Offshore wind technology cost reduction: one year on from the biggest industry study to date

EWEA

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Offshore wind technology cost reduction: one year on

Introduction

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Selected clients

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- Market analysis and business development
  - Supply chain development
  - Economic impact assessment
  - Support to industrialisation
- Technical innovation & engineering analysis
  - Support to investment in technology
  - R&D programme management
  - Design and engineering services
- Project implementation
  - FIT project development (UK only)
  - SCADA & condition monitoring
  - O&M technical support

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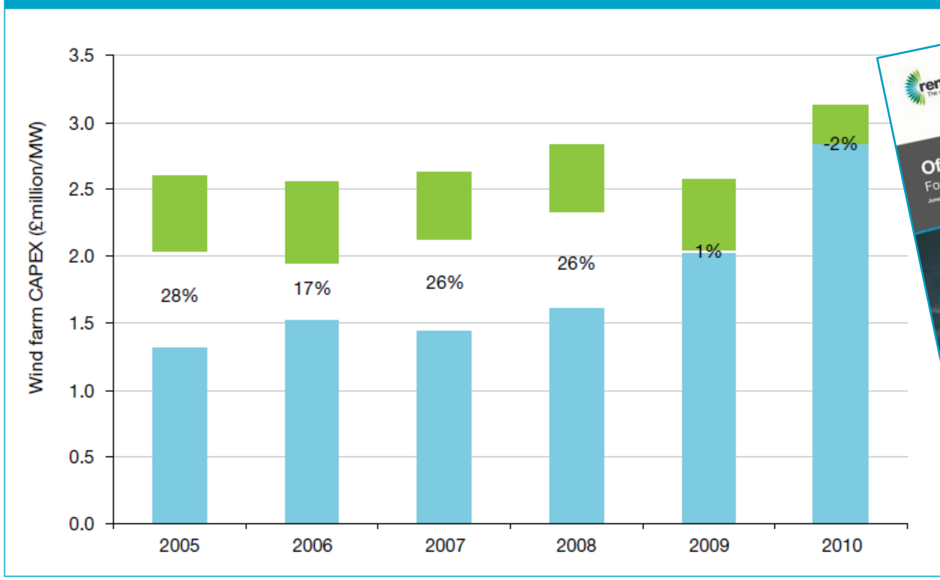
Offshore wind technology cost reduction: one year on

Health warning

CAPEX has been going up, not down

- Need to understand the past before talking about cost reduction in the future
- Between 2003 and 2010, CAPEX increased (blue bars)
- Much can be explained by change of site conditions
- Much of the rest can be explained by market conditions
- Due to increases in site wind speeds and use of larger turbines, LCOE decreased during period despite CAPEX increase
- CAPEX stabilised 2010-12

Figure 8: Gap between quoted costs and estimated and compensated CAPEX based on 2010 costs



Cost reduction pathways study

Overview

Context

- 2011 UK Government Energy white paper:
  - Central scenario 13GW by 2020
  - Minded to support to 18GW if cost of energy reduced – target £100/MWh

- The Crown Estate cost reduction pathways study established to evidence what industry thinks could be done
  - Supply chain, finance and technology work streams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- Published summer 2012

Methodology in numbers: technology work stream

4 Dimensional cost model: Time, types of wind farm site, turbine sizes, industry scenarios

6 Industry day-long workshops (in UK, DK, DE)

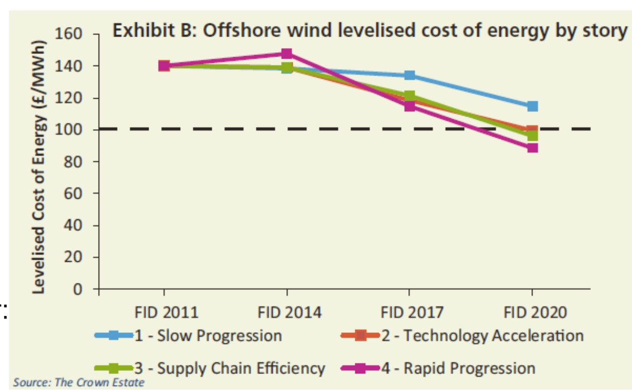
20 Deep industry interviews (4 hours +)

