



# Reducing the cost of the offshore wind projects in deeper waters: assessing the options and their implementation

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**Director**

**29 February 2012**



# **BVG Associates**

## **Market analysis & business development**

- **Supply chain development**
- **Economic impact assessment**
- **Support to industrialisation**
- **UK ports**

## **Technical innovation & engineering analysis**

- **Support to investment in technology**
- **R&D programme management**
- **Design and engineering services**

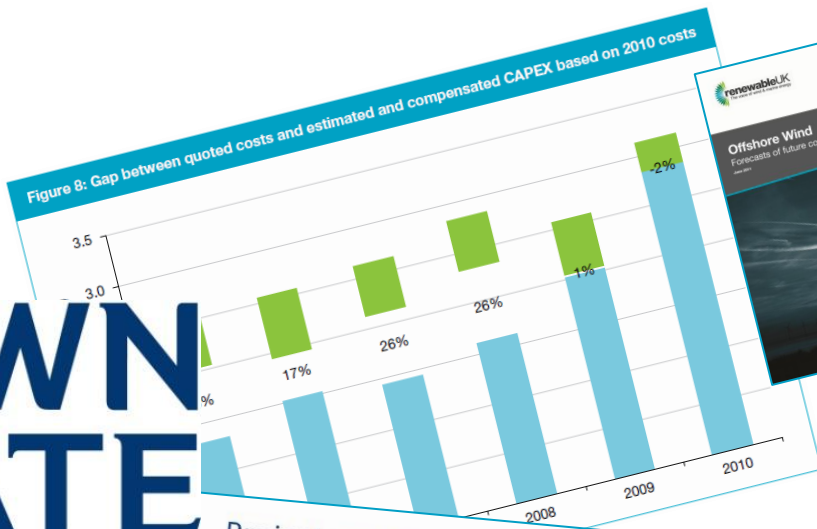
## **Project implementation**

- **SCADA & condition monitoring**
- **O&M technical support**

## **Technical education**



# The Crown Estate Offshore Cost Reduction Pathways Project



# THE CROWN ESTATE



Wind Energy Update  
Business Intelligence for Wind Energy

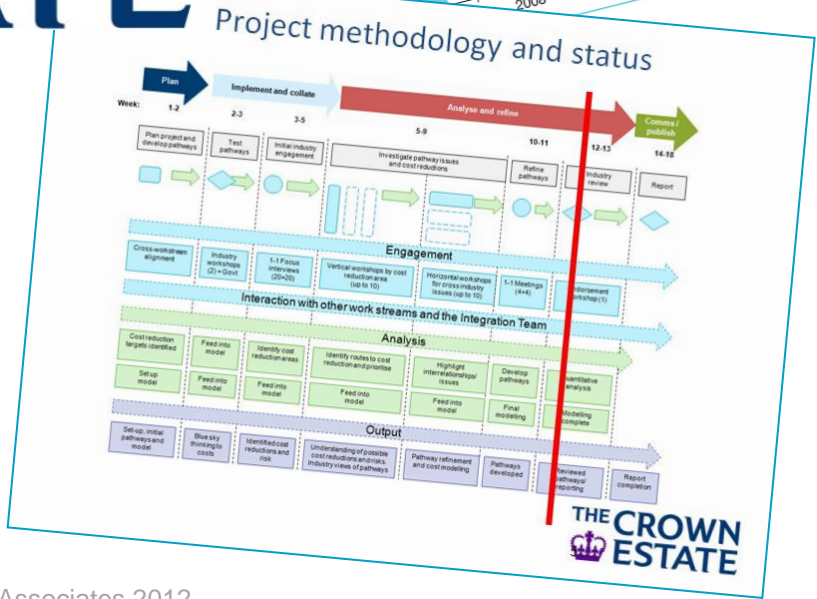
2<sup>nd</sup> Offshore Wind Supply Chain Conference  
28-29 February 2012, London, Regents Park Marriott

