



Offshore Wind 2016

Cost of energy – going below £100/MWh; the opportunities and barriers

Chair: Mike Blanch

London

1 December 2016

Intro

Cost of energy – going below £100/MWh; the opportunities and barriers

Panelists

1. Adrian Fox,
Portfolio Manager Energy Assets,
Crown Estate
2. Thomas Arensbach,
Senior Business Development Manager,
Offshore Renewable Energy Catapult
3. Peter Clusky,
Director UK Stakeholder Relations,
MHI Vestas

Why £100/MWh?

1. DECC's aspiration in 2012 for 2020 Offshore Wind. It was in £2012 but it was unclear whether it referred to projects coming online in 2020 or ones passing final investment decision in 2020.
2. £100 in 2012 = £109.9 in 2016

BVG Associates

Business advisory

- Analysis and forecasting
- Strategic advice
- Business and supply chain development

Economics

- Socioeconomics and local benefits
- Technology and project economic modelling
- Policy and local content assessment

Technology

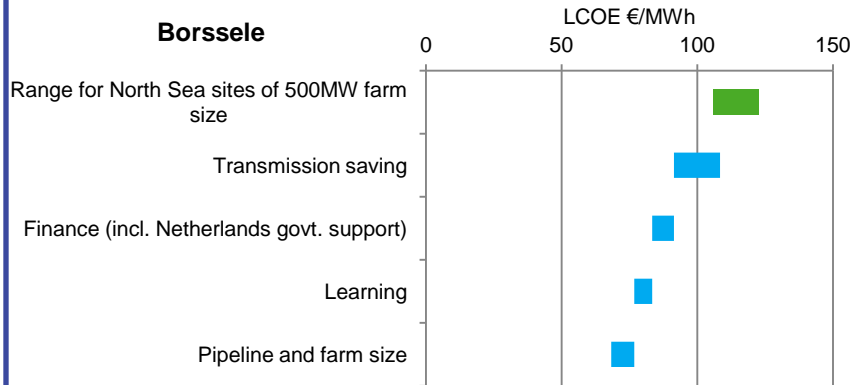
- Engineering services
- Due diligence
- Strategy and R&D support

Are we below £100/MWh already?

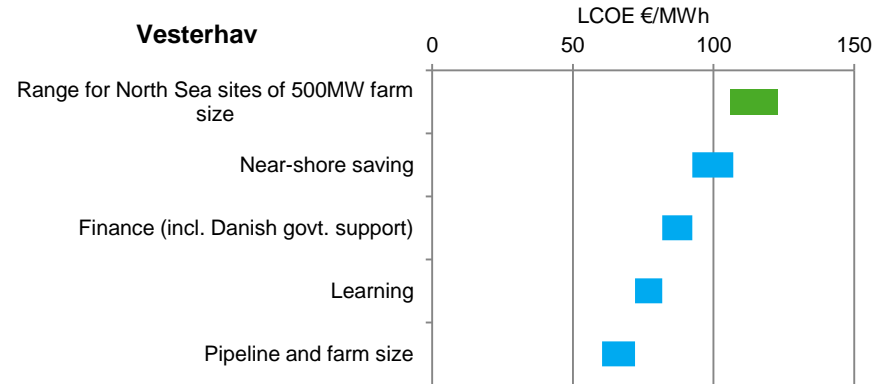
100 £/MWh = 118 €/MWh (yesterday)

Borssele 1 and 2 LCOE ~€68/MWh DONG, and Vesterhav Nord and Syd LCOE ~€60/MWh Vattenfall

BVGA best estimate of typical wind farm with:
Borssele site characteristics ~€108/MWh



