COST REDUCTION IN OFFSHORE WIND

What are the potential and why must R&D focus on it?

By Jørgen R. Krokstad

Industry meets Science – 20 September 2012

Statkraft

Content

- Definition of LCOE and status within the industry
- The potential of cost reduction
- OWA – a R&D mean to accelerate technology development against cost reduction
- Examples of Statkraft use of LCOE for research project initiation
- Some questions for the audience

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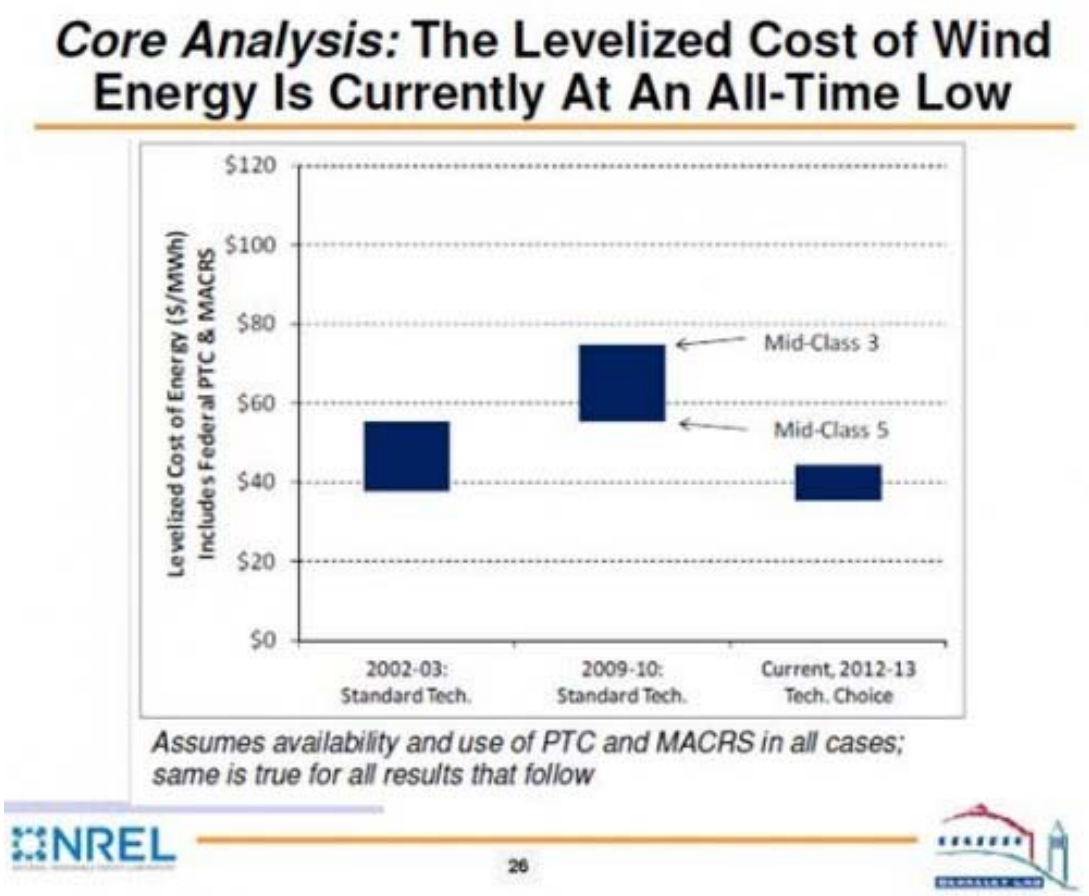
Good news in the wind business!



- LCOE is now between $33 and $65 per MWh
- Clearly beats fossil fuels
- Main reason:

  Bigger wind turbines that have a higher capacity factor

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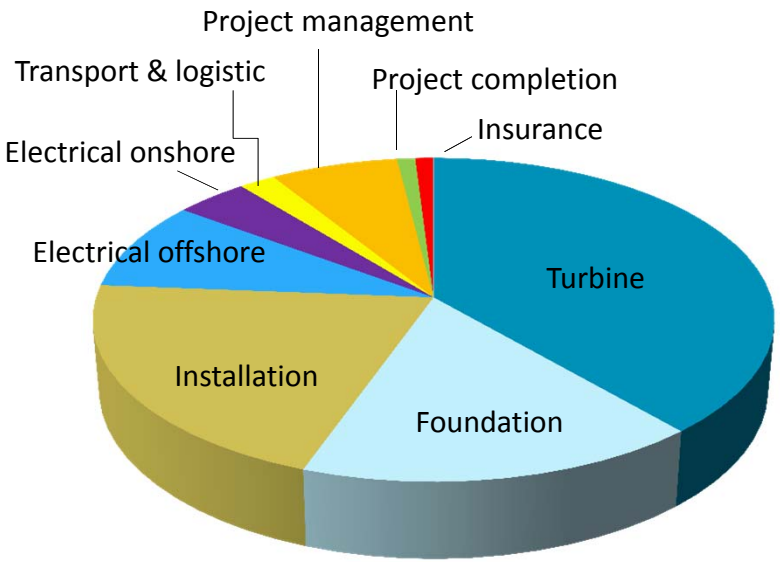
Definition of LCOE – Levelised Cost of Energy