## Offshore Wind Progress and Delivery

Adrian Fox  
Supply Chain Manager  
28<sup>th</sup> February 2012



THE CROWN ESTATE

# Technology work stream: methodology

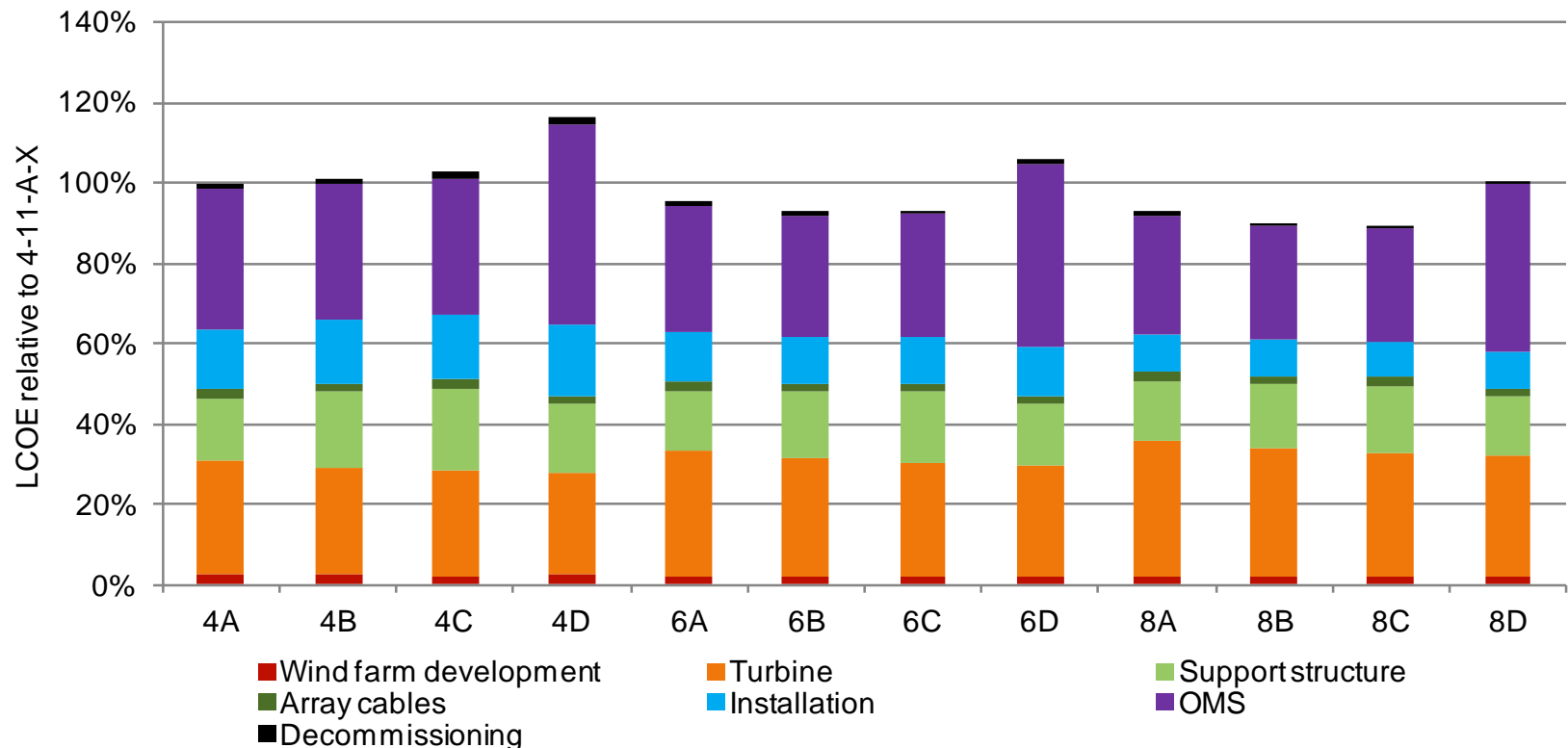
+1% change ~ +0.7% LCOE

~ +0.3% LCOE

$$\text{LCOE} = \frac{\text{Annualised CAPEX} + \text{OPEX}}{\text{AEP}}$$

~ -1% LCOE

## 1. Created baselines



# Technology work stream: methodology

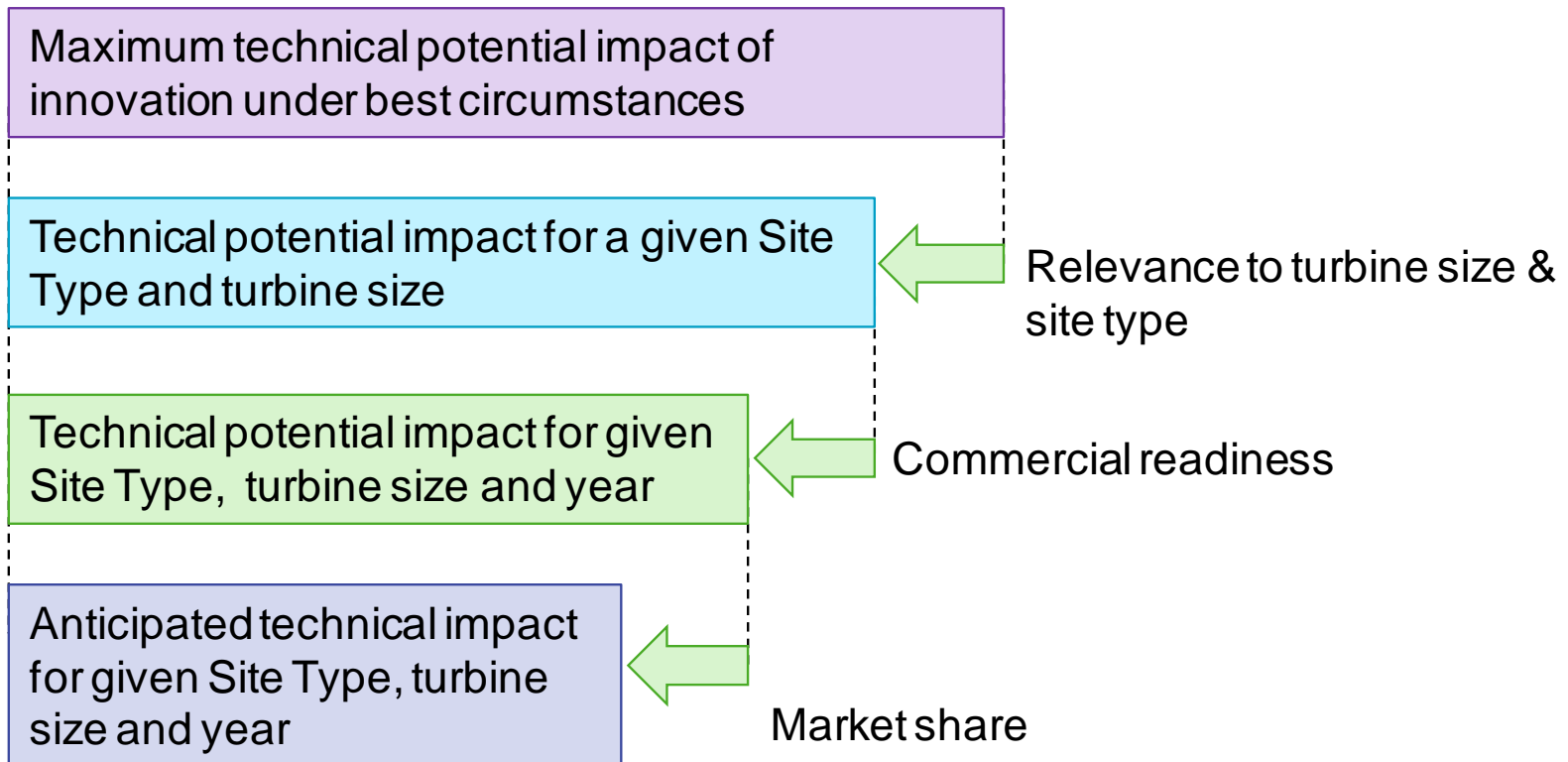
## 2. Considered (many) innovations

**Technology menu: Support Structure X-11-X-X to X-14-X-X**

Relative change in...																
Sub-element	#	Innovation	Wind Farm Development	Wind Turbine Rotor	Wind Turbine Nacelle	Support Structure	Array Electrical	Installation	Operation and planned maintenance	Unplanned service	Other OPEX	Increase in Gross AEP	Relative decrease in other turbine losses	Relative decrease in WF aerodynamic array losses	Relative decrease in WF electrical array losses	Relative decrease in WF unavailability
Main structure	5	Improvements in monopile design				3.0%		1.0%								