Vesterhav site characteristics ~€107/MWh

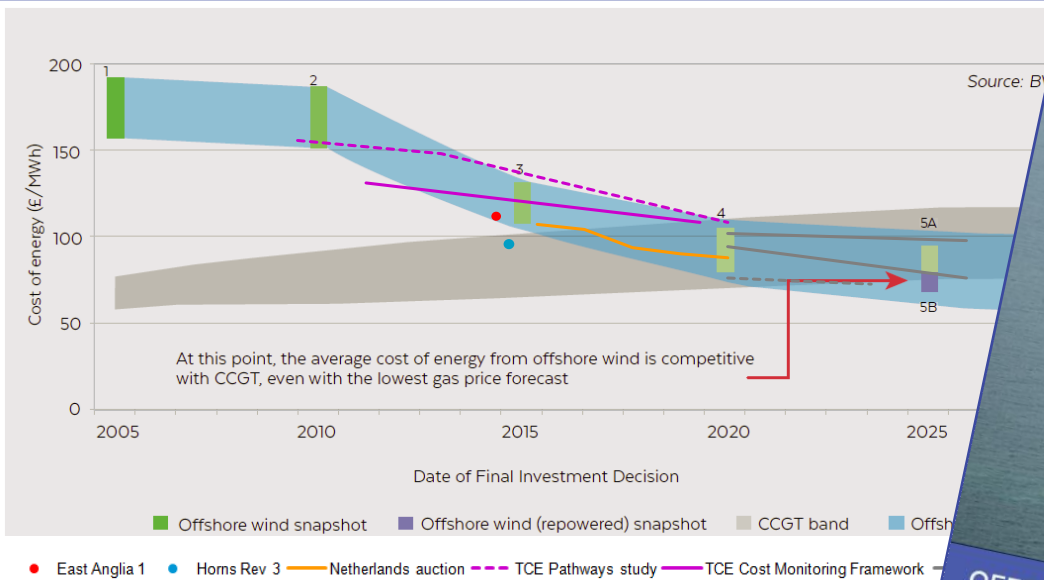


... and on Vattenfall's Kriegers Flak (€50/MWh bid price) we have seen a strategic business judgement in favour of very low cost of energy ...and if Danish sources are to be believed, possibly the first application of a 10MW+ turbine.....Look out for BVGA's Giles Hundleby's blog out soon.

Is this about being 'subsidy free'?

Going slow is not an option...

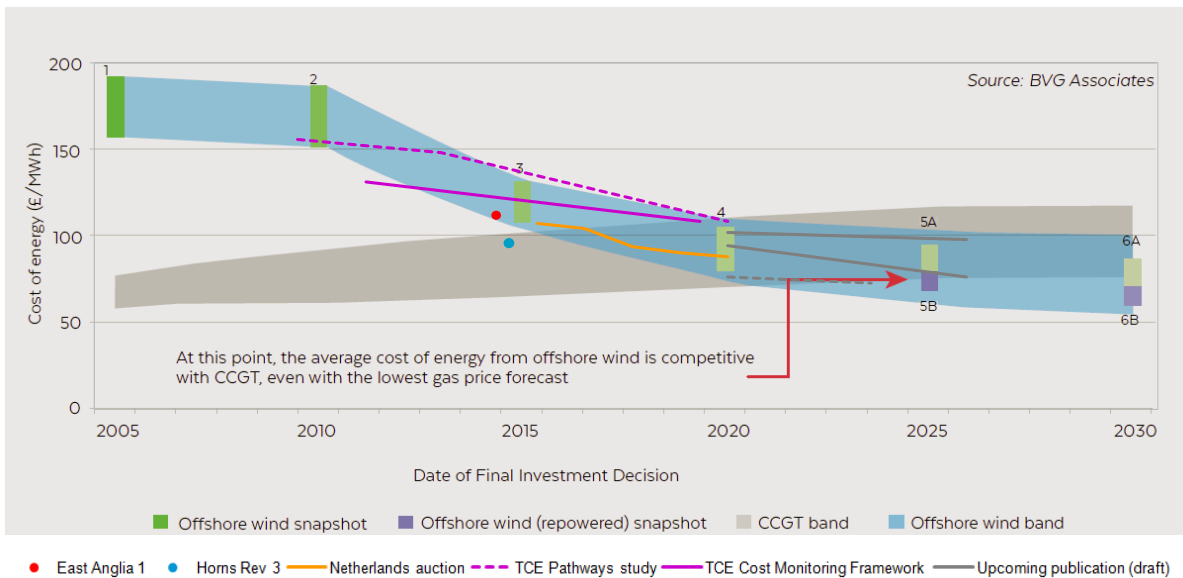
Cost of Energy Reduction = Offshore Wind



Is this about being 'subsidy free'?