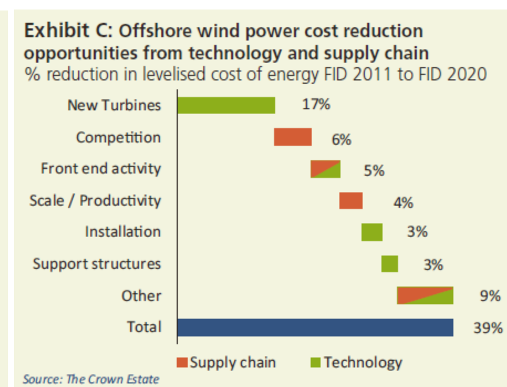
125 Industry individuals directly involved

215 Pages – available for download from our website

Cost reduction pathways study: results

- Given right external conditions, industry can meet target:
  - Confidence in market size to beyond 2020
  - Smooth and timely transition under EMR
  - Planning consent timelines reliably met
  - Clear and predictable offshore grid regulatory framework
  - Facilitation of new technology introduction
- To deliver, industry also needs to work together:
  - Best practice, standardisation, risk management, accessing new finance

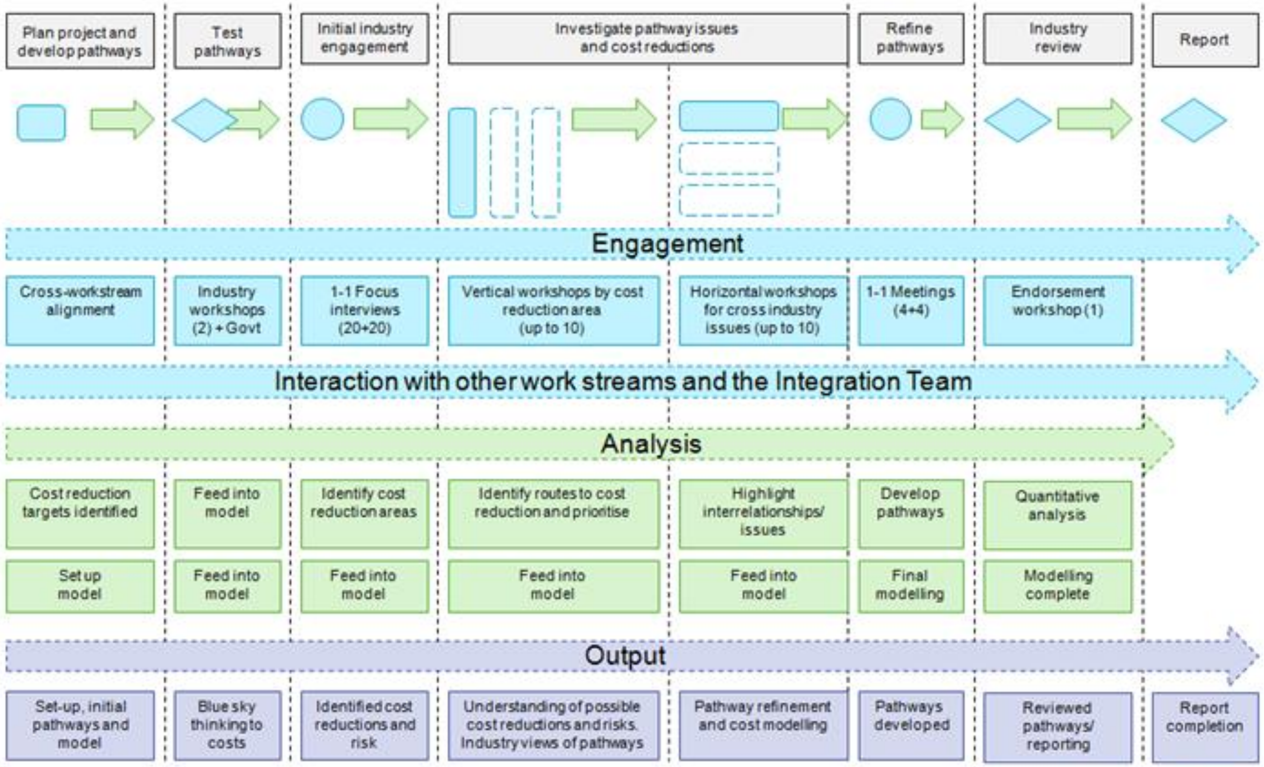




Methodology

Robust modelling and significant industry consultation

9 month process