# Technology work stream: methodology

## 3. Moderated impact of each innovation





## Aggregated impact of technology innovations

Element	4-11-B-X	6-20-B-X	Change	Impact of change in element on LCOE	Impact of innovation in element on LCOE
Wind Farm Development (£/MW)	84,657	79,608	-6.0%	-0.1%	-2.2%
Wind Turbine Rotor (£/MW)	383,181	508,029	31.6%	3.1%	3.5%
Wind Turbine Nacelle (£/MW)	616,306	685,149	11.2%	1.7%	-13.2%
Support Structure (£/MW)	690,399	490,120	-29.0%	-4.9%	-4.7%
Array Electrical (£/MW)	81,380	61,411	-21.3%	1.4%	-0.5%
Installation (£/MW)	638,825	374,530	-47.6%	-7.4%	-3.2%
Construction phase insurance (£/MW)	40,000	36,000	-10.0%	-0.1%	N/A
Contingency (£/MW) (Story 1)	249,175	216,145	-13.3%	-0.8%	N/A
CAPEX (£/MW)	2,784,222	2,412,591	-13.3%	-9.1%	-26.3%
Operation and planned maintenance (£/MW/yr)	26,896	20,578	-23.5%	-1.3%	-1.8%
Unplanned service (£/MW/yr)	55,163	31,301	-43.1%	-4.7%	
Other (£/MW/yr)	2,111	1,723	-18.0%	-0.1%	
Annual transmission charges (£/MW)	56,356	51,687	-8.3%	-0.9%	N/A
Operating phase insurance (£/MW)	14,000	14,000	0.0%	0.0%	N/A
OPEX (£/MW/yr)	154,407	119,290	-22.7%	-7.0%	-1.8%
Gross AEP (MWh/MW/yr)	4,520	5,140	13.7%	-	N/A
Net AEP (MWh/MW/yr)	3,691	4,311	16.8%	-14.4%	N/A
DECEX (£/MW)	383,295	200,718	-47.6%	-0.6%	N/A
Simple LCOE (T only) (£/MWh)			-28.6%	-28.6%	-28.6%

- Chosen as current and most likely technical solution in 2011, 2020 – not a product mix
- LCOE figures do not include supply chain levers, variable WACC, and exclude developers contingency so cannot be interpreted as an holistic LCOE impact
- Still subject to continuing work – will change

## Innovation #1: Increase in turbine rating

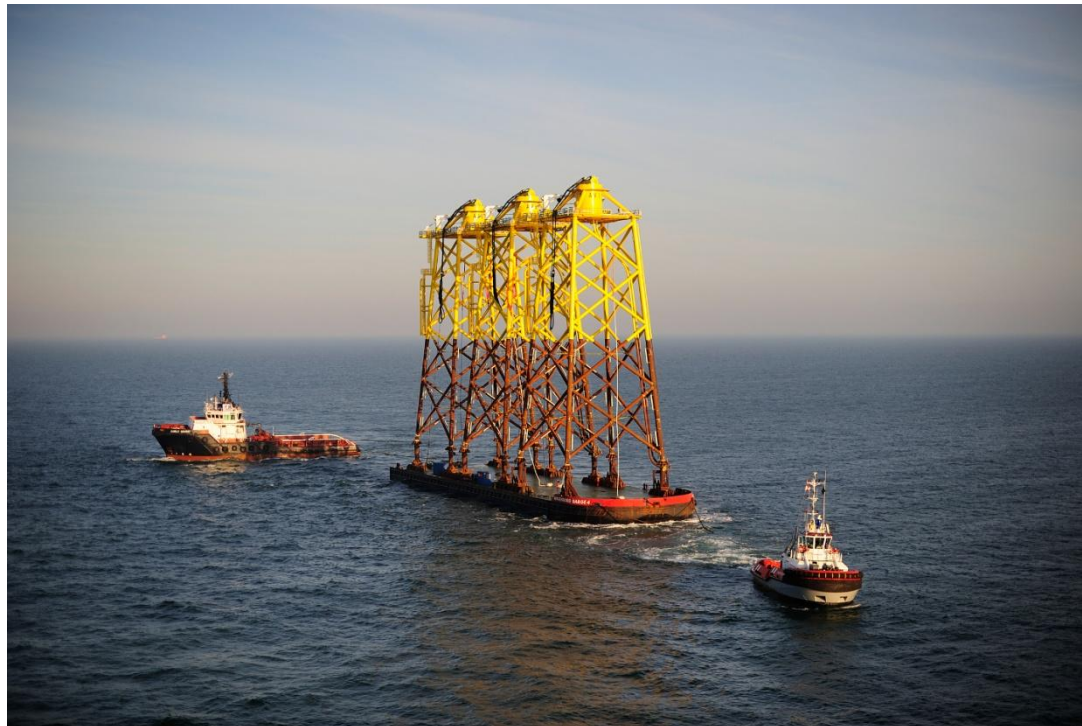
**What:** Move from 4MW-class turbines today to 6MW turbines installed 2016 onwards