Going slow is not an option...

Cost of Energy Reduction = Offshore Wind

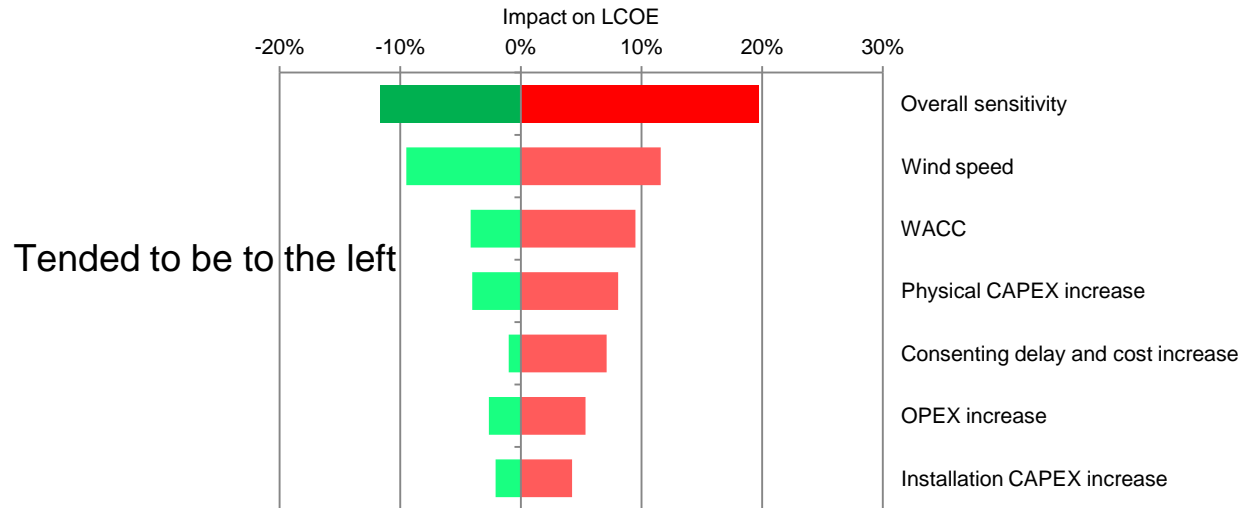


Subsidy free by '23



But have things gone our way?

For typical site



Source: BVG Associates

DELPHOS cost reduction analysis toolbox



Future renewable energy costs series

How technology innovation is anticipated to reduce the cost of energy in Europe

www.kic-innoenergy.com/reports

Developed in collaboration with



Online LCOE model for evaluation of impact of innovation

www.kic-innoenergy.com/delphos

Provide:

→Reference cost breakdown of renewable energy power plants (EU representative)

→List of innovations + impact description

→Fully customisable

Maximum technical potential impact of innovation under best circumstances

Technical potential impact for a given Site Type and Technology Type

Relevance to Site Type and Technology Type

Technical potential impact for given Site Type, Technology Type and year of FID

Commercial readiness

Anticipated technical impact for given Site Type, Technology Type and year of FID

Markets here

Objective: understand the impact of what we do

→Prioritize

→Invest

→Take decisions

→Serve as reference

Journey to 'subsidy free'

What progress needs to be made?

