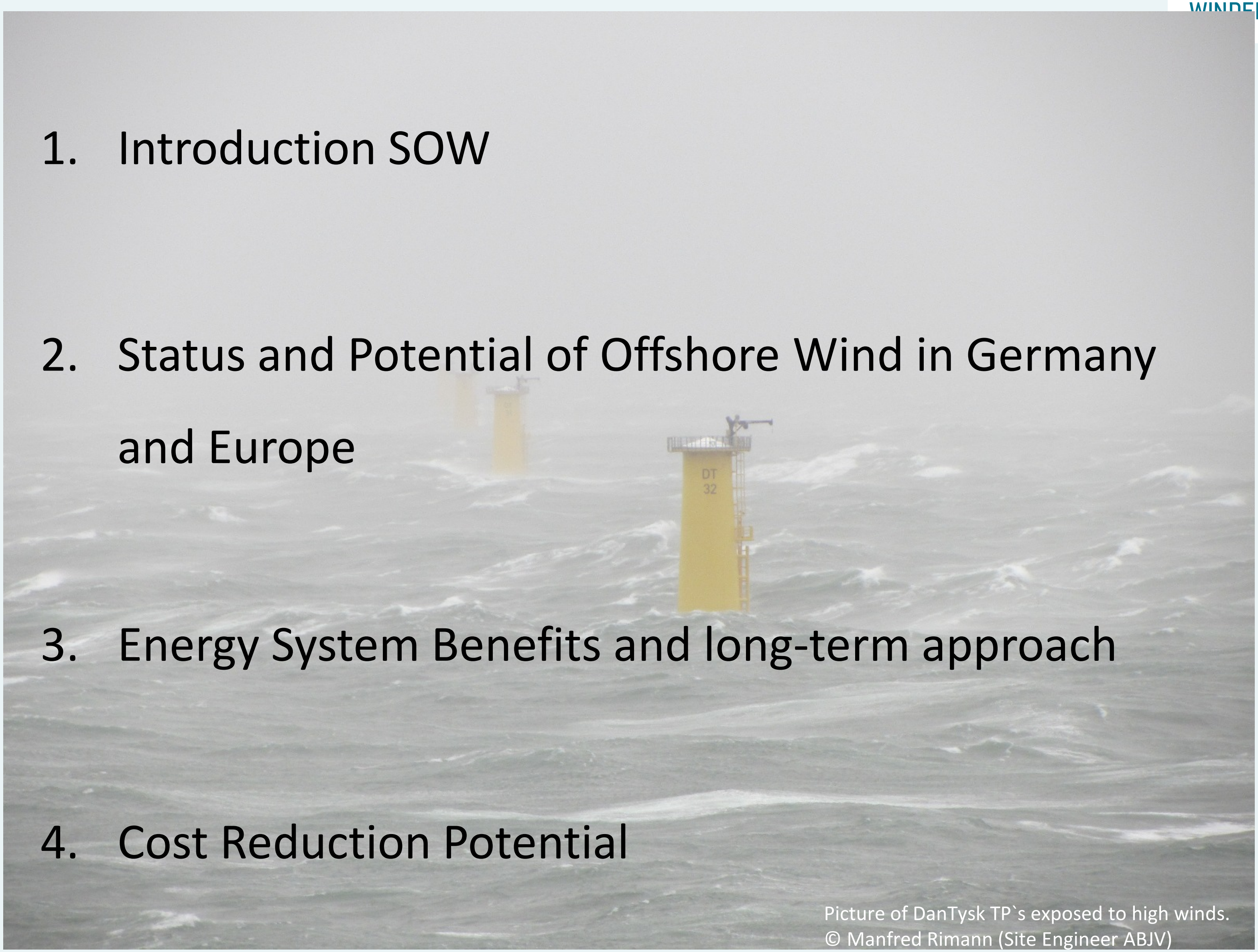
German Offshore Wind Energy Foundation

Lessons from Denmark - Agora Event 2:
Towards a Renewable Futurre – Energy Scenarios, the Grid and Support Schemes, Berlin, 12 Nov. 2015

Content



1. Introduction SOW

2. Status and Potential of Offshore Wind in Germany and Europe

3. Energy System Benefits and long-term approach

4. Cost Reduction Potential

Picture of DanTysk TP`s exposed to high winds.

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1. German Offshore Wind Energy Foundation

- Founded in 2005 as an independent, non-profit organisation to promote offshore wind deployment and R/D in Germany
- Acquisition of **ownership rights (permit) of alpha ventus** – moderated/accompanied process of Germany's first OWF
- Platform for **offshore wind/maritime industry and policy**, incl. trade associations, ministries and R/D
- Offices in Varel and Berlin
- **Initiator** of studies/initiatives, e.g. on *cost reduction* and *energy system benefits*
- Involved in various **projects** (EU and national), e.g. WINDSPEED, SEANERGY20202, POWER Cluster, South Baltic OFFER, 4POWER, **AK Vernetzung** (since 2010), **OffWEA** (2011-14), **OFT** (Offshore Test Site, 2013-14),

Wanderausstellung FASZINATION OFFSHORE WIND VOM MEER FÜR SAUBERE ENERGIE

Gefördert von: Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit

OFT

windspeed SUPPORTING DECISIONS

Seanergy 2020

European Union European Regional Development Fund

INTERREG IVC

4POWER

SOUTH BALTIC OFF.E.R

POWER cluster

The Interreg IVB North Sea Region Programme

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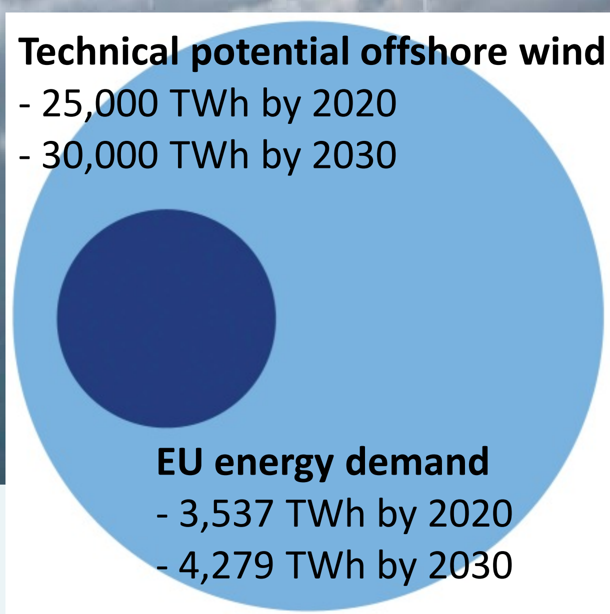
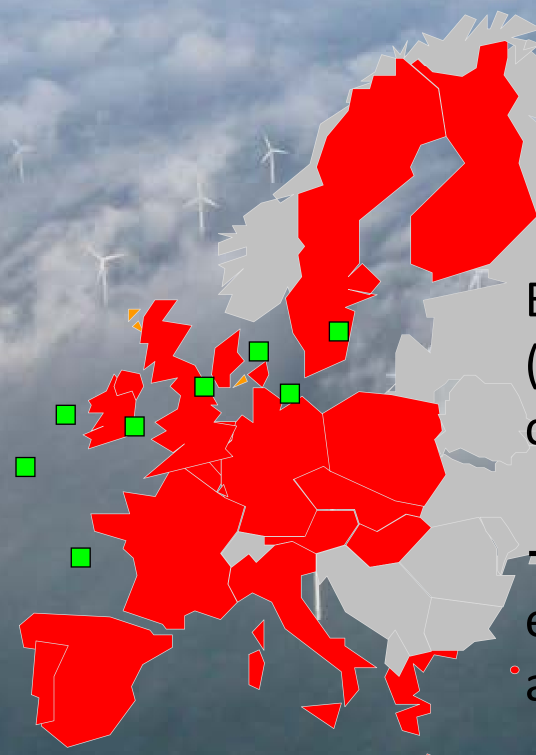
2. Offshore Wind – vast physical potential



Source: EEA, 2009



Eight offshore wind farms (each 100x100 km) could produce 3,000 TWh

→ Equivalent to annual electricity consumption of all EU member states

Source: Siemens, EWEA, 2009 (Oceans of Opportunities)

