Offshore wind innovation for cost reduction

What are the knobs to turn? Offshore wind innovation to 2030

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Session title: Optimising O&M to reduce LCOE

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About KIC InnoEnergy

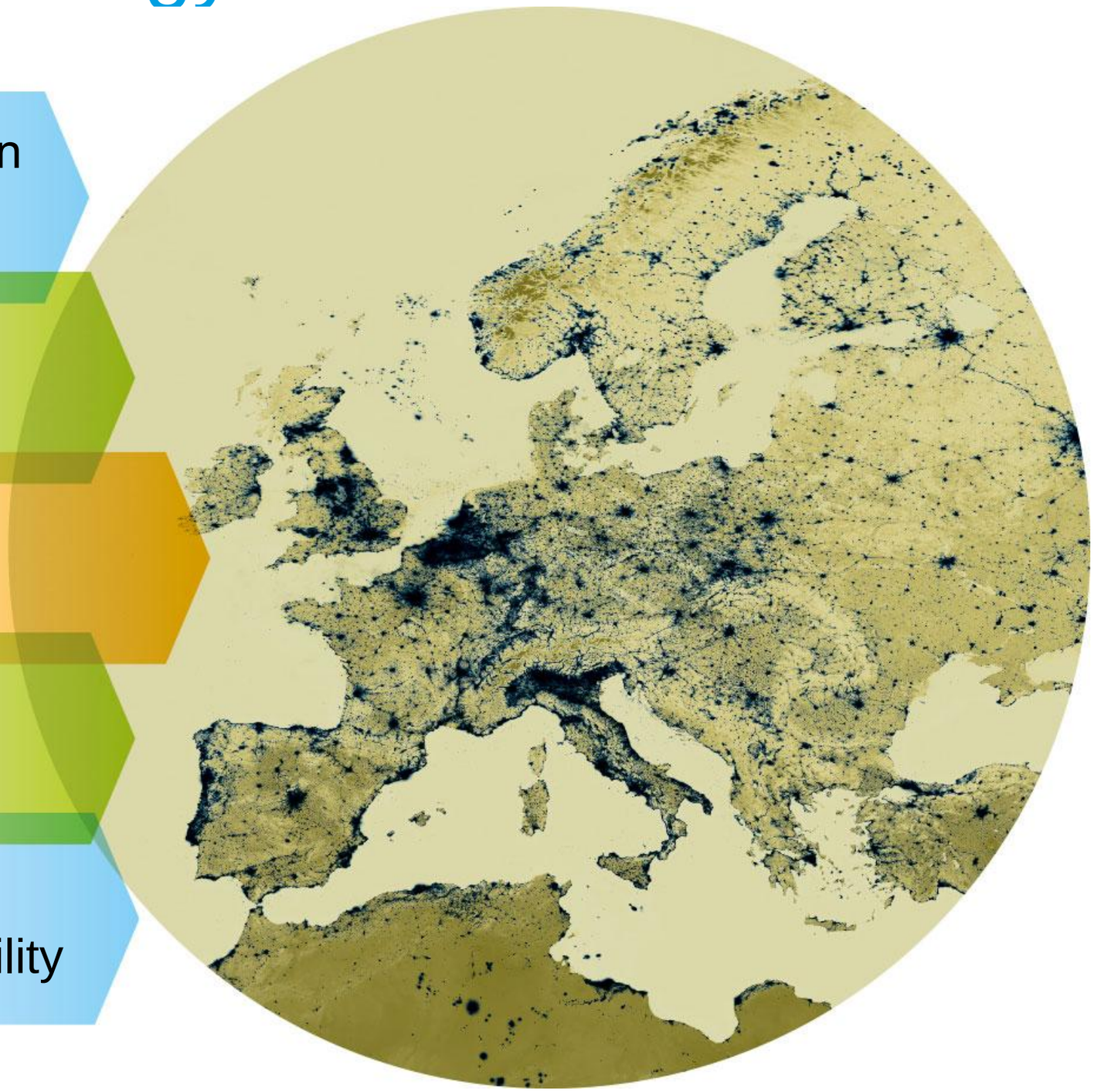
Europe's engine for innovation in sustainable energy

Empowering every stage of the innovation process

Investing in people, technologies, businesses

Established 2010: supported by the EIT

Public-private partnership aiming for financial sustainability



About BVG Associates

Business advisory

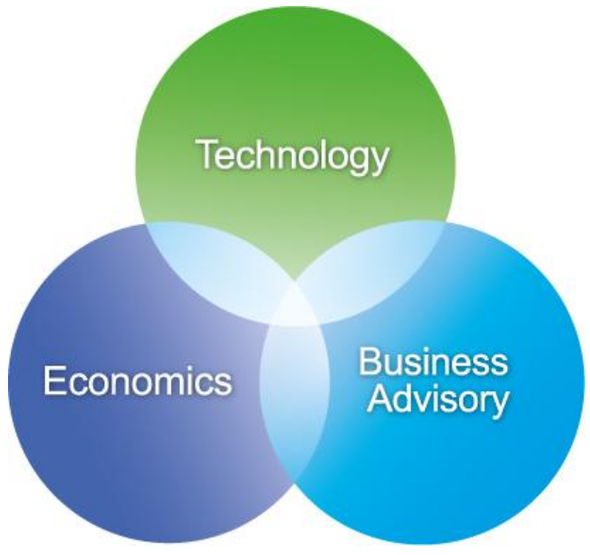
- Analysis and forecasting
- Strategic advice
- Business and supply chain development