Nothing radical (except the largest rotating machines on earth)



Turbines

| | |
|--------------------------------|-----------------|
| Large quantities offshore | 130m diameter |
| Prototyped onshore | 164m diameter |
| Soon to be prototyped (public) | 180m diameter |
| FID in 2025 | > 200m diameter |

Main per MW benefits

Decreased foundation and installation CAPEX
Decreased OPEX
Increased energy production



Foundations

Improved design & manufacture
Extended use of monopiles

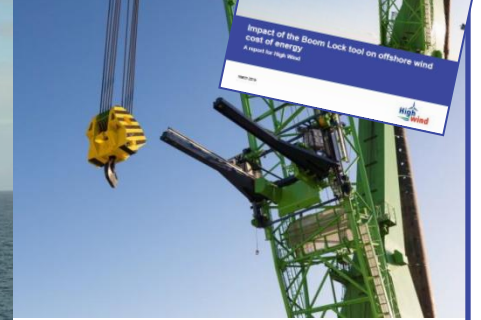
Decreased CAPEX



Transmission

Mounted on turbines
HVDC improvements

Decreased CAPEX



Installation

More capable vessels
Decreased weather sensitivity
Less use of crane vessels

Decreased CAPEX
Decreased cost of capital



Journey to 'subsidy free'

What progress needs to be made?

Well beyond technology...



Bigger projects

Savings in development and installation
Savings in transmission
Other savings in procurement

Longer project life and repowering

Better use of assets

Improved competition

Increased focus on cost
Auctions target developers

Collaboration

Sharing of costs, benefits
and experience

Main per MW benefits

Decreased CAPEX
Decreased OPEX

Decreased WACC

Improvements in all
aspects of LCOE

Improvements in all
aspects of LCOE

Journey to 'subsidy free'

Will this just happen? June 2015 report

Needs governments and industry to trust each other

- Published alongside the CCC's progress report on decarbonisation and fed in to its recommendations for the 5th carbon budget

Objective:

- To present recommendations to UK government about policies to drive down LCOE from offshore wind in 2020s and give value to UK energy users

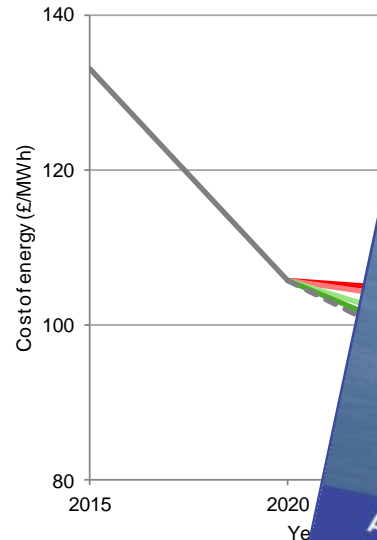
Delivered:

- By quantifying the impact of government policy drivers on cost of energy and support cost for UK offshore wind in 2020s
- In a European market context, through robust industry dialogue

1st time been robust analysis of the LCOE impact of policy

Key conclusions:

1. Substituting market with huge R&D funds isn't the answer
2. Clear visibility of short-term plans for min 1GW/yr in 2020s
3. Increasing to 3.5GW/yr across EU hardly costs any



Journey to 'subsidy free'

Will this just happen? June 2015 report

Needs governments and industry to trust each other

- Published alongside the CCC's progress report on decarbonisation and fed in to its recommendations for the 5th carbon budget

Objective:

- To present recommendations to UK government about policies to drive down LCOE from offshore wind in 2020s and give value to UK energy users