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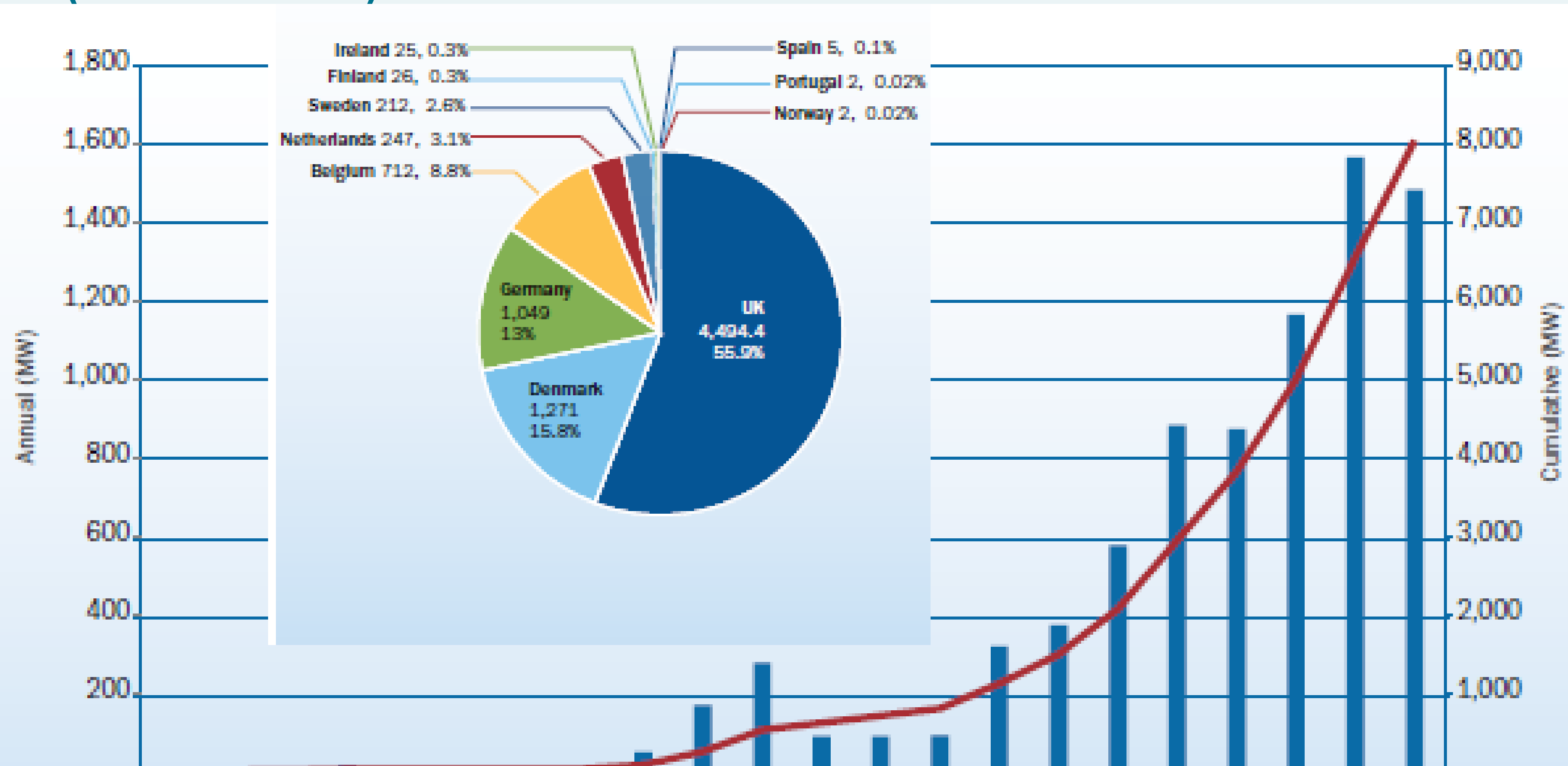
2. Offshore Wind Development in the EU (1993-2014)



	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Annual	-	2.0	5.0	16.80	-	2.80	-	4.0	50.50	170.0	276.20
Cumulative	4.950	6.950	11.950	28.750	28.750	31.550	31.550	35.550	86.050	256.05	532.25

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Annual	89.70	90.0	92.50	318.40	373.48	576.90	882.70	873.55	1165.5	1567.0	1483.3
Cumulative	621.95	711.95	804.45	1122.8	1496.3	2073.2	2955.9	3829.4	4994.9	6561.9	8045.2

Source:EWEA, 2015

2. EWEA Offshore Wind Scenarios for 2030

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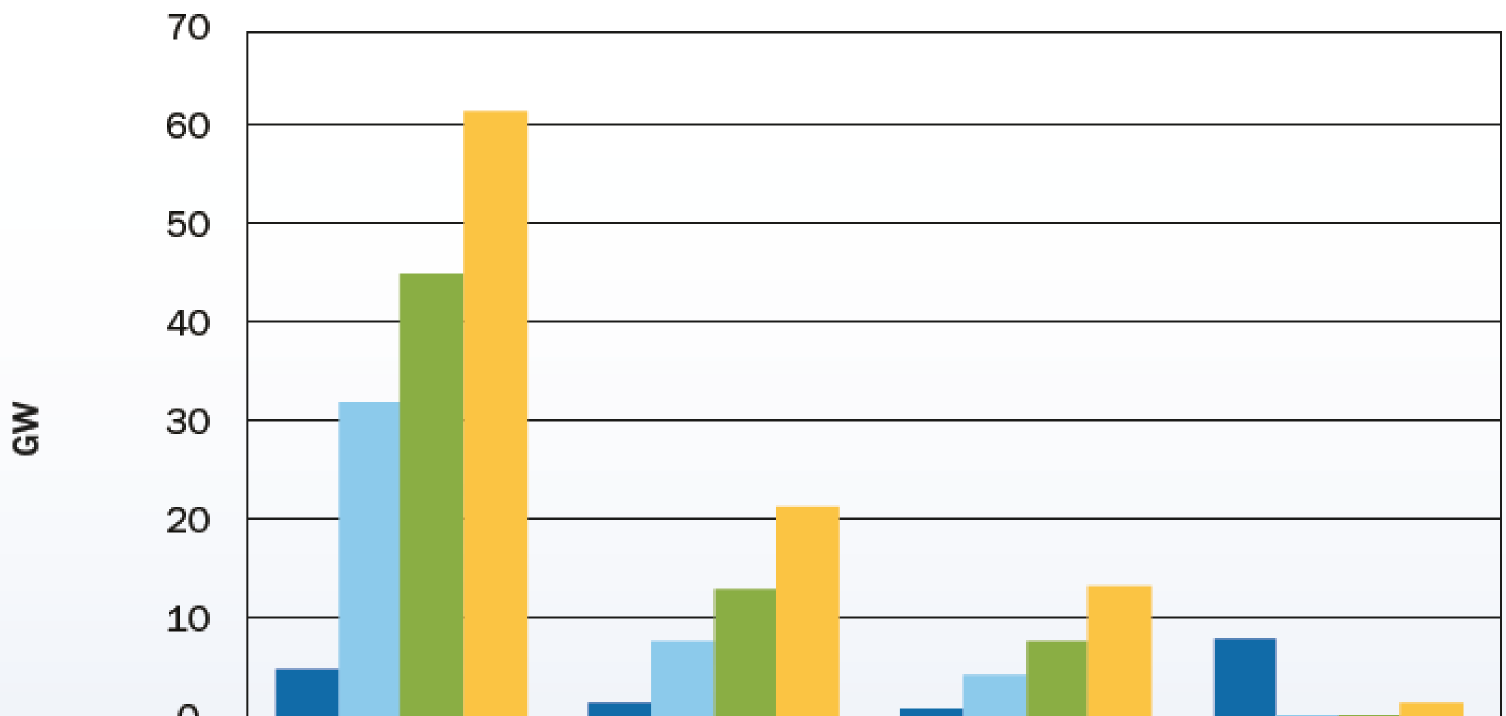
FIGURE 7: OFFSHORE WIND INSTALLATIONS PER SEA BASIN



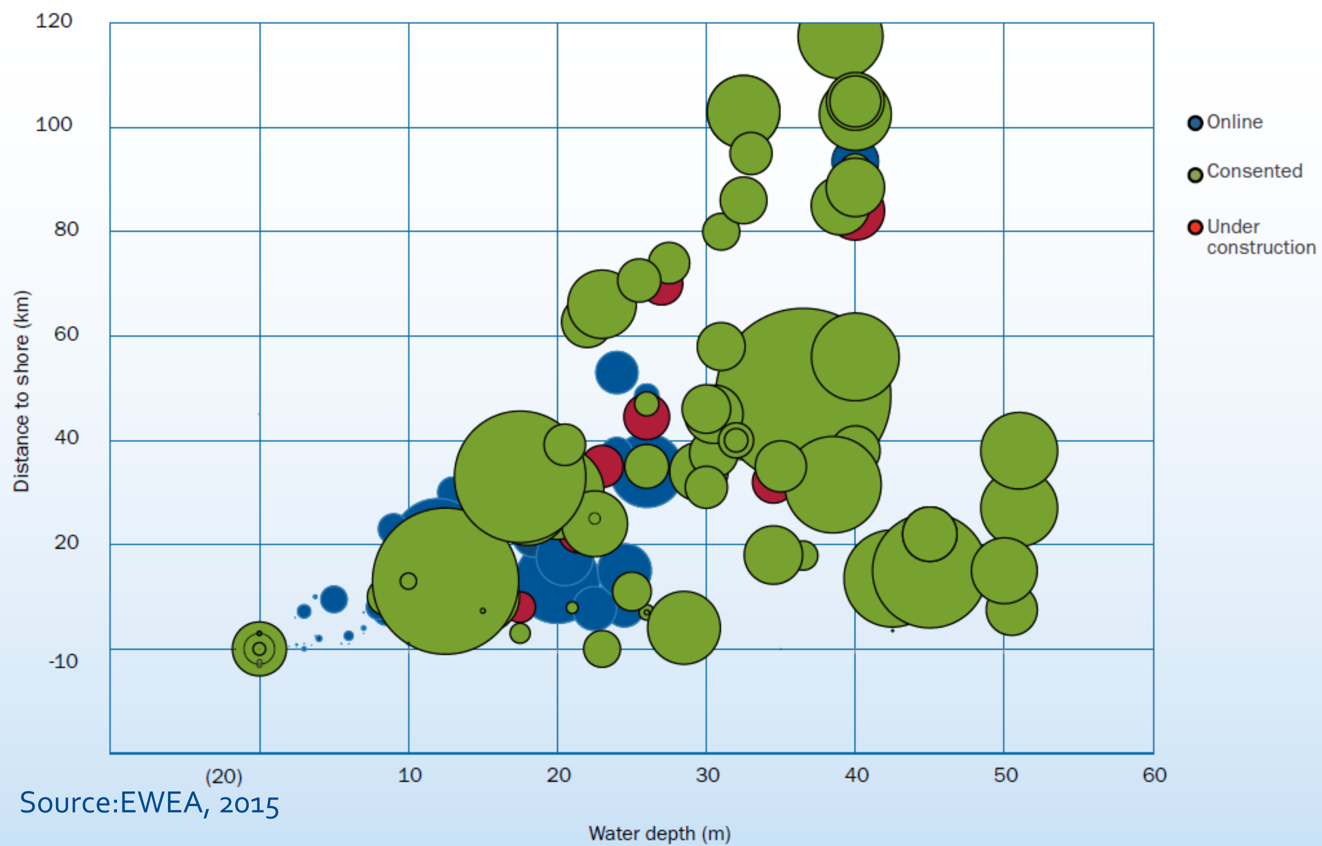
	North	Atlantic	Baltic	Mediterrean
2015*	5.1	1.8	1.1	0
Low	32.1	7.9	4.6	0.02
Central	45.2	13.3	7.9	0.02
High	61.5	21.5	13.5	1.5

*Figures current as of July 2015, EWEA. (2015). The European offshore wind industry - key trends and statistics 1st half 2015.