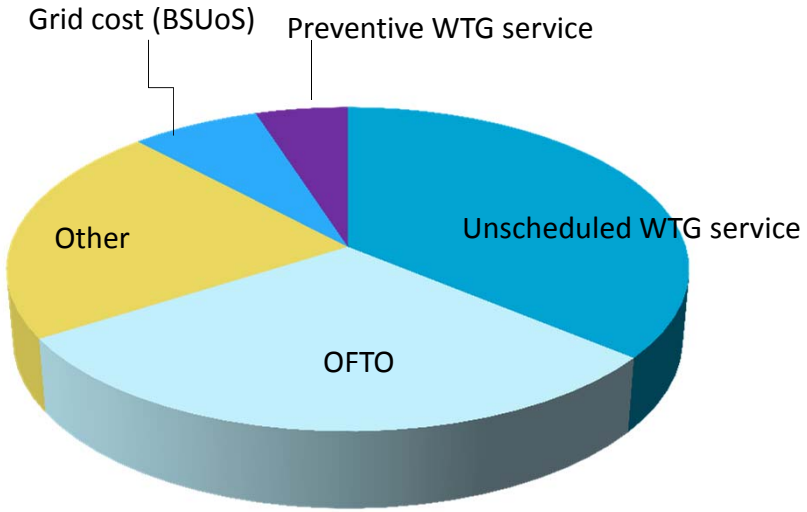
- The sum of discounted lifetime generated cost (£)- divided by the sum of discounted lifetime electricity output (MWh)
- Generation cost: Capital (CAPEX), operating (OPEX) and decommissioning costs including transmission costs (OFTO) over the lifetime of the project
- An expression of cost rather than revenue
- The discount rate is the Weighted Average Cost of Capital over the lifetime

CoE split (typical UK R2 project)

CAPEX ~ 2/3



OPEX ~ 1/3



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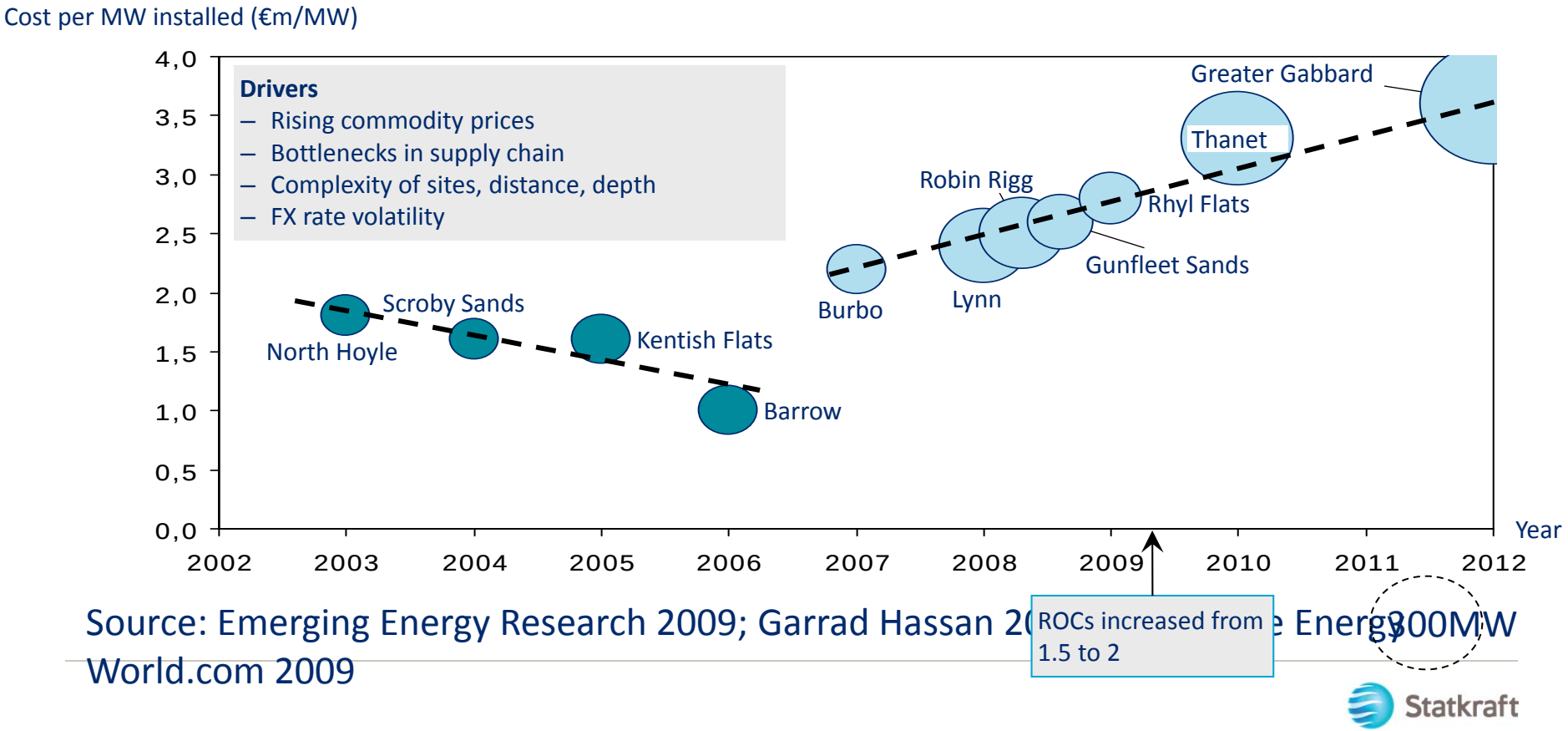
Costs must come down

Otherwise projects will not get built



Source: Emerging Energy Research 2009; Garrad Hassan 20 e Energy World.com 2009

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Innovation as input to Cost Reduction