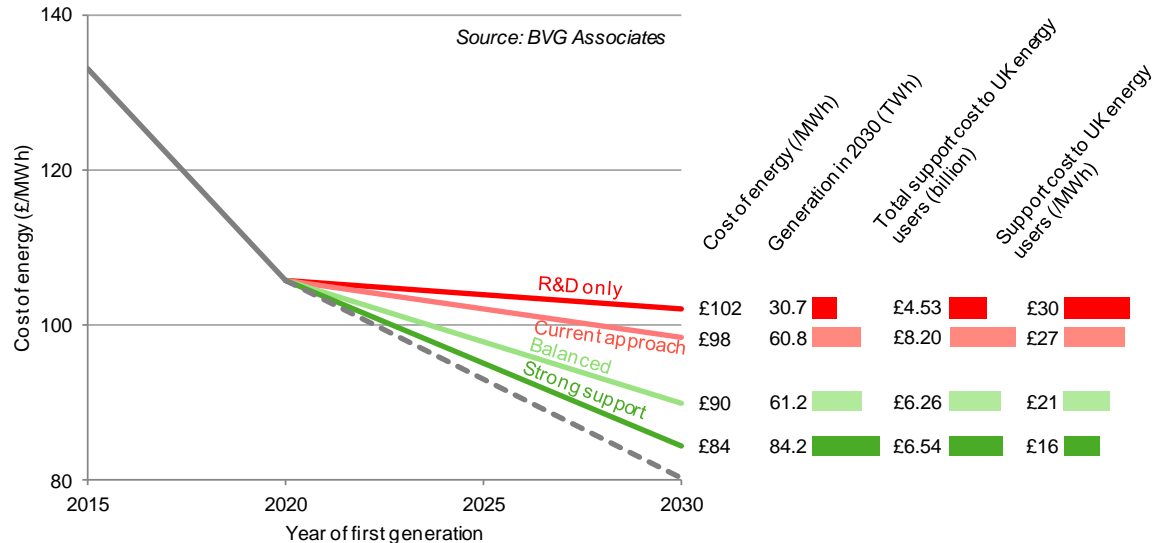
Delivered:

- By quantifying the impact of government policy drivers on cost of energy and support cost for UK offshore wind in 2020s
- In a European market context, through robust industry dialogue

1st time been robust analysis of the LCOE impact of policy

Key conclusions:

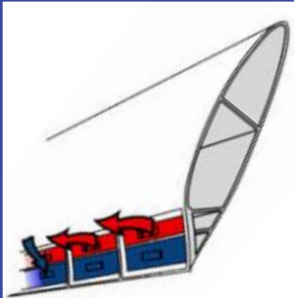
1. Substituting market with huge R&D funds isn't the answer
2. Clear visibility of short-term plans for min 1GW/yr in UK & long-term intent saves 25% cost of support & increases UK activity
3. Increasing to 3.5GW/yr across EU hardly costs any more for 35% more output due to LCOE impact



And beyond...

Plenty more evolution but also disruption

Focus on the future



Aero control

Huge blades need
better control



Float-out-and-sink

Avoid offshore crane cost



Floating

Access new area



Multi-rotor

Better use foundations



Kites

Aim higher

Main per MW benefits

Increased AEP
Decreased OPEX

Decreased installation CAPEX

Increased AEP

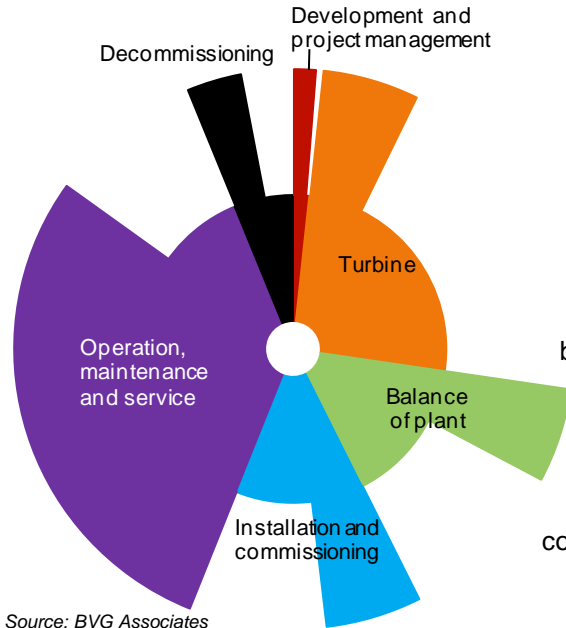
Decreased CAPEX
Decreased OPEX

Decreased CAPEX

Local benefit – key to continued support

We have the largest market, but...