2. Trends in Offshore Wind Development:

Deeper, more distant to shorelines, larger projects/turbines, more financial volumes

Water depth, distance to shore and size of OWF under construction during 2014

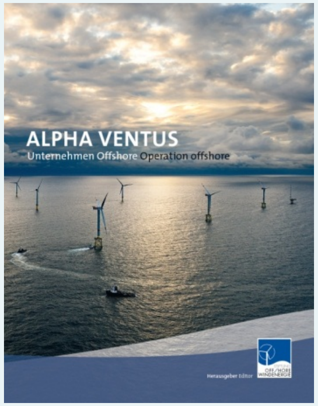


Source:EWEA, 2015

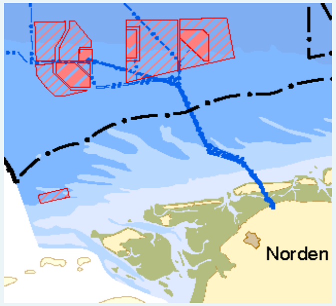
2. Pioneering project *alpha ventus (test site)*

First Offshore Wind Farm (OWF) in Germany,
Paving the way for commercial projects

- ➢ 60 km distance to shore, 30 m water depth
- ➢ First OWF with 5 MW class (12 turbines) → 60 MW
- ➢ 2 turbine manufacturers, 2 types of foundations
- ➢ **Permits acquired by SOW** in 2005, **leased to DOTI** end of 2006
- ➢ Construction start in 2008, **commissioning in 2009/10. Inauguration on 27 April 2010**
- ➢ Impressive operational results – **50 % capacity factor** (4,450 full load hours) > **1 TWh** electrictiy production by 2014

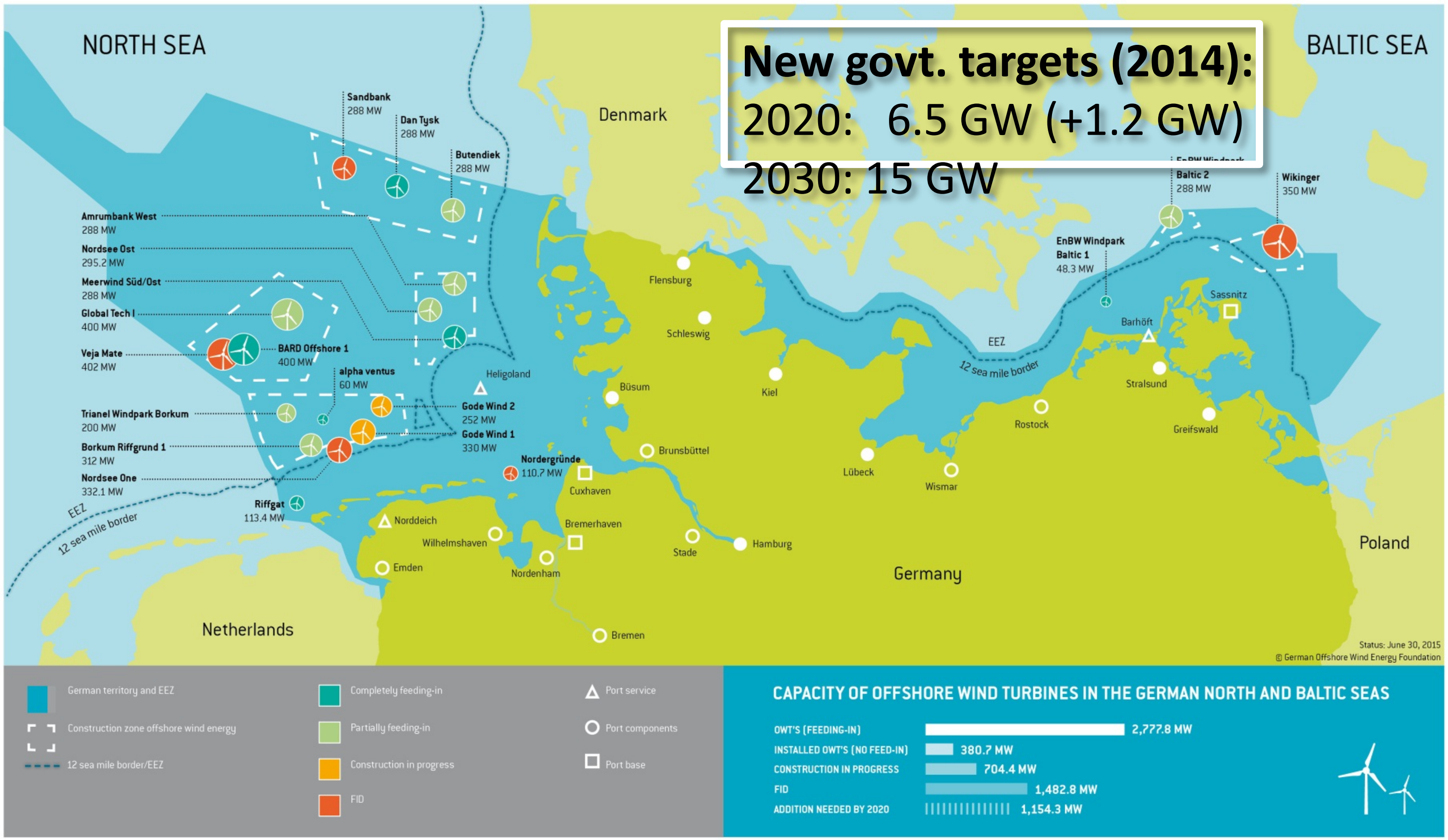


- ➢ RAVE – Research at alpha ventus
  Extensive ecological and technological R&D Program funded by the German government (50 Mio €)



2. Status of German Offshore Wind Development (as of 30 June 2015) – **on track for 2020!**

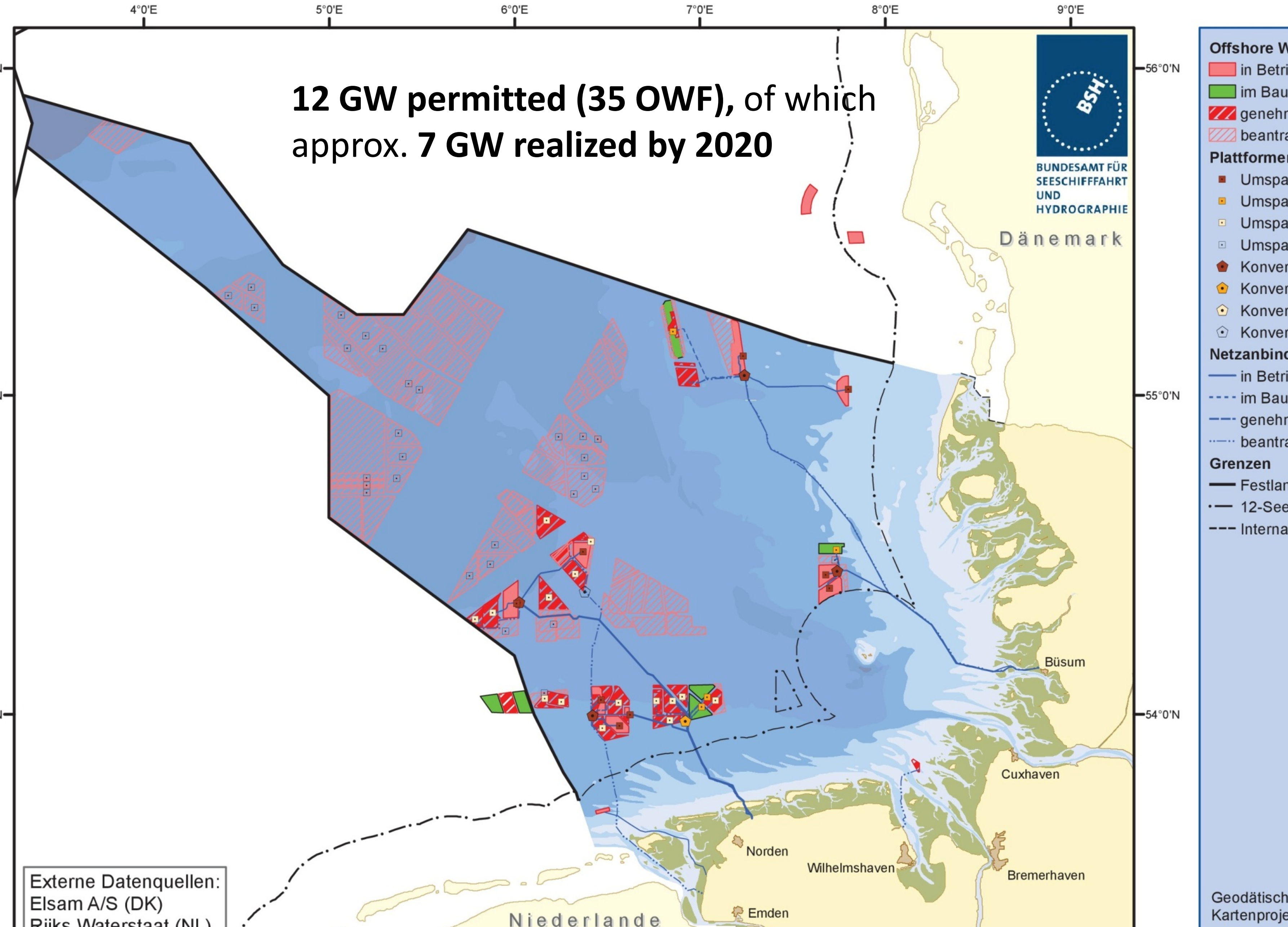
New govt. targets (2014):
2020: 6.5 GW (+1.2 GW)
2030: 15 GW