Offshore Wind Cost Reduction. Pathway Study: Crown Estate 2012

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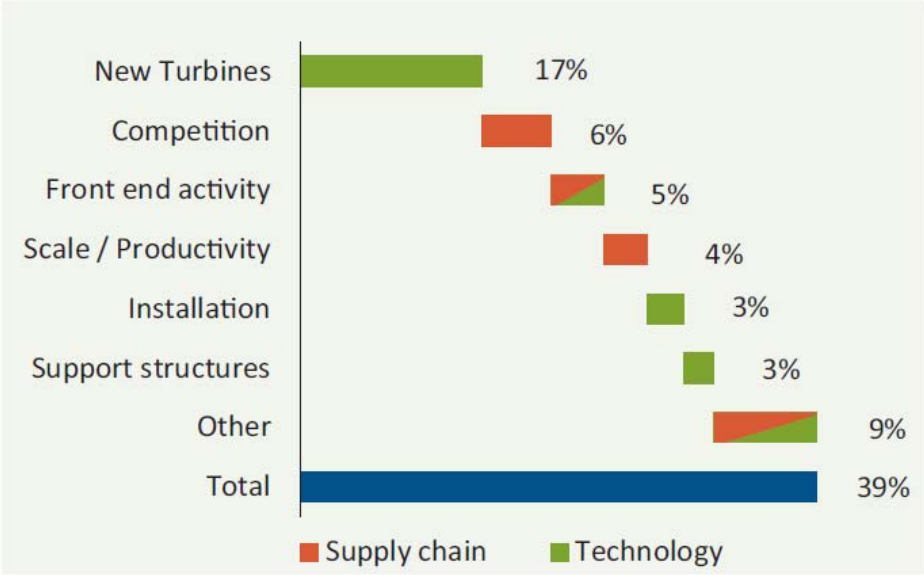
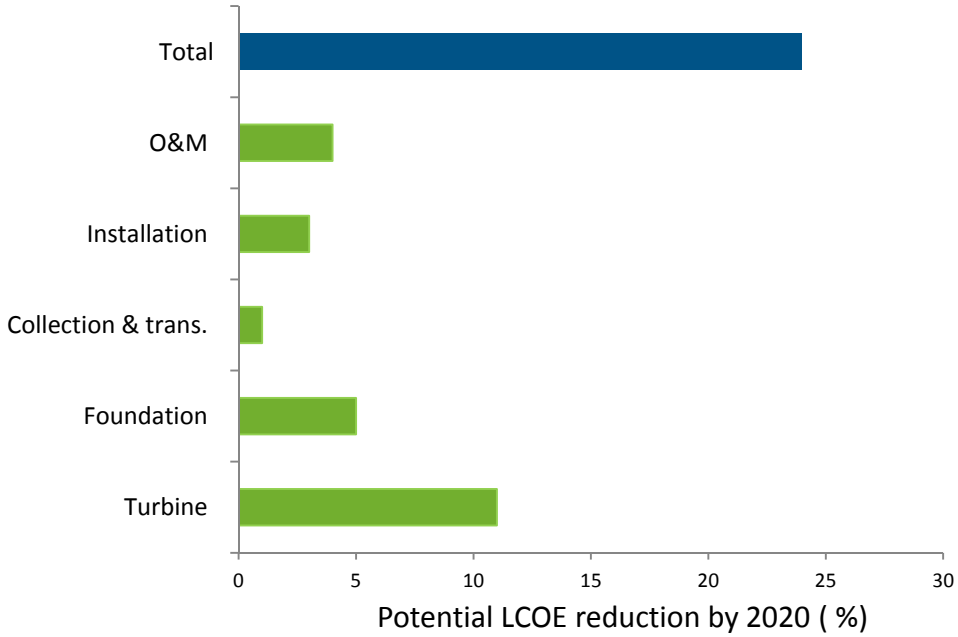
Potential LCOE cost reduction





TCE study 2012: FID 2011 to 2020

Technology Innovation Needs Assessment Offshore Wind 2011

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Offshore Wind Accelerator (OWA)

Aim: Reduce cost of offshore wind by 10%

CARBON TRUST
DONG energy
RWE
SCOTTISHPOWER RENEWABLES
SSE Renewables
Statoil
Statkraft
MAINSTREAM RENEWABLE POWER
e·on

Offshore wind returns

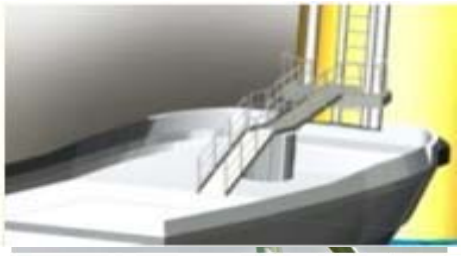
CAPEX | **OPEX** | **Yield**


Gifford-BMT Freyssinet


Keystone

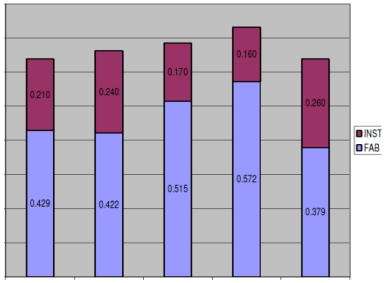

MBD


SPT & Wood Group



Foundations

De-risking and cost modelling



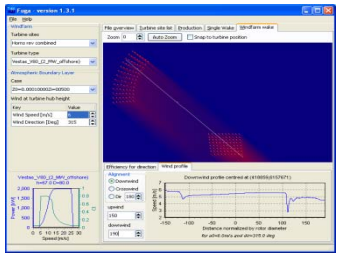
Access

Competition:
400 entrants, 13 to be supported

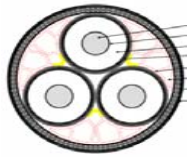
Wake effects

Electrical systems

Efficient software and layout optimisation study



Investigating possibility and benefits of moving to higher voltage for array cables



