Load factors of the future

Global Offshore Wind 2012

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BVGassociates

Introduction

Load factors of the future

Contents

- BVG Associates
- The Crown Estate, Cost Reduction Pathways project
- Results, load factors varying with time, site and turbine
- Thoughts on cost of energy

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Making a difference in offshore wind and ocean energy

Market analysis & 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

Publications

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The Crown Estate – Cost Reduction Pathways project

A complex and in depth modelling task

Modelling iterations

3 Work streams; Technology, Supply chain, Finance

4 Time periods; financial investment decision (FID) in 2011, 2014, 2017, 2020

4 Site Types; covering different water depths, distances from shore and wind speeds

4 Turbine sizes; 4MW-Class, 6MW-Class, 8MW-Class, (10MW-Class, not reported)

4 Industry stories; slow progression, technology efficiency, supply chain acceleration, rapid growth

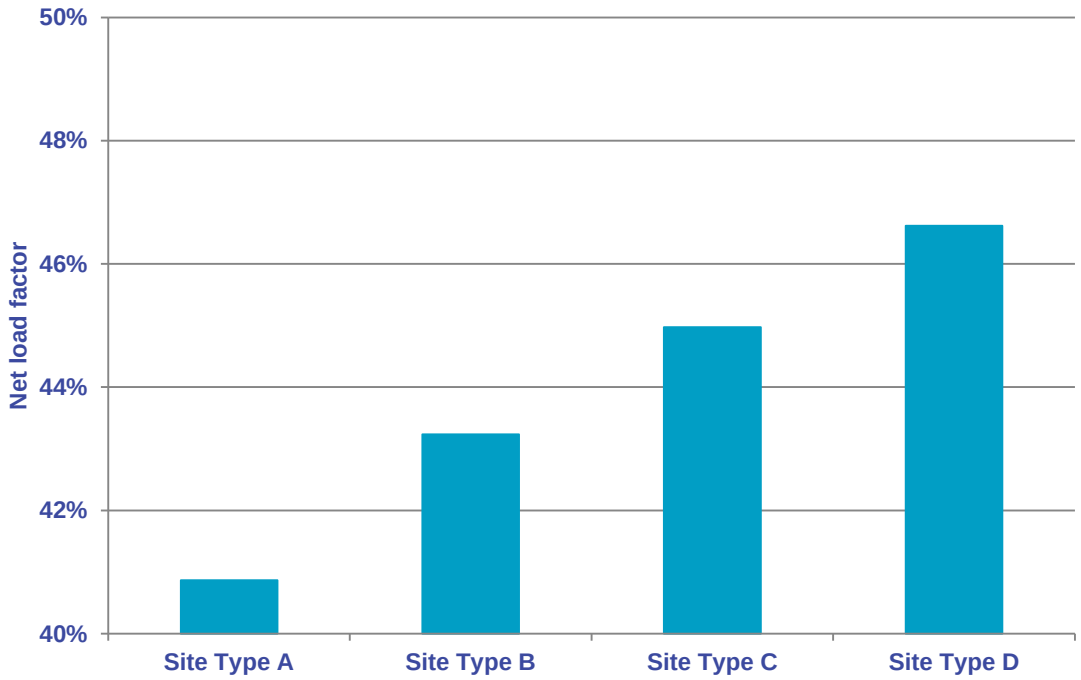
7 Workshops involving about 50 companies

20 Key organisations interviewed from a cross section of industry

How load factors vary with Site Type

Load factors increasing from Site Type A to Site Type D

6MW-Class turbine in FID 2011



Site Type	A	B	C	D
AMWS* at 100m	9.0m/s	9.4m/s	9.7m/s	10.0m/s
Distance to shore	40km	40km	40km	125km
Water depth	25m	35m	45m	35m

Why are load factors increasing?

- Increased wind speed giving higher gross energy yield
- Wake losses reduce with increased wind speed
- Availability is the same for all site types, effects of accessibility are addressed through varying operations, maintenance and service costs.