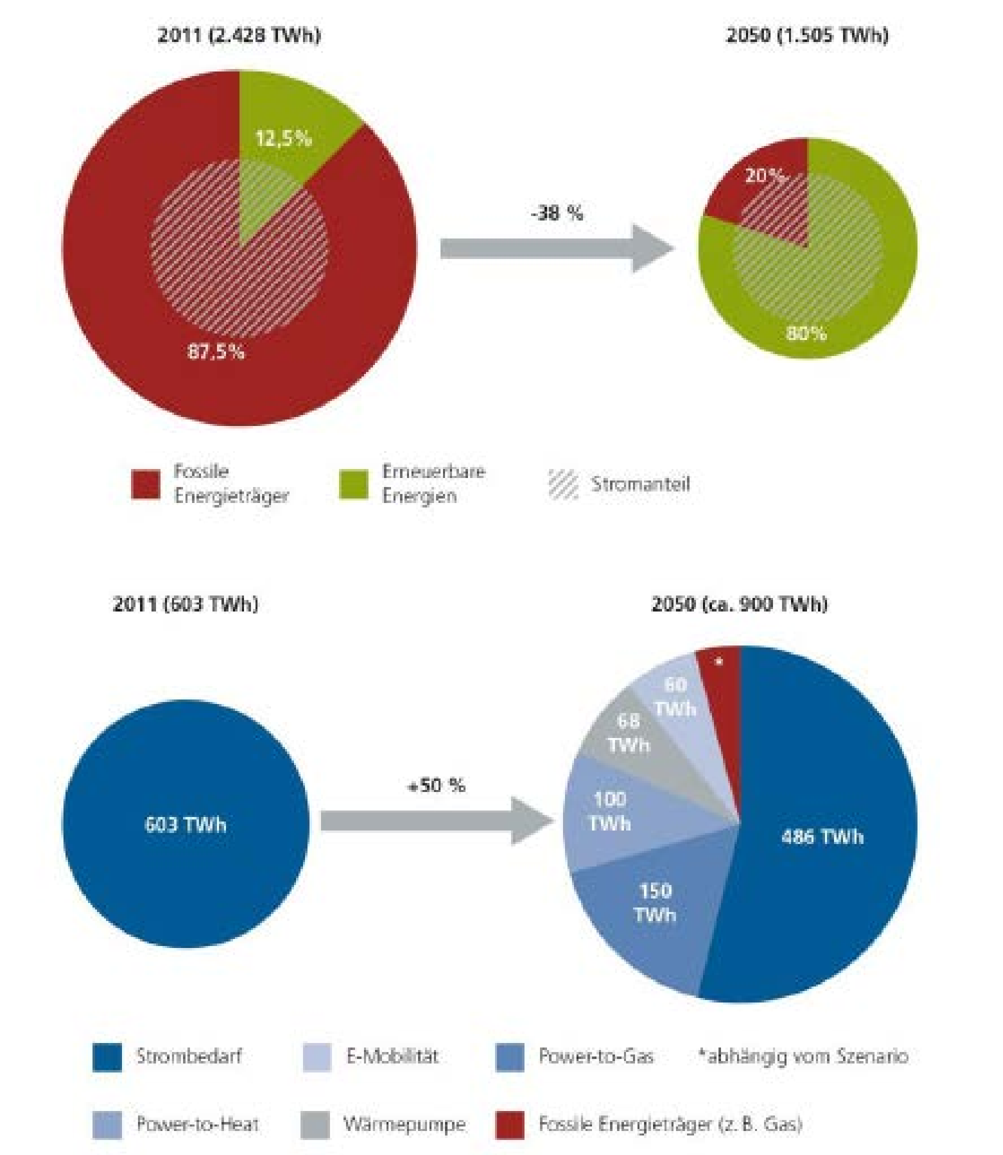
> 1 GW online by 2014, > 3 GW by end of 2015

Nordsee: Offshore Windparks

12 GW permitted (35 OWF), of which approx. **7 GW realized by 2020**



3. Germany Energiewende – Transformation of Energy Mix 2011-2050



Today: € 90 Billion/yr for energy imports

Future (2050) –
Primary Energy Consumption
- 80 % RE,
- 20 % fossil fuels

Electricity Production 2050
Sharp increase → higher shares of CHP, e-mobility, P2H&P2G.
- **95 % from RE**
- Fossil fuels mainly for balancing requirements

3. RE Potential (Wind, PV) and its limitations Generation Mix assumptions

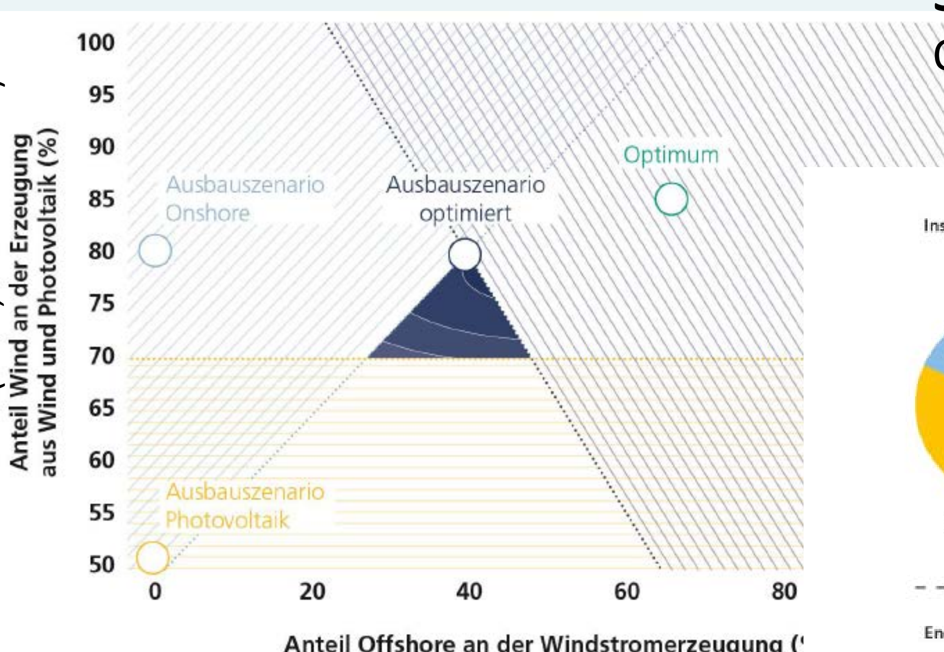
Scenario input:

Optimum distribution of wind/PV

3 Scenarios:

Optimized - Onshore Focus - PV Focus Mix

Wind (on- and offshore) share (%), related to FEE (wind, PV combined)

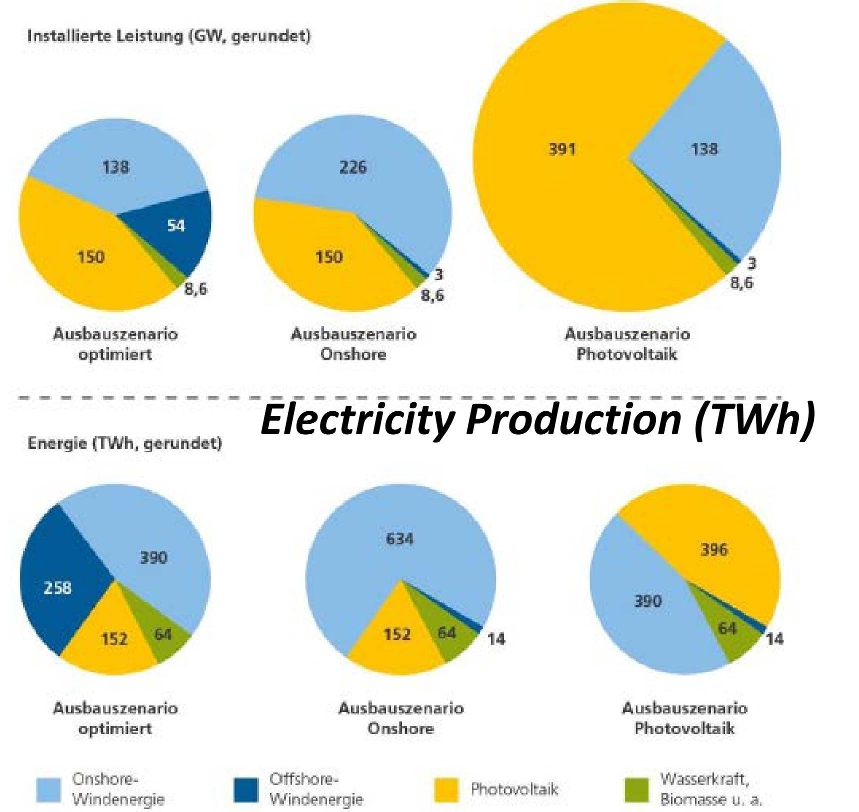


Offshore wind share (%), related to total wind electricity. production

© Fraunhofer-IWES, 2013

Installed Capacity (GW)

Electricity Production (TWh)