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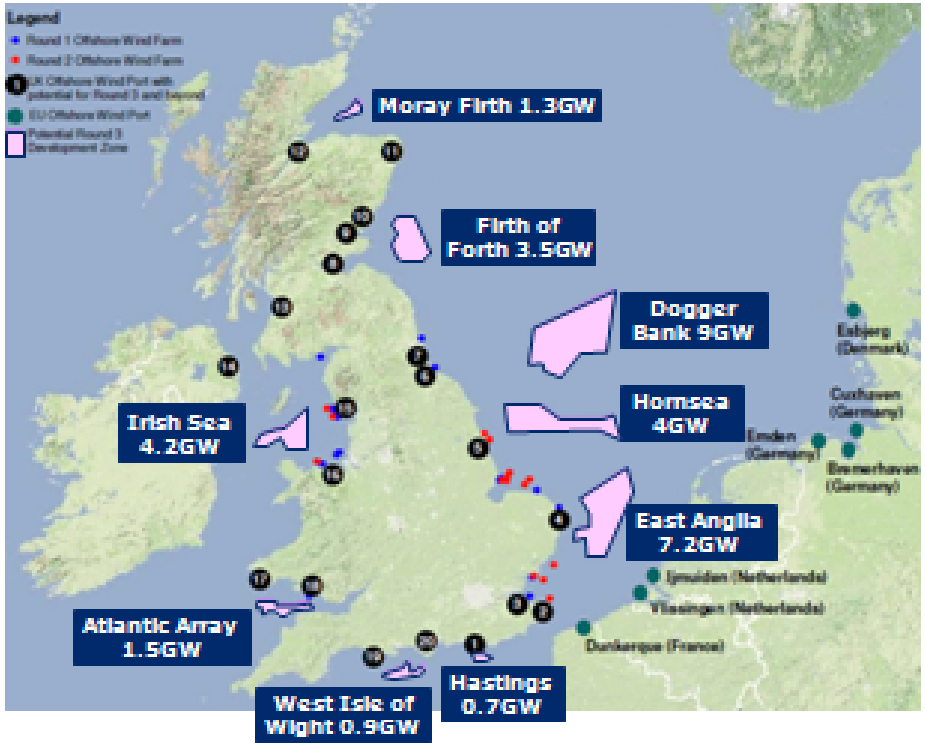
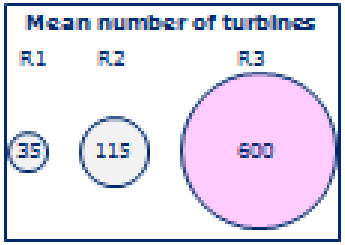
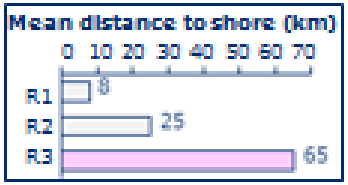
Projects are becoming more technically challenging

Larger, further from shore, in deeper water, with bigger turbines







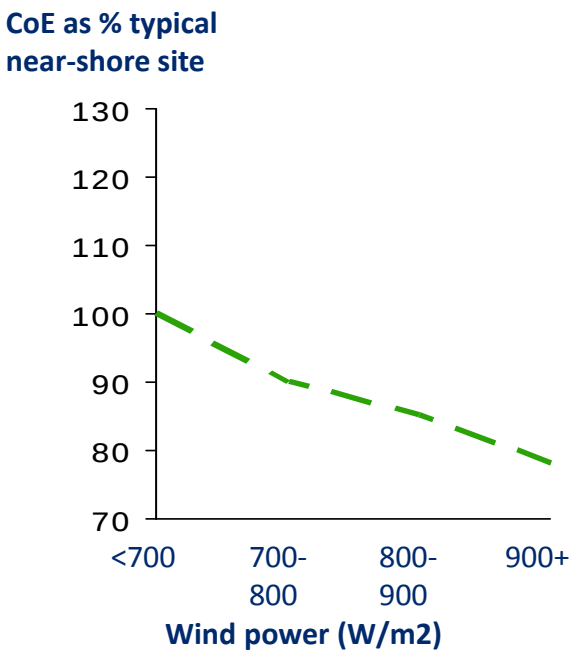
Source: UK Ports for the Offshore Wind Industry: Time to Act, DECC / BVG Associates, 5 February 2009, p.17; Financial Times, January 2010; Carbon Trust analysis

7

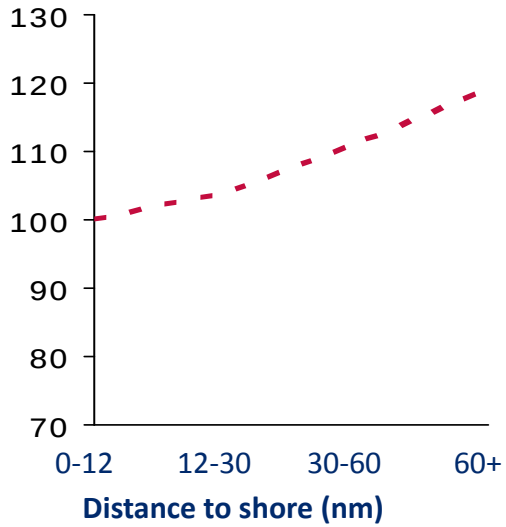
Choose sites carefully

Focus on reducing sensitivity of cost to distance and depth

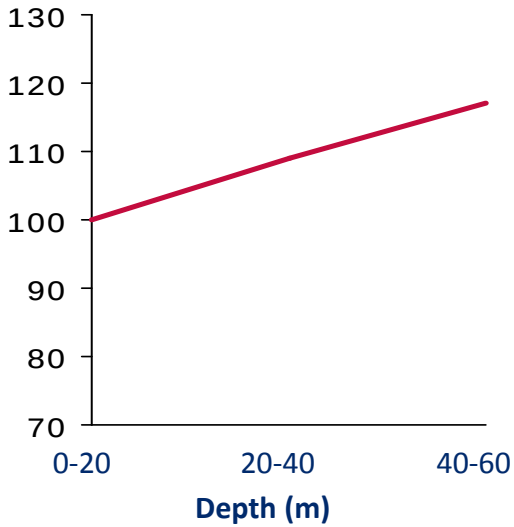
Wind speed



Distance



Depth



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Source: Carbon Trust “Big Challenge, Big Opportunity” 2008

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Significant opportunity for innovation to drive down costs

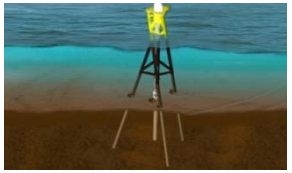
Development	Electrical	Foundations	Installation	Turbine	O&M
New layouts	AC vs HVDC links	Monopiles	Jack-up barges + shuttles	Larger turbines	Port-based vs mother-ship
	Higher voltage arrays	Gravity bases	Floating installation vessels	Blades	New vessels, transfer systems
	Radial vs loops	Jackets		Drivetrain	Condition monitoring
		Buckets	Float-out and sink		