* AMWS = annual mean wind speed

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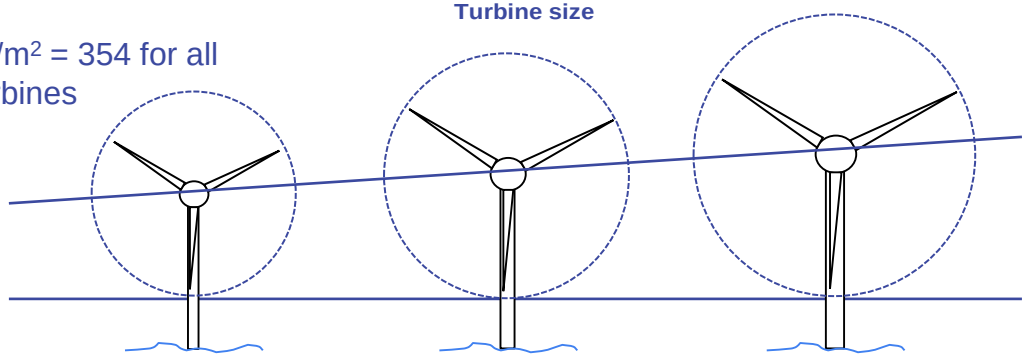
How load factors vary with turbine size

Load factors increasing with larger turbines

Site Type B in FID 2011

W/m^2 = 354 for all turbines



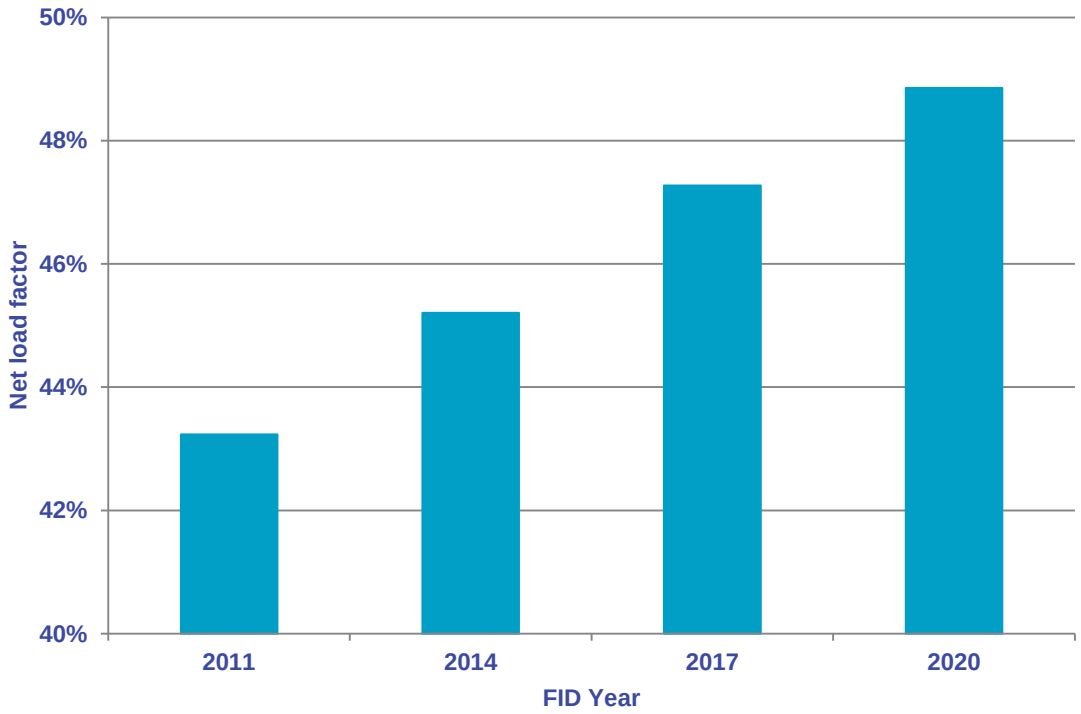
Why are load factors increasing?