Confidence and market size are key to how far we get



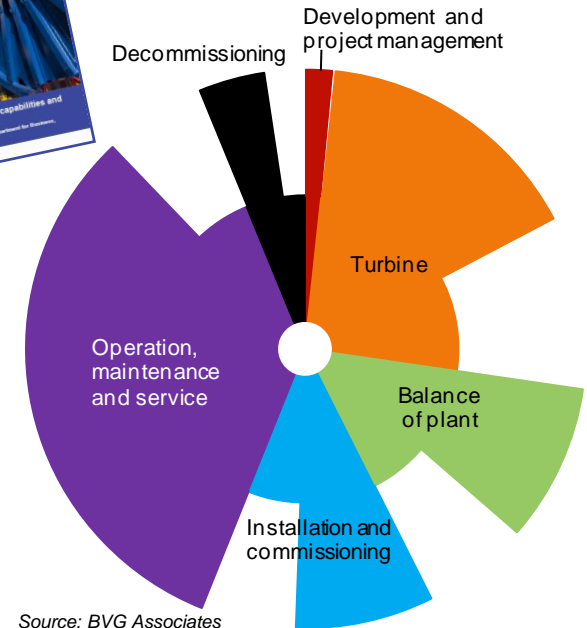
50% UK content – good target for current projects

Nacelle assembly and
main component supply

Export cable and increased UK-
based foundation supplier success

Increased UK-based
supplier success

UK manufacture of replacement
components and UK SOV operators



70% UK content – not in current environment

.. and the price of fish?

EU Multiuse of space directive means what?

Our analysis showed combination with mussels reduced levelised cost – looking for partners to trial

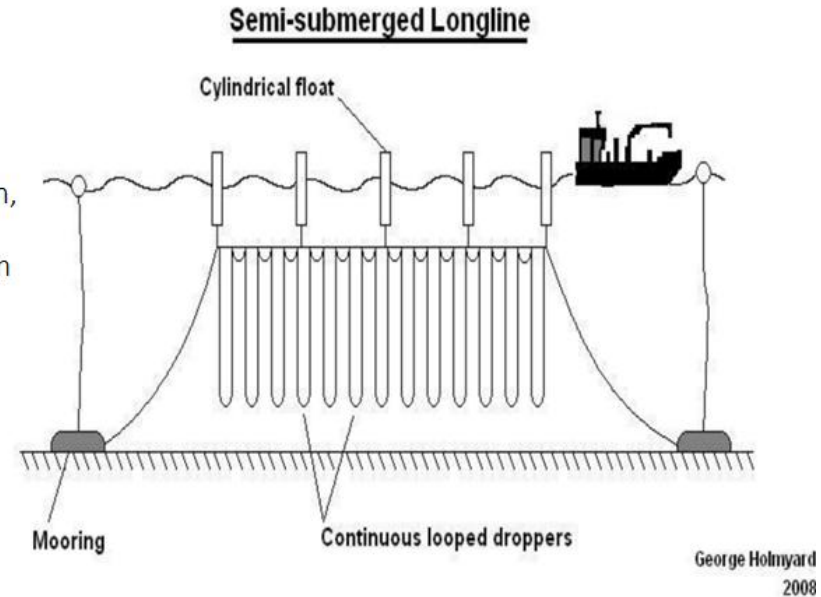
AQUACULTURE

+

FIXED OFFSHORE
WIND

Mussel farming and offshore wind

- Multi-use of space – structures are separate allowing turbine access
- Considered feasibility for Dutch Borssele wind farm
 - Development of wind farm is a given, with fixed structures
 - Water depth between 15m and 35m
- Double long lines (continuous) attached to anchors
- Annual production target for mussels: 5.5 million kg of mussel seed



Thank you

BVG Associates Ltd
The Blackthorn Centre
Purton Road
Cricklade, Swindon
SN6 6HY UK
tel +44(0)1793 752 308

mjb@bvgassociates.com
@bvgassociates
www.bvgassociates.com

BVG Associates Ltd
The Boathouse
Silversands
Aberdour, Fife
KY3 0TZ UK
tel +44(0)1383 870 014

BVG Associates LLC
Green Garage
Second Avenue
Detroit, MI
48201 USA
tel +1 (313) 462 0673

This presentation and its content is copyright of BVG Associates Limited - © BVG Associates 2016. All rights are reserved.