Four designs prioritised for Round 3 from 104 entries

Objective: Reduce foundation costs by up to 30% in 30-60m

Shortlist

Finalists



Keystone

Gifford / BMT / Freyssinet

SPT Offshore

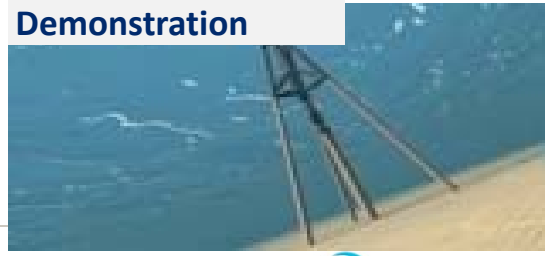
Universal Foundation

Stage II focus

Fabrication

Installation

Demonstration



Source: Carbon Trust Offshore Wind Accelerator 2010, IHC

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Concept development of 13 access systems is underway

Vessels

Fjellstrand Windserver

Nauti-Craft

Pivoting Deck Vessel – North Sea Logistics

Surface Effect Ship – UMOE Mandal

SolidSea Transfer – University of Strathclyde

University of Strathclyde Glasgow

TranSPAR – ExtremeOcean Innovation

Concept development of 13 access systems is underway

Transfer systems, launch & recovery systems

Auto Brow –
Ad Hoc Marine, South Boats

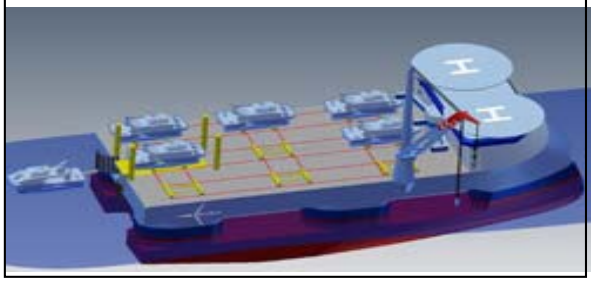
Ad Hoc Marine Designs Ltd.

South Boats

MOTS - Momac

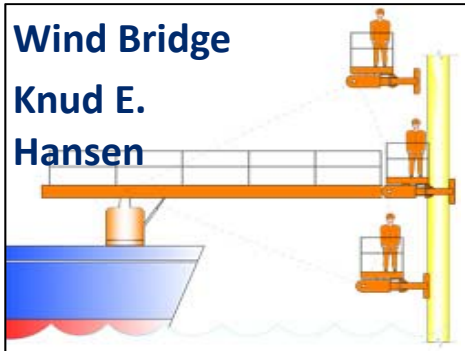
Divex LARS - Divex

Offshore Kinetics L&R

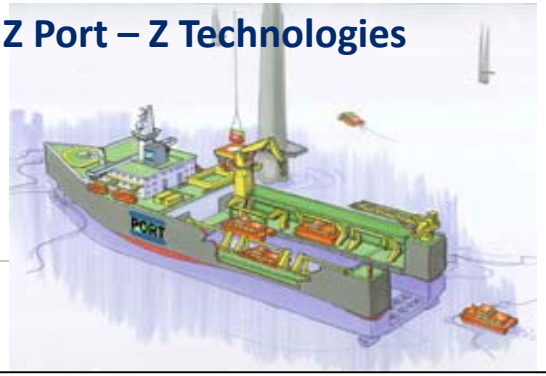


Gee

Wind Bridge
Knud E.
Hansen



Z Port – Z Technologies



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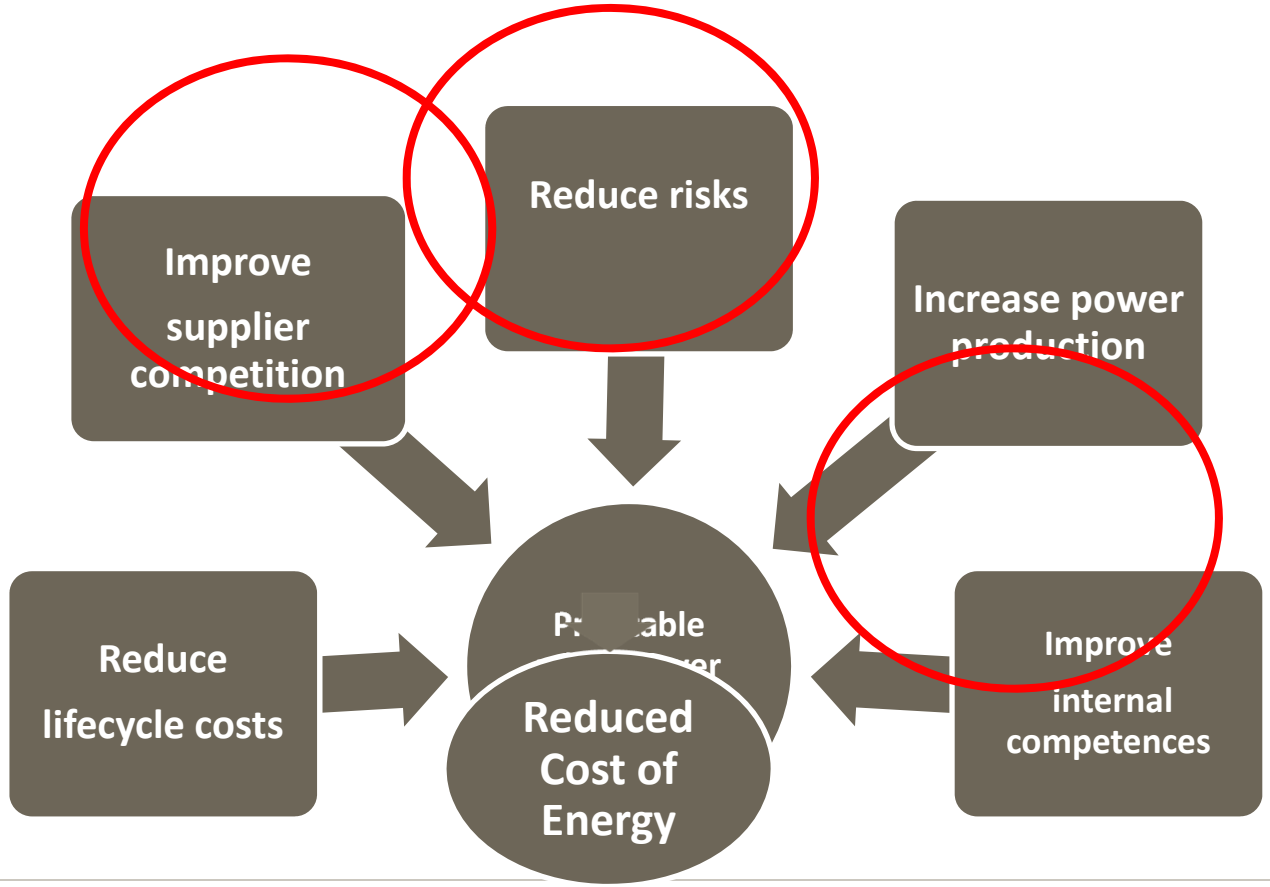
R&D general selection criteria in Statkraft