3. Scenario Results

Annual flexibility costs and LCOE (2050) in the scenarios

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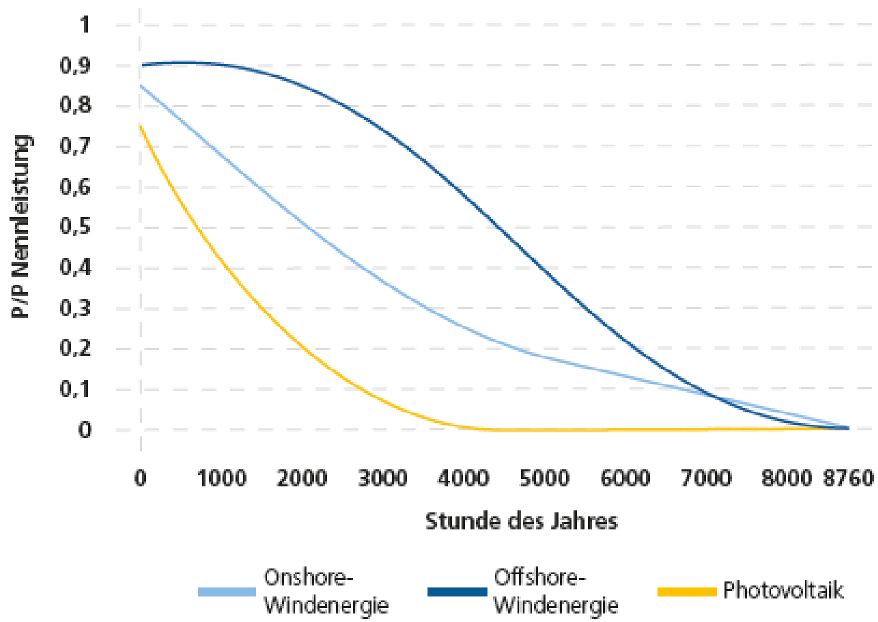
	Optimized growth scenario	Onshore growth scenario	Photovoltaics growth scenario
Back-up capacity (GW)	54,4	62,0	62,6
Investment costs – annuity basis (billions of euros)	1,8	2,0	2,0
Residual power demand (TWh)	53,4	68,9	81,8
Fuel costs for residual power demand (billions of euros)	4,8	6,2	7,4
Storage capacity (GW)	67,9	74,3	83,9
Investment costs – annuity basis (billions of euros per year)	3,2	3,6	4,0
Excess production (TWh)	20,3	35,9	51,2
Curtailment costs (billions of euros)	1,3	2,3	3,4
Cumulative flexibility costs (billions of euros)	11,1	14,0 (+26%)	16,8 (+50%)
Cumulative levelised costs of electricity (billions of euros)	52,4	50,4	52,9
Total costs for flexibility and power production (billions of euros)	63,5	64,5	69,7

Power Plant Characteristics - Offshore wind:

Steady electricity production/high availability



→ Ideal Growth Scenario:

€ 2.9 – 5.6 bn savings/yr on flexibility cost

→ Ideal Growth Scenario:

€ 1 - 6.2 bn savings/yr on total cost

3. Lower System Cost with Offshore Wind

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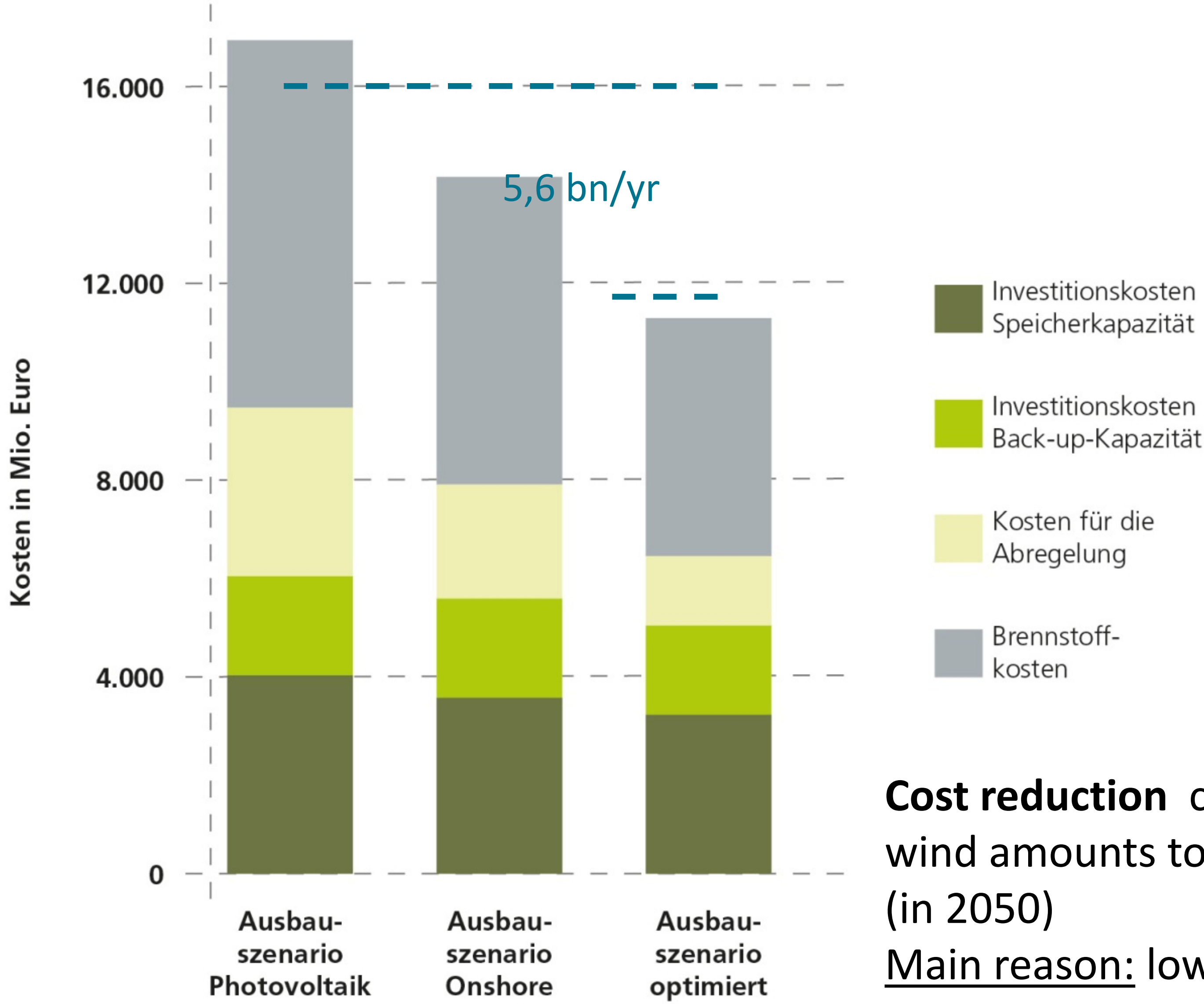

Investment cost for **storage** capacity

Investment cost for **back-up** capacity

Investment cost for **curtailment**

Fuel Cost

Cost reduction caused by offshore wind amounts to **3-5,6 bn € p.a.** (in 2050)

<u>Main reason:</u> lower flexibility cost

3. Energy System Benefits of Offshore Wind

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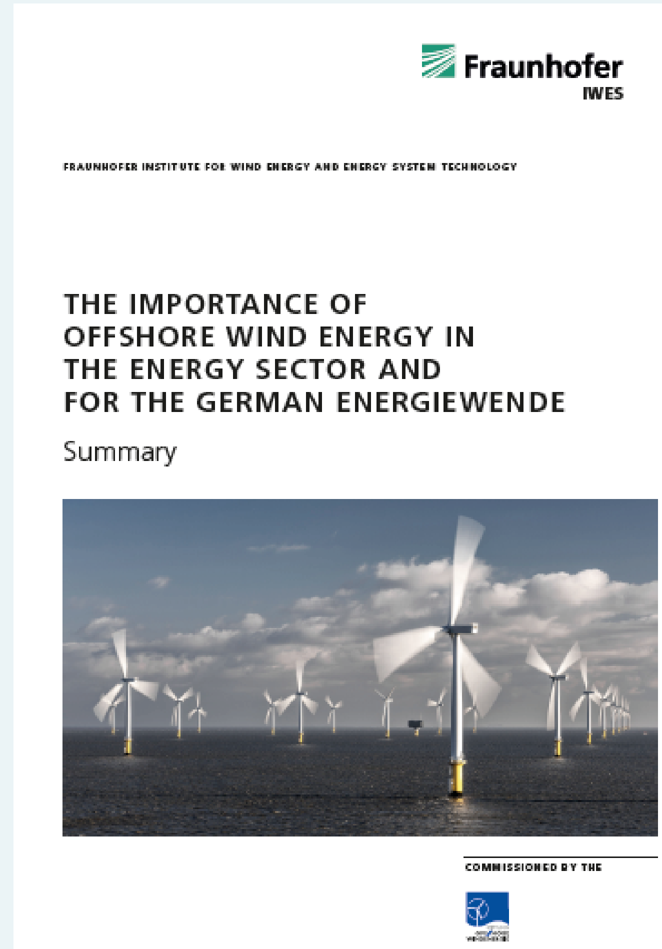
Key Assumptions/Study Results

1. By 2050, German **Energiewende requires 800 TWh from wind and solar energy** – *only achievable with large OWE capacities (up to **54 GW**)!*
2. Leads to ***reduced cost for flexibility measures*** → least-cost option OWE
3. Offshore wind has considerable ***power plant characteristics –*** important for **security of supply** (provision of balancing power, high schedule reliability, etc.)
4. *Stable and **continuous expansion*** of OWE capacities allows to ***harvest energy system benefits and cost reduction potentials***