- All turbines modelled with same specific rating in FID 2011, but…
- Wake losses are reduced due to relatively more turbines on edge of the array.
- Tower height is increased for larger turbines, to maintain minimum blade clearance above sea level, giving a wind speed benefit.

How load factors vary over time

Load factors increasing to FID 2020

6MW-Class turbine on Site Type B



Why are load factors increasing?

Wind farm development
- Optimised site layouts

Turbine
- Optimised rotor diameter and improved blade aerodynamics
- More reliable turbines

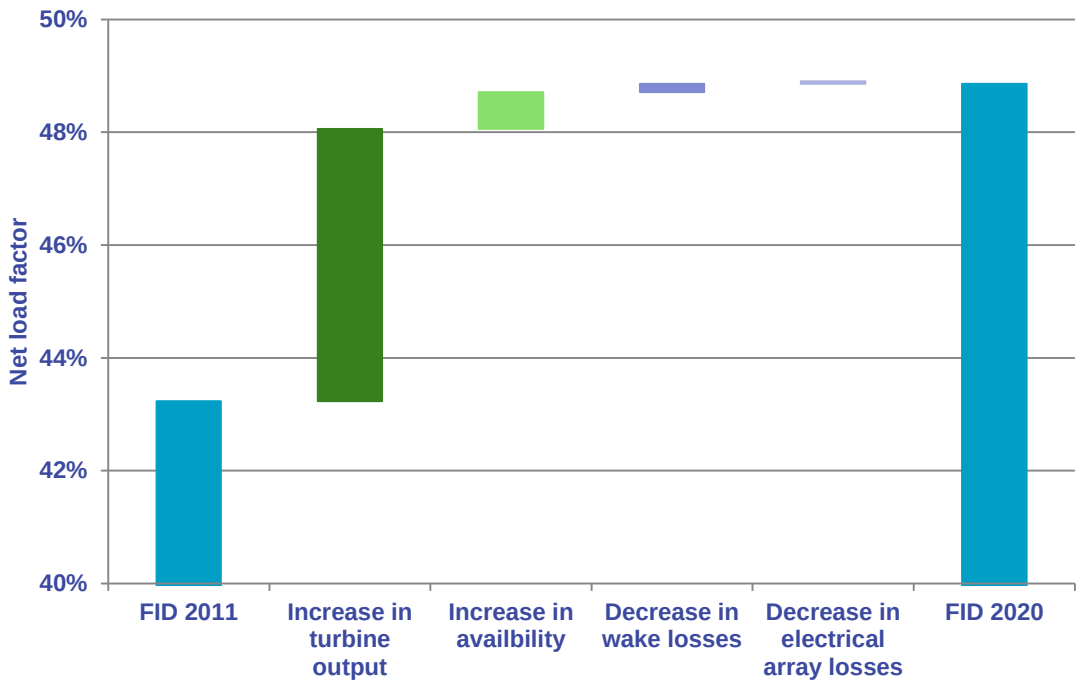
Balance of plant
- Reduction of electrical losses through increased voltage and DC cables

Operations, maintenance and service
- Use of condition monitoring
- Improved turbine access