- Effect evaluation
  - reduced risk
  - increased long-term value
  - increased margin
  - increased volume

- Expected added value – a multiple of R&D cost

Objectives for the Demonstration Programme of DONG Energy – More objectives than to reduce LCOE



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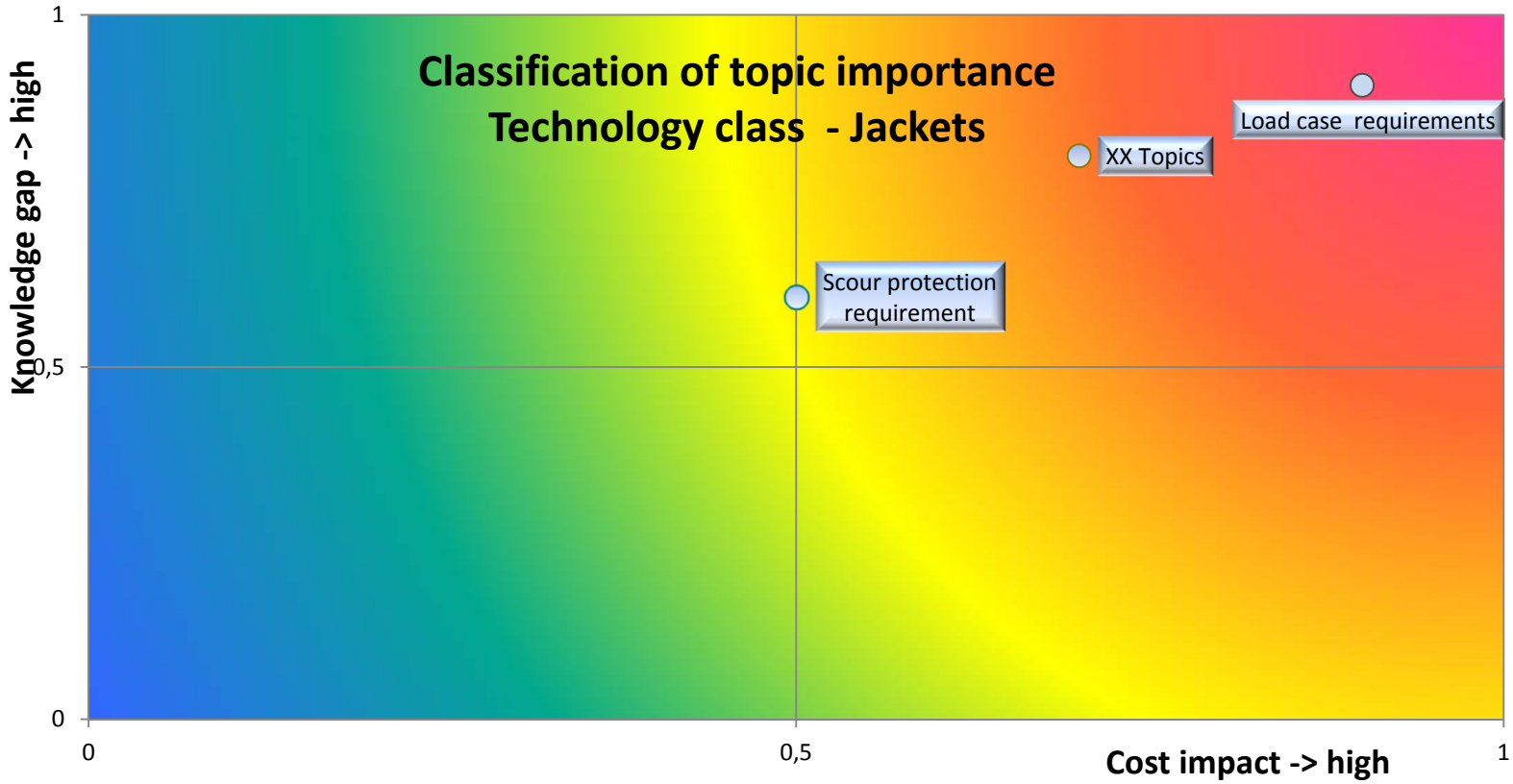
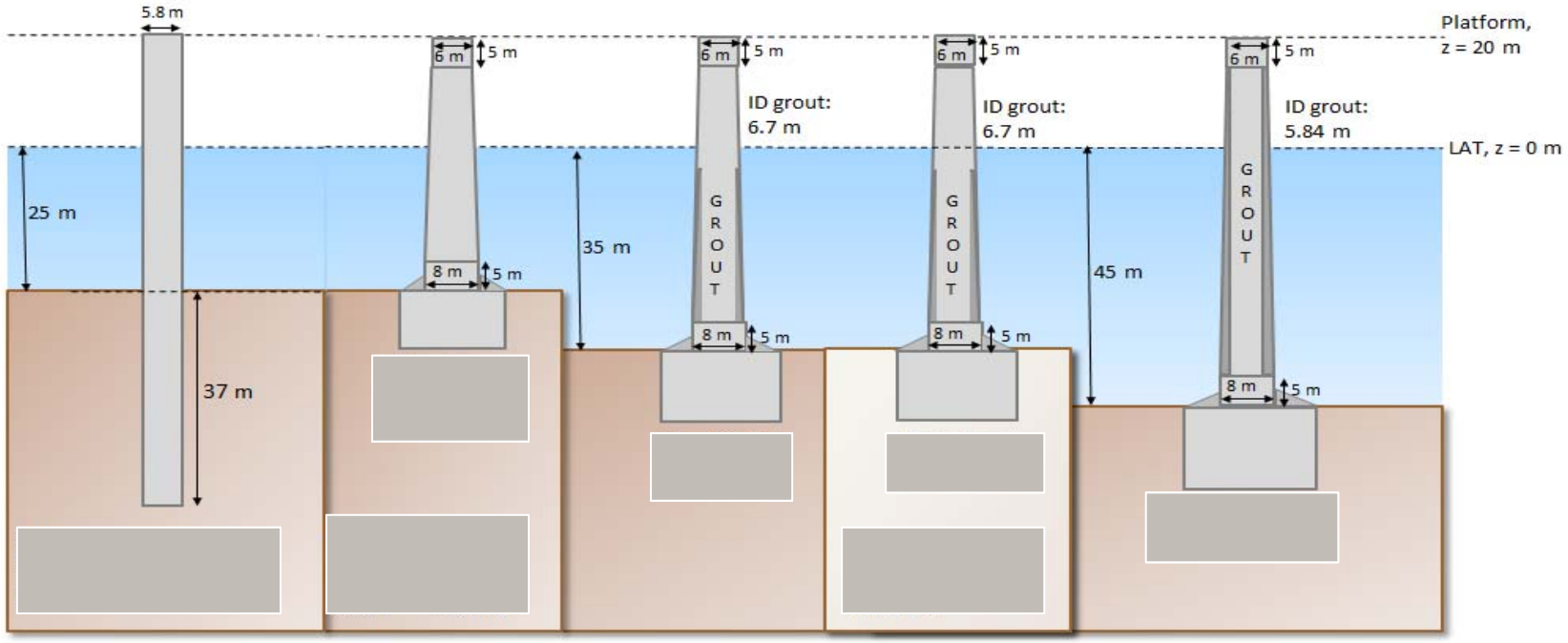
Example of classification of R&D importance