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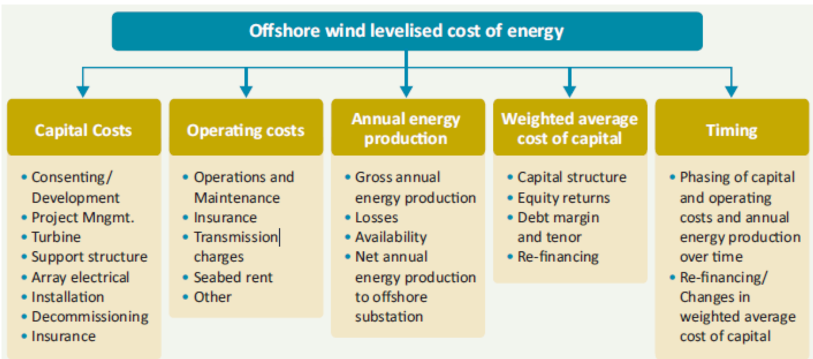
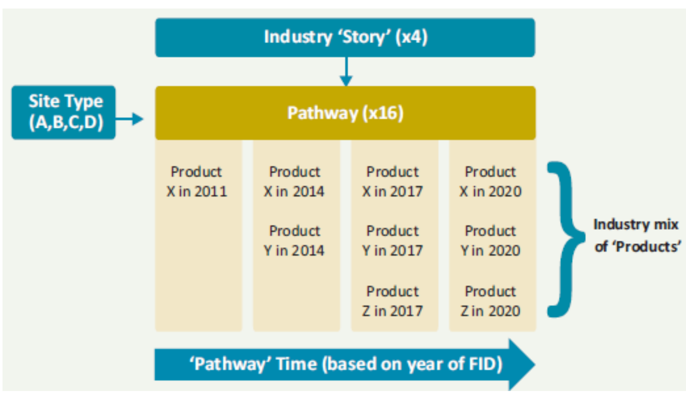
Methodology

Robust cost model and industry-supported baselines

Cost Model



- Models changes in risk, with resulting impact on financing cost
- Numerous other stated assumptions, agreed with industry



Baselines

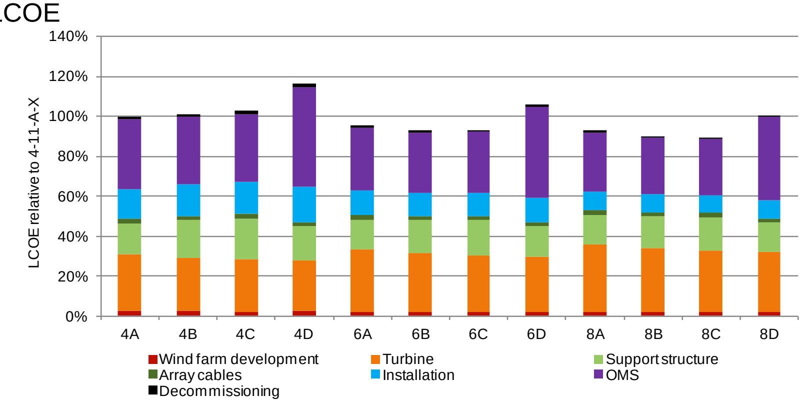
Wind turbines

Turbine MW-Class	Nominal range of power rating (MW)	Typical range of rotor diameter (m)	Diameter modelled (m)	Example current and future turbines
4MW	3 to 5	up to 145	120	AREVA M5000-116 and 135, REpower 5M and 6M, Siemens SWT 3.6-107 and 120, Vestas V112-3.0
6MW	5 to 7	145 to 162	147	Alstom Haliade 150-6MW, Siemens SWT-6.0-154
8MW	7 to 9	162 to 180	169	MPSE Sea Angel, Samsung S7.0-171 Vestas V164-8.0MW