Fraunhofer IWES

FRAUNHOFER INSTITUTE FOR WIND ENERGY AND ENERGY SYSTEM TECHNOLOGY

THE IMPORTANCE OF OFFSHORE WIND ENERGY IN THE ENERGY SECTOR AND FOR THE GERMAN ENERGIEWENDE

Summary

COMMISSIONED BY THE

Study launched in Nov. 2013,
at EWEA Offshore 2013, Frankfurt

4. Continuous dynamic growth is contributes to cost reduction and energy system benefits/savings

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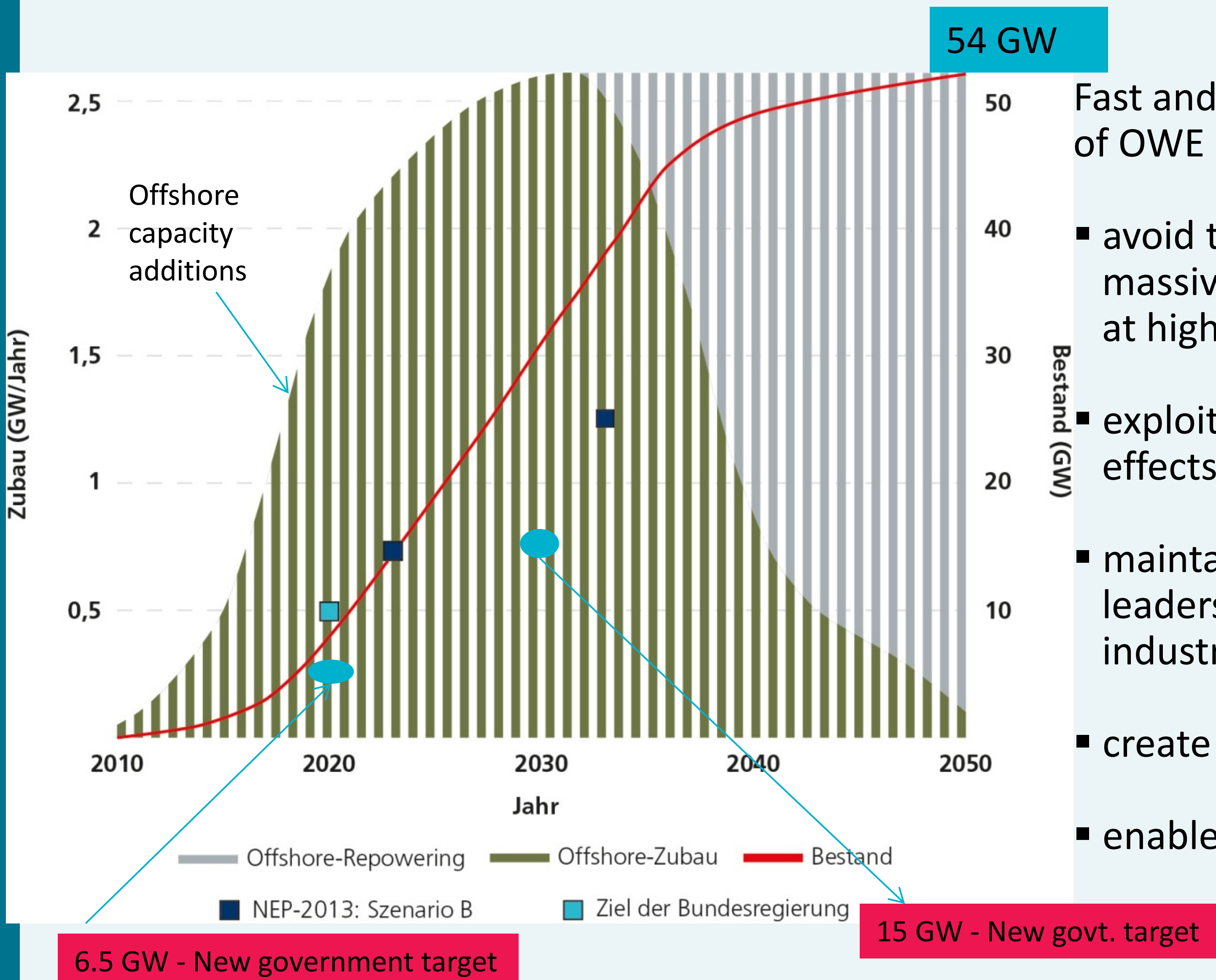


Fast and continuous growth of OWE is helping to

- avoid the need for massive capacity build-up at higher cost at a later stage
- exploit learninig curve effects
- maintain technology leadership of German industry
- create jobs (18,000 today)
- enable the Energiewende

4. Talking about Cost Reduction … Costs, what kind of Costs?

- Technology progress
- Efficiency
- Economies of scale
- Standardisation
- Competition
- Supply Chain
- Water depth
- Distance to shore
- Availability and load factor
- Reliability
- Planning delays
- Finance availability and cost
- Exchange rate impacts
- Commodity prices
- Permitting and regulatory cost
- …

→

DEVEX
CAPEX
OPEX
DECEX

AEP

LCOE

4. Cost Reduction Roadmaps – UK, Germany

Cost reduction pathways TCE, 2012 (LCOE vs. Time/Capacity)

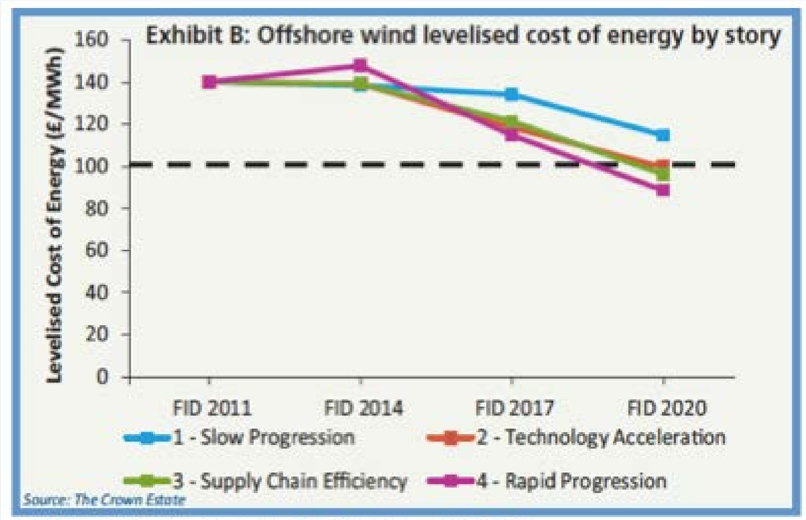
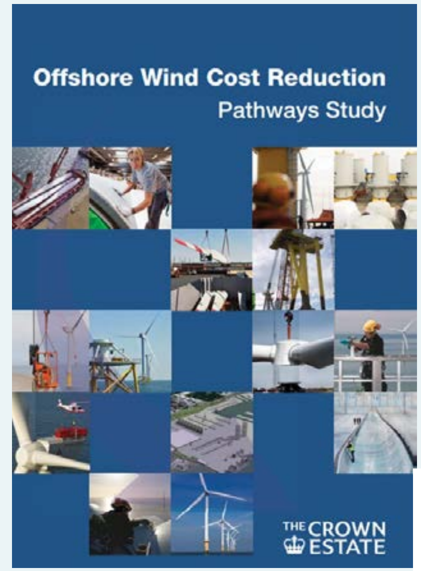
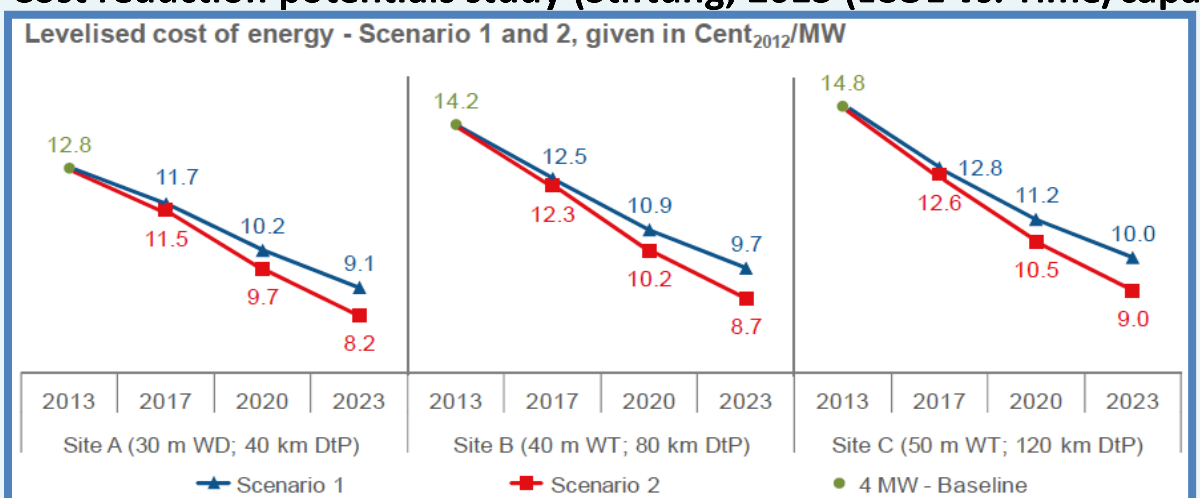


Figure 7, Pathway cost reduction scenarios TCE



Cost reduction potentials study (Stiftung, 2013 (LCOE vs. Time/capacity)



4. Prognos/Fichtner scenario assumptions:

Two growth scenarios at 3 sites (North Sea)

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Scenario definition

Installed capacity	Scen. 1	Germany: 0,6 GW* Europe: 6 GW	GER: 3,2 GW EU: 13 GW	GER: 6 GW EU: 20 GW	GER: ≥ 9 GW EU: > 20 GW
	Scen. 2	Germany: 0,6 GW* Europe: 6 GW	GER: 5-6 GW EU: 25 GW	GER: 10 GW EU: 40 GW	GER: ≥ 14 GW EU: > 40 GW

Site A

Plant and wind farm configuration in the two scenarios

	Scenario 1					Scenario 2				
Initial operation	Number WTG	Capacity WTG	Size wind farm	Hub height	Rotor diameter	Number WTG	Capacity WTG	Size wind farm	Hub height	Rotor diameter
2013	80	4 MW	320 MW	90 m	120 m	80	4 MW	320 MW	90 m	120 m
2017	75	6 MW	450 MW	100 m	145 m	75	6 MW	450 MW	100 m	145 m
2020	75	6 MW	450 MW	100 m	154 m	56	8 MW	450 MW	110 m	164 m
2023	75	6 MW	450 MW	105 m	164 m	56	8 MW	450 MW	115 m	178 m