Concepts Phase I Monopiles – Bucket (UF)
Numerical qualification with R&D input

0.231 Hz **0.265 Hz** **0.267 Hz** **0.244 Hz** **0.271 Hz**



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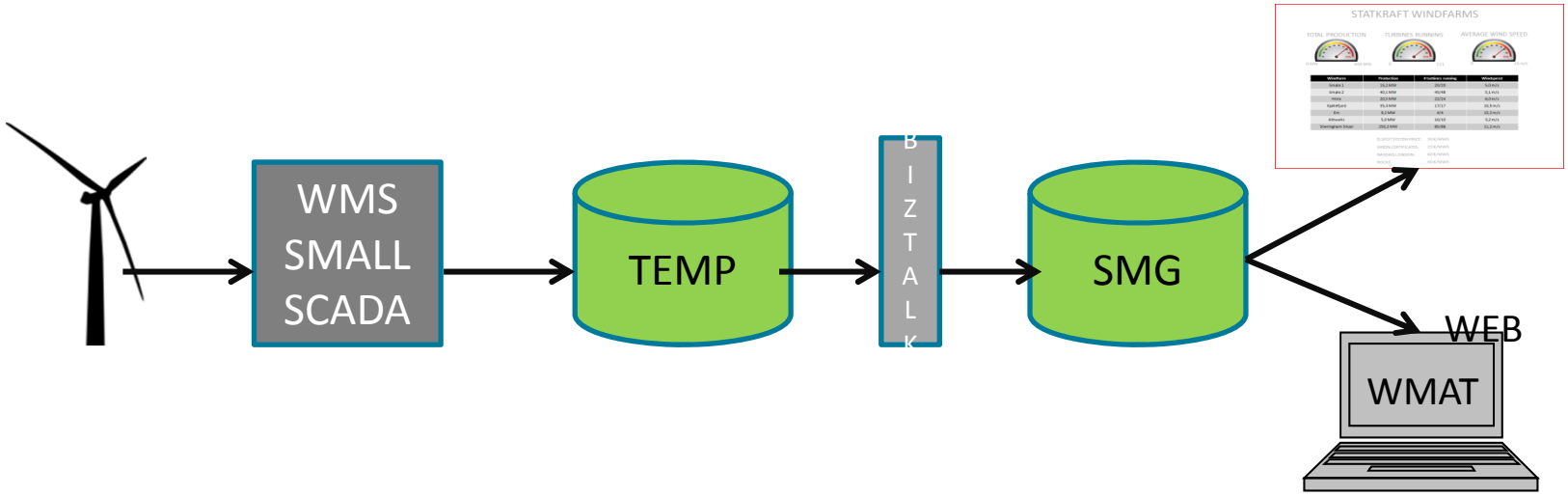
WMS SYSTEM (Wind Management System)
Economical goals in Statkraft



1% increased production
1% reduction of O&M-costs
5% reduction of balancing costs

Assessment of Standards

Potential for Savings via Code Review. Revision B					Ramboll Offshore Wind		
			Phases				
			CAPEX			OPEX	
System/components			Design	Manufacturing	Transport and installation	Operation and maintenance	Decommissioning
Support structure							
	Foundation		2	2	0	0	1
	Substructure		2	2	0	0	1
	Tower		1	1	0	0	0-1
Rotor nacelle assembly							
	Structure						
	Drive train						
		Gear box					
		Bearings					
		Generator					
		Shaft					
		Couplings					
	Blades		0-1	0-1	0-1	0	0-1
Control and protection							
Electrical systems							
	Turbine electrical						
	Cables						
		Internal					
		Array	0-1	0-1	0-1	0	0-1
		Export	0-1	0-1	0-1	0	0-1
	Converters						
Substation							
	Structure		2	2	2	0	1
	HVDC converter						
	AC transformer station						
HSE			0	1	1	1	1
Note: The potential for a cost saving is estimate qualitatively as 0 to 3, where 0 is no saving potential and 3 is largest potential							

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Some questions for the audience

- Do you think LCOE or RISK REDUCTION is most important for offshore wind R&D?
- Can pre-competitive research contribute to LCOE?