Wind farm sites

Site Type	Average water depth (MSL) (m)	Distance to nearest construction and operation port (km)	Average wind speed at 100m above MSL (m/s)
A	25	40	9
B	35	40	9.4
C	45	40	9.7
D	35	125	10

LCOE



Methodology

For each independent innovation (60+ covered)

Maximum potential impact of innovation

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
Introduction of DC power take-off (incl impact of DC array cables)			4.0%		10.0%	0.5%		5.0%		1.2%			10.0%	1.0%

Impact of innovation in real world

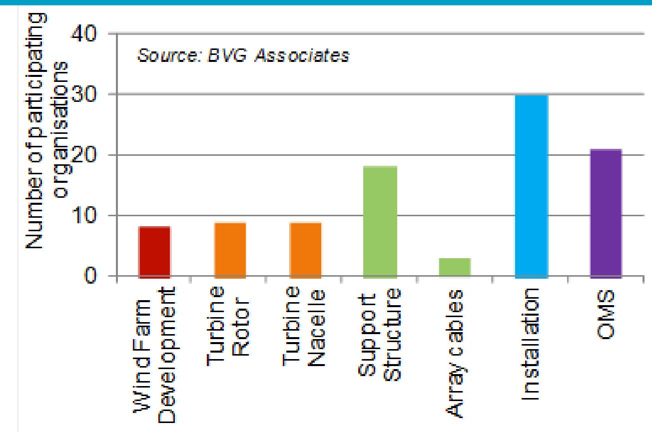
Maximum technical potential impact of innovation under best circumstances

Technical potential impact for a given Site Type and turbine size ← Relevance to turbine size & site type

Technical potential impact for given Site Type, turbine size and year ← Commercial readiness

Anticipated technical impact for given Site Type, turbine size and year ← Market share

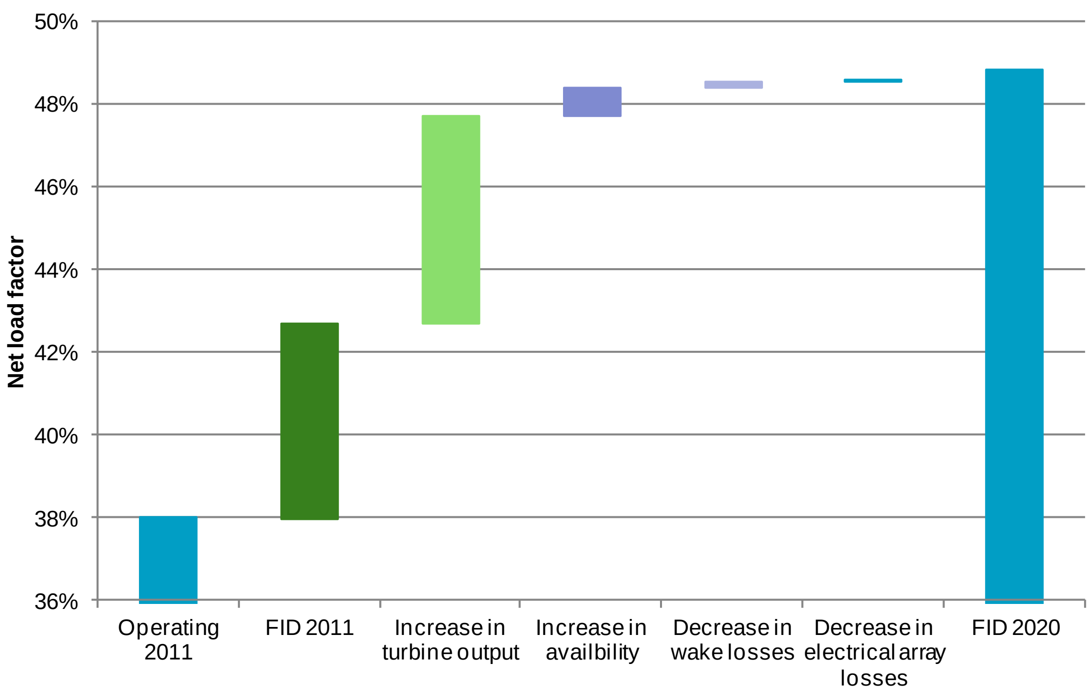
Thorough peer review (4 stages)