How load factors vary over time

Increase in load factor dominated by increased turbine output

6MW-Class turbine on Site Type B



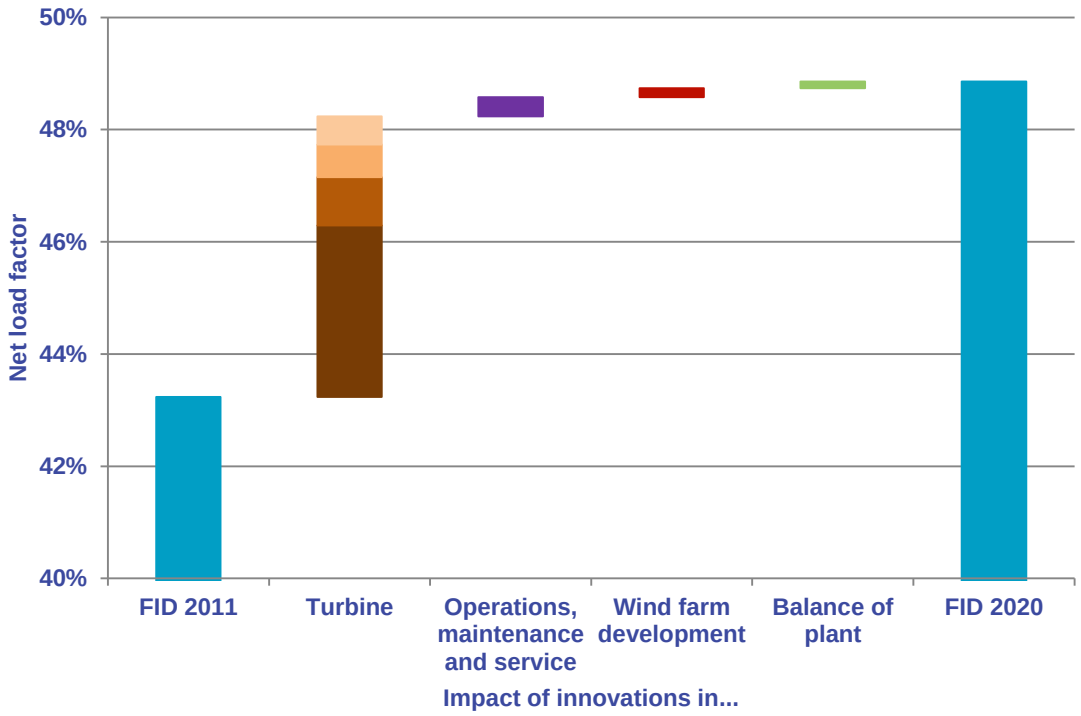
Discussion

- Overall increase in load factor from 43.2 per cent to 48.9 per cent between FID 2011 and 2020.
- Change in load factor equivalent to 13 per cent increase in energy.
- Increase in turbine output accounts for more than an 11 per cent increase in load factor.
- Increase in availability driven equally by increase in turbine reliability as improvements in operations, maintenance and service methods.

How load factors vary over time

Increase in load factor gained mainly through improvements in turbine technology

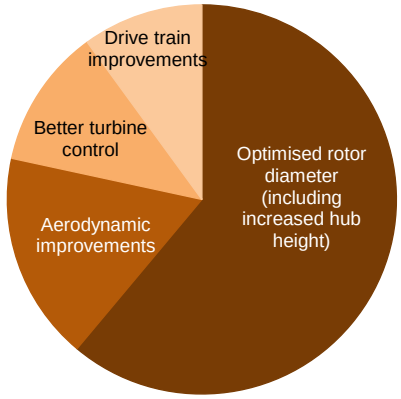
6MW-Class turbine on Site Type B



Discussion

- 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



Cost of energy

Increased load factor allows increased CAPEX while cost of energy reduces

Turbine comparison

Turbine A (4MW-120m)	Turbine B (6MW-158m)
Turbine CAPEX = 100%	Turbine CAPEX = 124%
Wind farm CAPEX = 100%	Wind farm CAPEX = 103%
OPEX = 100%	OPEX = 91%
Load factor = 42.1%	Load factor = 46.2%
Cost of energy = 100%	Cost of energy = 90%

Discussion

- Turbine B significantly more expensive (per megawatt) due to larger size and relatively larger rotor.
- CAPEX savings elsewhere due to fewer turbines (on fixed capacity wind farm).
- OPEX savings also from fewer turbines.
- Cost of energy reduction driven by higher load factor; don't just look for lowest turbine or wind farm CAPEX solution.

Conclusions

- Load factors set to increase toward 2020
- Most improvement in load factor from increasing turbine output
- Developments in turbine technology contributing the most to increasing load factors
- Cost of energy comparisons more important than load factor or CAPEX

Thank you

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