THANK YOU

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PURE ENERGY

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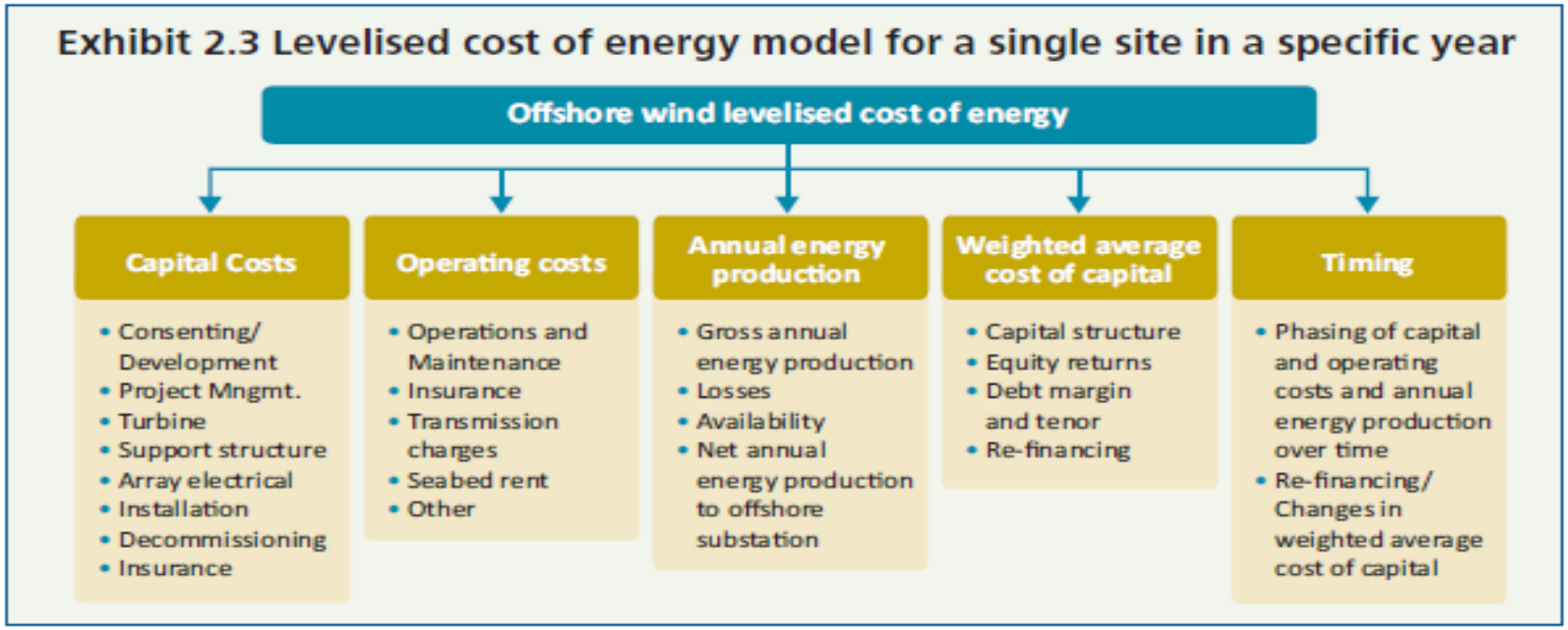
LCOE – break down



Offshore Wind Cost Reduction. Pathway Study: Crown Estate 2012

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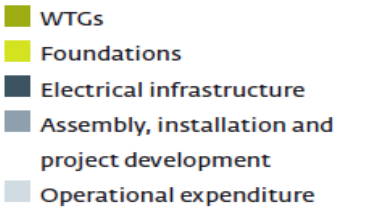
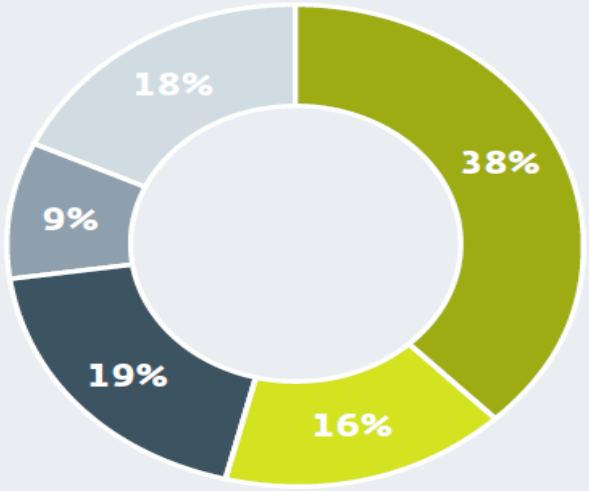
Cost targets from Denmark – motivates R&D focus areas

Figure 6

Capital and operational expenditures in relation to CoE (own adaptation)





SOURCE: Danish Energy Agency, 2010; Nielsen et al, 2010 and own calculations. CoE is defined as the average cost of electri-city production measured in €/MWh during the total life span of the electricity production facilities. Discount rate is 10%.

-2020 target - CoE reduced by 50 %

- -25 % increase in annual production
- -40 % reduction of Capex (WTG, Foundation, Installation)
- -50 % reduction of Opex (O&M)

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OWA and Universal Foundations

UF is the most promising OWA foundation design

Average of lowest 2 Baseline fabrication and Benchmark installation costs, 25-55m, 150km

CARBON TRUST

- Large cost reductions
- No piling noise
- Simple installation process
- Easier to fabricate
- Transitions piece is not required
- Reversible – decommissioning possible

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