Example output

Increase in load factor gained mainly through improvements in turbine technology

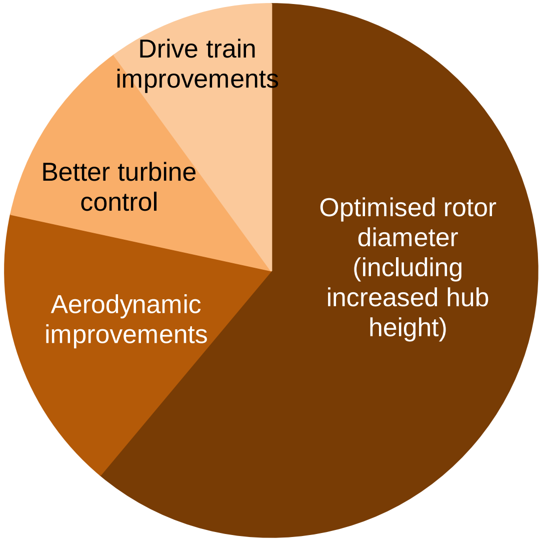
6MW-Class turbine on Site Type B



Explanation

- Majority of load factor improvement coming from developments in turbine technology.
- More than 60 per cent of this benefit comes from optimisation of rotor diameter to minimise cost of energy.

Impact from turbine improvements



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Progress

one year on

Definitions

- LCOE: Levelised cost of energy – income required from whatever source to give 10% rate of return to project owner
- Innovations listed [nn] reference Table B.2 in report.
- Changes are compared to a baseline wind farm of 4MW turbines, in 35m water depth, FID 2011
- Potential: Maximum technical potential impact on LCOE of innovation under best circumstances
- Anticipated: Anticipated technical impact on LCOE for project:
  - 35m water depth
  - 6MW turbines
  - FID in 2020
  - Takes into account:
    - Relevance of innovation to given conditions
    - Commercial readiness
    - Anticipated market share
- Progress:
  - (two green circles) More than sufficient progress visible to keep on track*
  - (green circle) Sufficient progress
  - (amber circle) Insufficient progress
  - (red circle) Little or no progress

* For £100/MWh target by FID in 2020

Development

	Potential	Anticipated	Progress	Evidence	Challenges
Greater level of array optimisation and feed [9, 10, 22, 52]	-4%	-2%	(amber circle)	More early-stage collaboration Recognition of benefit (Little extra site investigation or progress with array optimisation)	Increasing project (rather than zone) approach Increased risk on early spend, especially if delays later

Progress

one year on

Turbine

	Potential	Anticipated	Progress	Evidence	Challenges
Increase in turbine power rating [2]	-9%	-9%	Green	Most new development in 7-8MW range 1st 6MW project operating 2 other 6MW prototypes up	Lack of market confidence slowed progress for some
Optimisation of rotor diameter and aerodynamics [5, 6, 25]	-4%	-3%	Green	Samsung S7.0-171 & Siemens SWT-4.0-130 Delays to some rotor extension projects	Lack of market confidence slowed progress for some Lack of test site has delayed one project
Introduction of next generation drive trains [8, 11, 13, 15, 49]	-7%	-3%	Green	In-house and open-access drive train test rigs progressing Increased focus on mid-speed solutions and reliability	High cost of thorough verification / high risk to change Uncertainty on PM material costs
Advanced drive trains [30, 47, 59]	-9%	-0.4%	Green / Green	MHI hydraulic at 2-3MW proto in 2013; 7MW in 2013; Vestas DC generation players progressing	Insufficient evidence from some smaller players to get traction from turbine manufacturers
Improvements in aerodynamic control [4, 23, 31, 50]	-5%	-2%	Green	Number of in-house teams strengthening Vestas announced trial	Long time / expensive for thorough verification on turbine
Improvements in blade design, manufacture and materials [19, 21, 26]	-2%	-1%	Amber	Vestas announced change in blade concept Blade Dynamics / ETI £15m project announced	Low quantity production for offshore for some time