**Impact:**  
Turbine CAPEX + 11%  
Wind farm CAPEX -5%  
Wind farm OPEX -8%  
AEP + 3%  
LCOE -10%



## Innovation #2: Improvements in steel space-frame manufacturing

**What:** Automation of welding & selective standardisation  
**Impact:** Support structure CAPEX -11%  
Wind farm CAPEX -4%  
LCOE -3%



## Innovation #3: Optimised rotor diameter

**What:** At 6MW scale, going to optimum instead of just scaling up 4MW today

**Impact:** Turbine CAPEX +13%  
Wind farm CAPEX +7%  
OPEX +0.3%  
AEP + 7%  
LCOE -2%



## **Top dozen innovations (anticipated impact on LCOE by 2020 for 6MW-scale turbines)...**

- 1. Increase in turbine rating**
- 2. Improvements in steel space-frame manufacturing**
- 3. Optimised rotor diameter**
- 4. Introduction of multi-variable optimisation of array layouts**
- 5. Improvements in blade aerodynamics**
- 6. Improvements in blade pitch control**
- 7. Introduction of direct drive drive trains**
- 8. Greater level of optimisation during FEED**
- 9. Introduction of mid-speed drive trains**
- 10. Improvements in AC power take-off system design**
- 11. Improvements in range of working conditions for support structure installation**
- 12. Improvements in personnel access from transfer vessel to turbine**

## And largest potential impact to 2020 & beyond (for range of turbine sizes, ignoring previous)...

1. Introduction of float out and sink installation of turbine and support structure (likely CGB)
  2. Introduction of DC power take-off (inc. impact of DC array cables)
  3. Introduction of direct-drive superconducting drive trains
  4. Introduction of suction bucket technology
  5. Introduction of holistic design of the tower with the rest of support structure
  6. Introduction of continuously variable transmission drive trains
  7. Improvements in monopile design standards
  8. Introduction of whole turbine installation
  9. Improvements in support structure condition monitoring
  10. Improvements in AC power take-off system design
  11. Increase in blade tip speed
  12. Introduction of inflow wind measurement
- + Wind farm life time extension
- ++ Innovations that impact LCOE via reducing risk only

## Summary

- 1. Plenty of technology innovations out there**
- 2. Progress relies on confidence to invest**
- 3. Not all about CAPEX reduction**
- 4. Combined with supply chain & finance innovations, much potential for cost reduction**
- 5. Crown Estate report will be published next few months**
- 6. Detailed and supportive engagement from industry with lots of ambition for growth**
- 7. Useful input to inform areas where governments could help catalyse innovation**
- 8. Helped us built really good modelling capability & understanding of how costs of different technologies are anticipated to evolve**

The image shows an offshore oil and gas rig in the foreground on the left, with its red hull and white superstructure. In the background, there are several other rigs and a large ship on the water. The sky is hazy and the water is choppy. The text is overlaid on the right side of the image.

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**Thank you**