Source: [Prognos / Fichtner]; WTG = Wind Turbine Generator

Initial operation:	2013	2017	2020	2023

*Source: [Prognos / Fichtner]; * expected installed capacity by the end of 2013*

4. Cost Reduction Potentials for OWE, Germany

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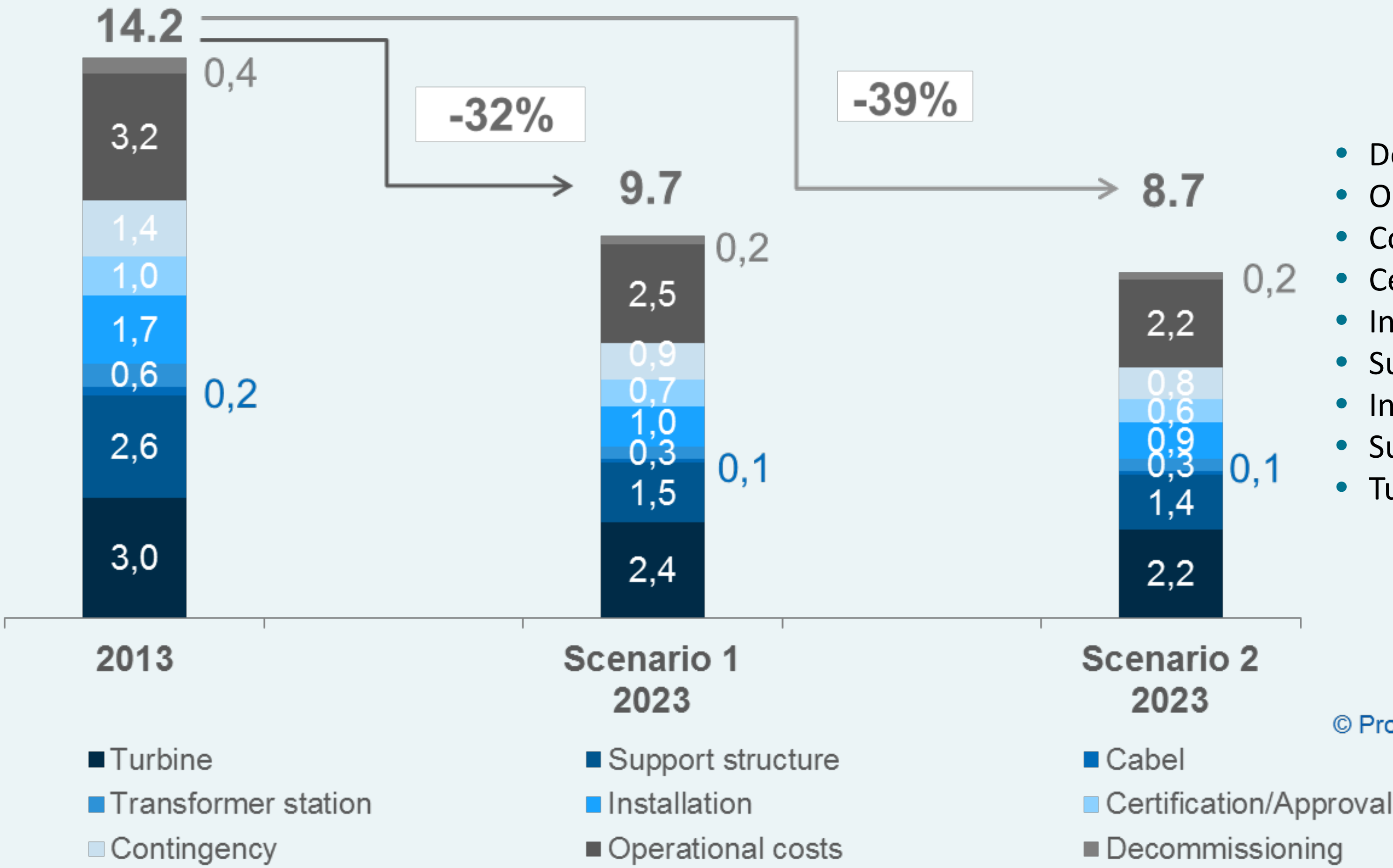
Site B, results in €cent/kWh, based on 2012 real terms



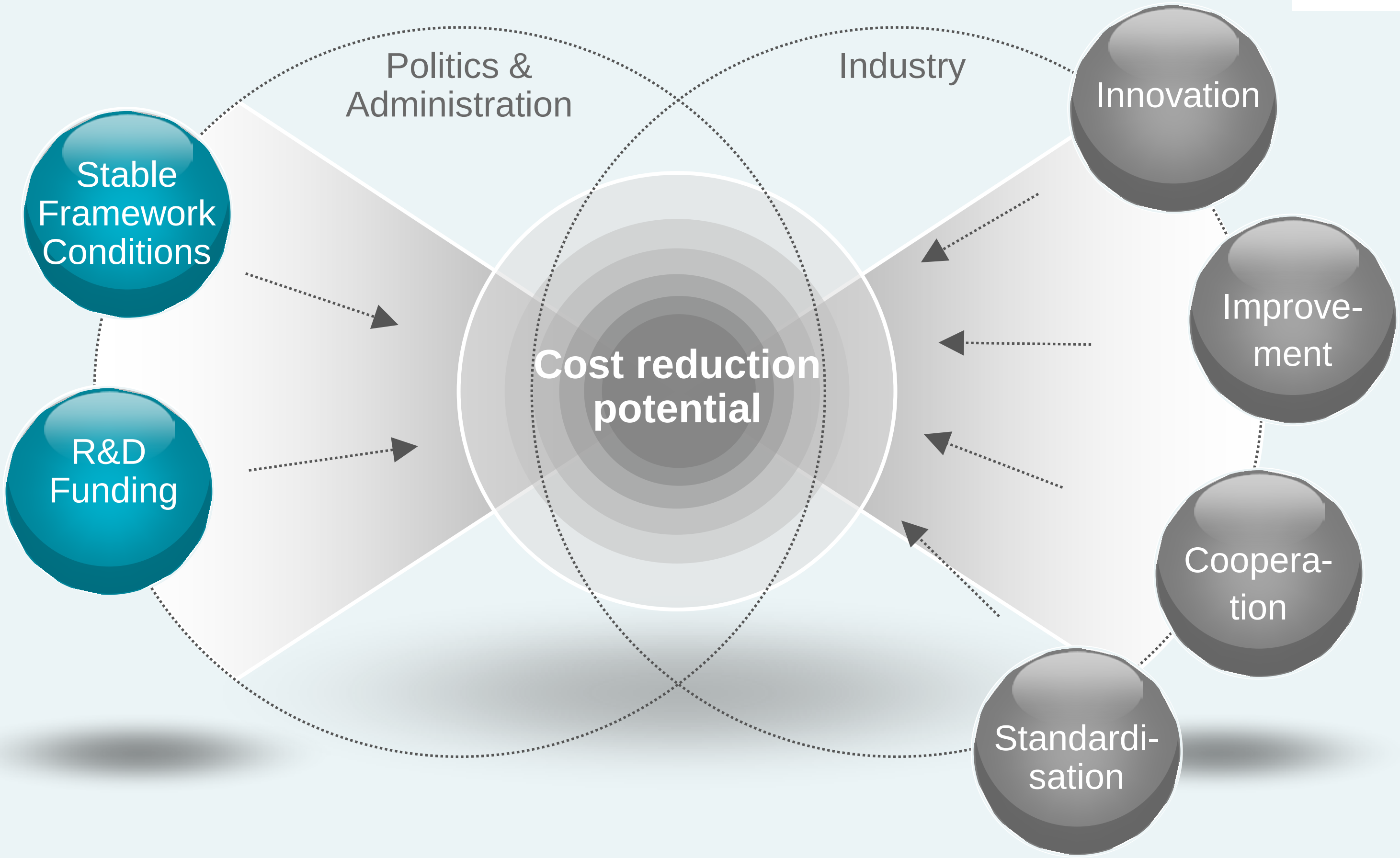
- Decommissioning
- OpEX
- Contingency
- Certificat./Approval
- Installation
- Substation
- Internal cable
- Support structure
- Turbine

© Prognos/Fichtner, 2013

Learning Curve Effect stimulated by *constant market growth*

→ project pipelines, economies of scale, increasing competiton, growing turbine size

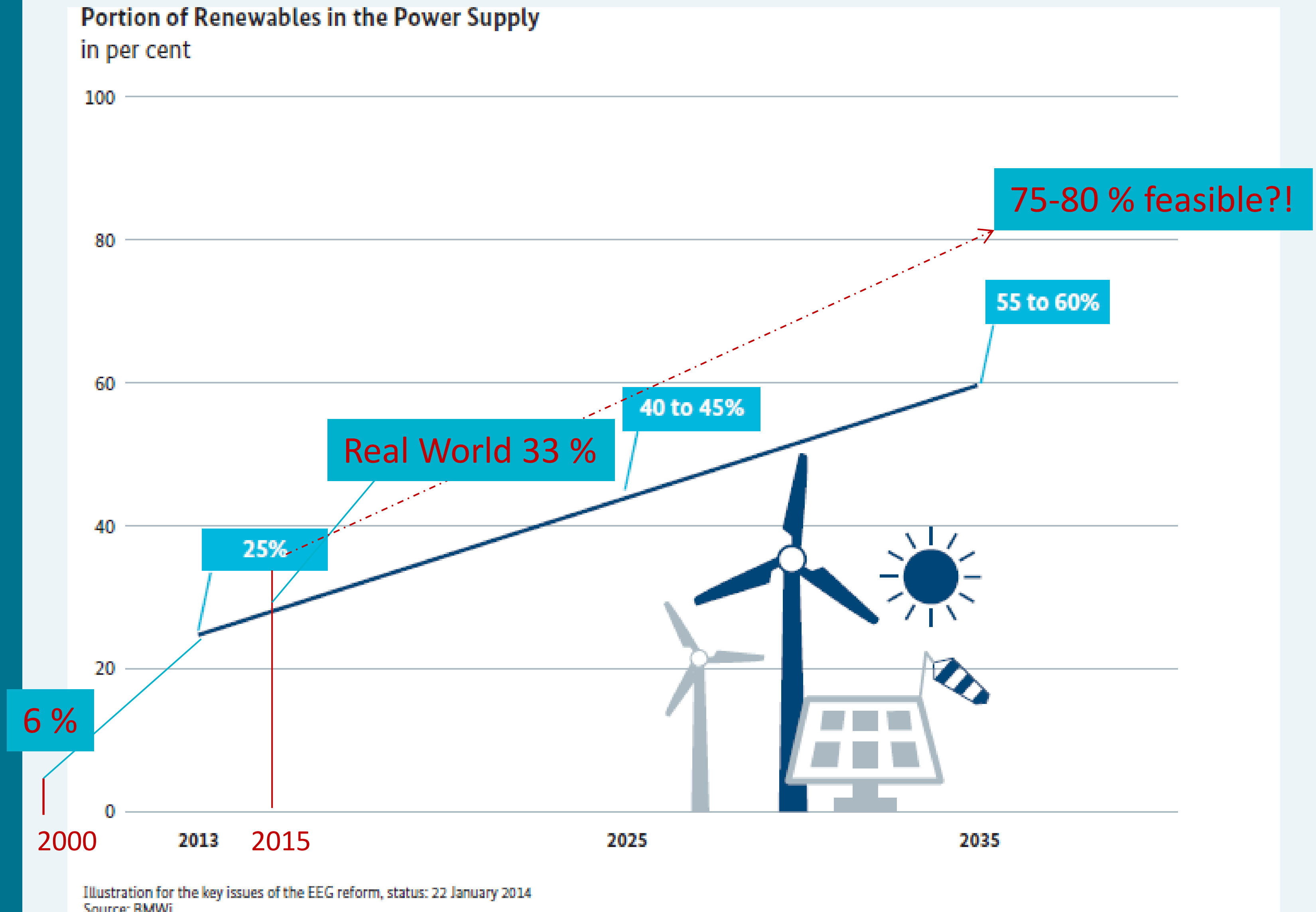
How to exploit the Cost Reduction Potential