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Progress

one year on

Support structure

	Potential	Anticipated	Progress	Evidence	Challenges
Improvements in jacket design and manufacturing [3, 16, 36]	-4%	-3%	Amber	At least one JIP established Industry extending monopile use Tata mass-production tubulars OGN developing new facility	Challenging environment for future investment Uncertainty about technology usage – eg. jacket / concrete
Introduction of tower design improvements [18, 20]	-2%	-1%	Green	Benefits recognised – relatively easy to implement 2-B Energy progressing with holistic space frame design	Single-section towers need suitable portside facilities
Introduction of suction bucket technology [29]	-2%	-0.3%	Green	Two suppliers deploying for met stations Fred Olsen progressing demonstrators	Availability of suitable test sites

Array cables

	Potential	Anticipated	Progress	Evidence	Challenges
Introduction of array cables with higher operating voltages [35]	-0.4%	-0.2%	Green	Strong demand and innovative solutions being developed	Long lead time to develop and certificate solutions
Improvements in array cable standards and client specification and design [38, 44, 53]	-0.5%	-0.3%	Amber	More than one JIP being established Supplier-installer-developer dialogue increasing	Long lead time to implement due to typical wind farm project processes

Progress

one year on

Installation

	Potential	Anticipated	Progress	Evidence	Challenges
Improvements in range of working conditions for installation [7, 32, 42]	-2%	-1%	Green	Areva blade lift solution one of many Access solutions for OMS progressing	
Greater levels of optimised installation vessels, processes, tooling and strategies [12, 24, 28, 33, 34, 40, 51]	-3%	-2%	Amber	Slow progress on optimised jacket installation vessels Better progress on cable installation	Foundation concepts still evolving
Introduction of radical installation strategies [27, 39, 45]	-9%	-0.6%	Green	New investment in Seatower Gov funding for concrete demo More interest in floating for deeper Round 3 projects	Long time to commercial sales at wind farm scale

OMS

	Potential	Anticipated	Progress	Evidence	Challenges
Improvements in base, transport and access solutions [17, 37, 55]	-2%	-0.7%	Green	Access solutions for higher waves progressing Higher focus on mother ship arrangements	
Improvements in OMS strategies [14, 41, 46, 48]	-2%	-1%	Amber	Slow progress on condition-based maintenance Some progress on integrating ops management tools	Across-organisation collaboration and data sharing

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Summary and reflections

one year on

Wind farm

	Potential	Anticipated	Progress
Turbine	-31%	-17%	Green
Balance of plant	-9%	-5%	Green
Installation	-14%	-4%	Amber
OMS	-3%	-2%	Amber
Development	-4%	-2%	Amber
Overall			Green But…

Summary

- Overall, from technology perspective, currently on course to reduce LCOE to £100/MWh
- Cost of energy reduction does not simply mean CAPEX reduction. CAPEX will rise for some time; OPEX and AEP will drive reduction

But…

1. Confidence in European markets is weakening
2. Significant investment is needed to implement cost reductions
3. Breakdown of zonal approach to UK Round 3 is meaning less action
4. Need clear governmental support to industry (UK and elsewhere)
   - Market scale
   - Revenue
   - Industrial strategy
   - Technology support
5. Need industry to help itself where it can
   - Communication
   - Collaboration
   - Courage to back itself to succeed

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