"Cost reduction comes through volume!
Volume needs confidence,
Confidence needs consistent policies".

(Andrew Garrad, Windkracht 14)

4. Government Roadmap for RE Expansion by 2025/35 (based on EEG 2014)



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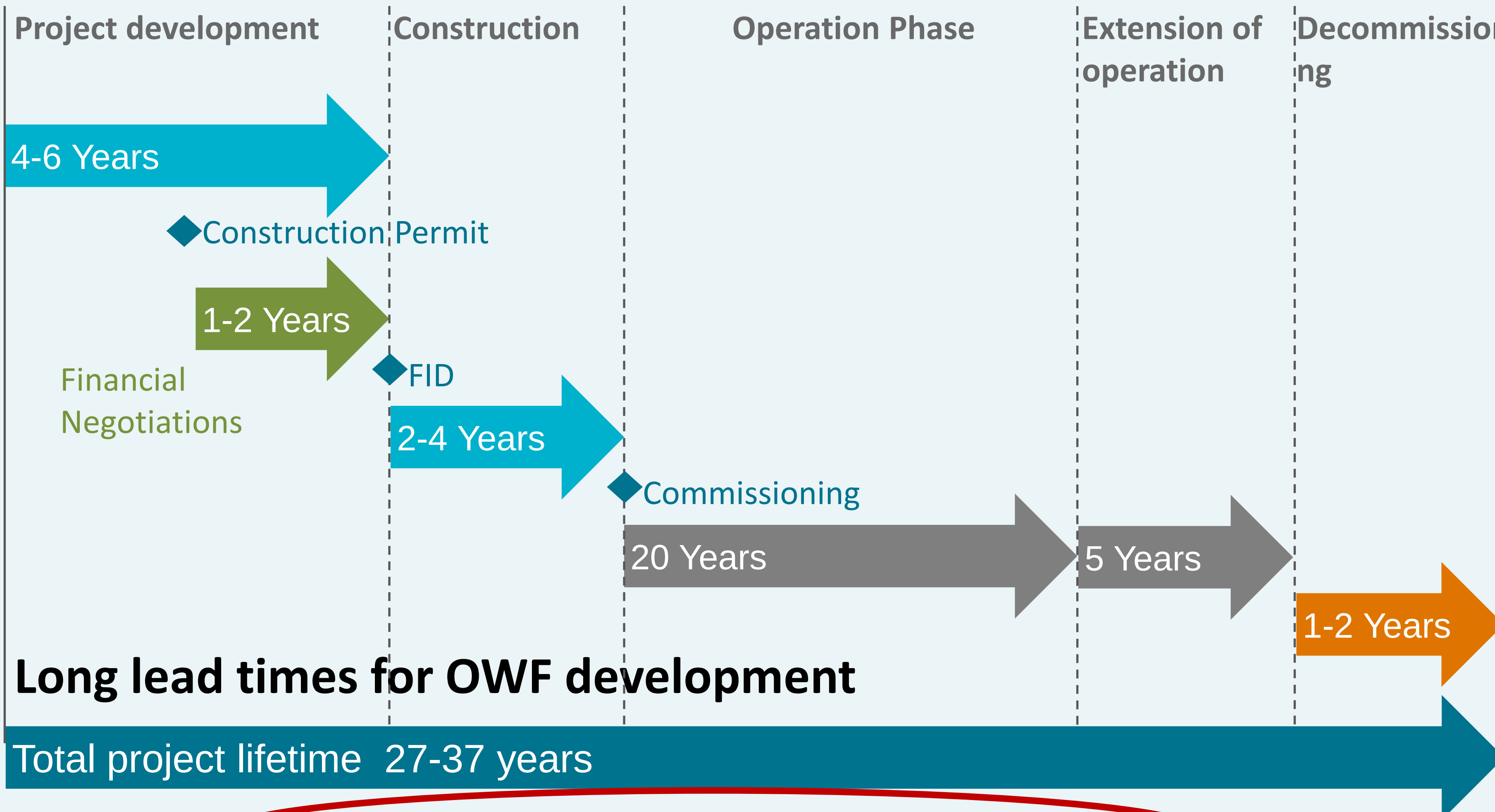
4. Don‘t forget: Offshore Wind is different …

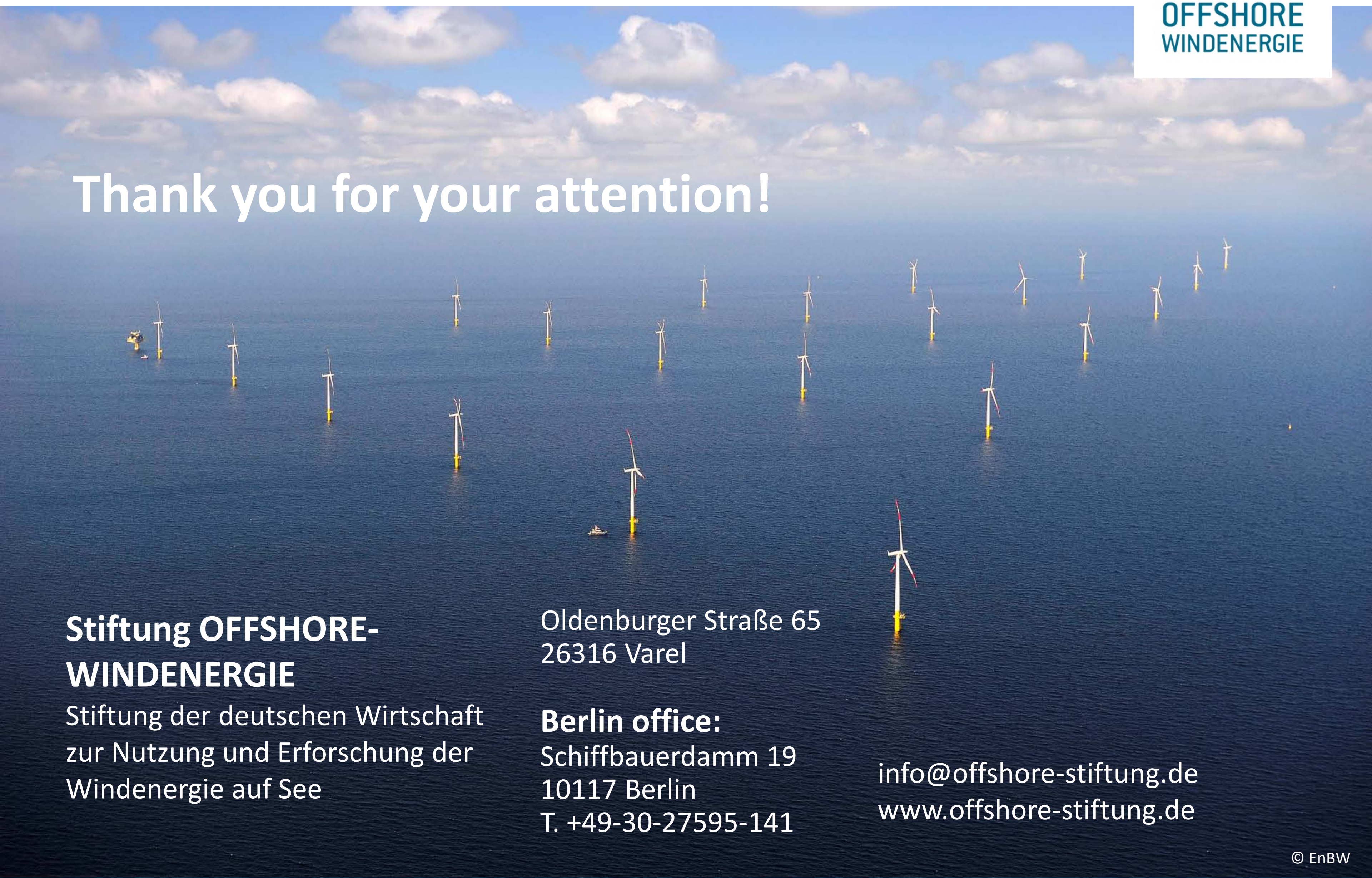
Idealized Project Schedule



Long lead times for OWF development

Reliable & stable legal framework crucial

© Prognos/Fichtner, 2013



Thank you for your attention!

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