Economics

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

Technology

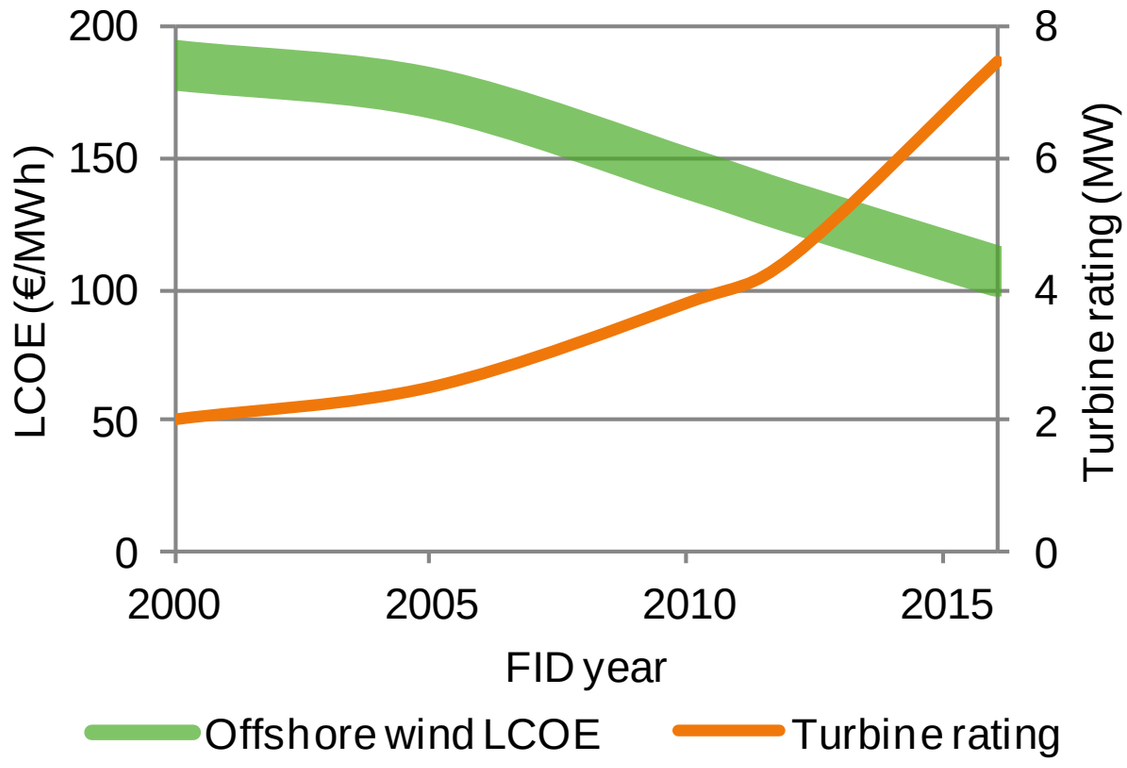
- Engineering services
- Due diligence
- Strategy and R&D support



1. Problem

Need for dramatic cost reduction in offshore wind to compete in the energy market.

The industry has been achieving this through technological innovation (as shown by increases in turbine rating) and by supply chain effects.



What's next?

1.1 Methodology - overview

Baseline Offshore Wind Farms

As a combination of:

WTG size	Sites	FID dates
4, 6, 8, 10 MW	40km fr/shore – 25m depth 120km fr/shore – 35m depth	2014/20/25/30

WACC

Supply chain

Permitting

Decom.

Impact on cost of
- Wind farm development
- Wind turbine
- Support structure
- Array electrical
- Construction
- Planned wind farm operation, maintenance and service, and
- Unplanned service and other OPEX

Impact on
- Gross AEP, and

Innovations' impact

Future Offshore Wind Farms

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www.kic-innoenergy.com/reports

1.2 Methodology - example

Innovation: Improvements in range of working conditions for support structure installation vessels

(For a WF on Site Type A, with Turbine Size of 10MW and FID in 2025 compared to same WF in 2014)

Effect on construction CAPEX:

Maximum technical potential impact	→ 9.6%
x Relevance to Site Type A and 10MW-Size Turbine is 83%	→ 7.9%
x Commercial readiness at FID in 2025 is 92%	→ 7.3%
x Market share for project using 10MW-Size WTG - FID 2025 is 78%	→ 5.7%
Anticipated impact on construction CAPEX	→ 5.7%

→New CAPEX

→New LCOE

(Same for all innovations' impact on CAPEX, OPEX, AEP)

1.3 Methodology – do it yourself

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 BVGassociates

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

Objective: understand the impact of what we do

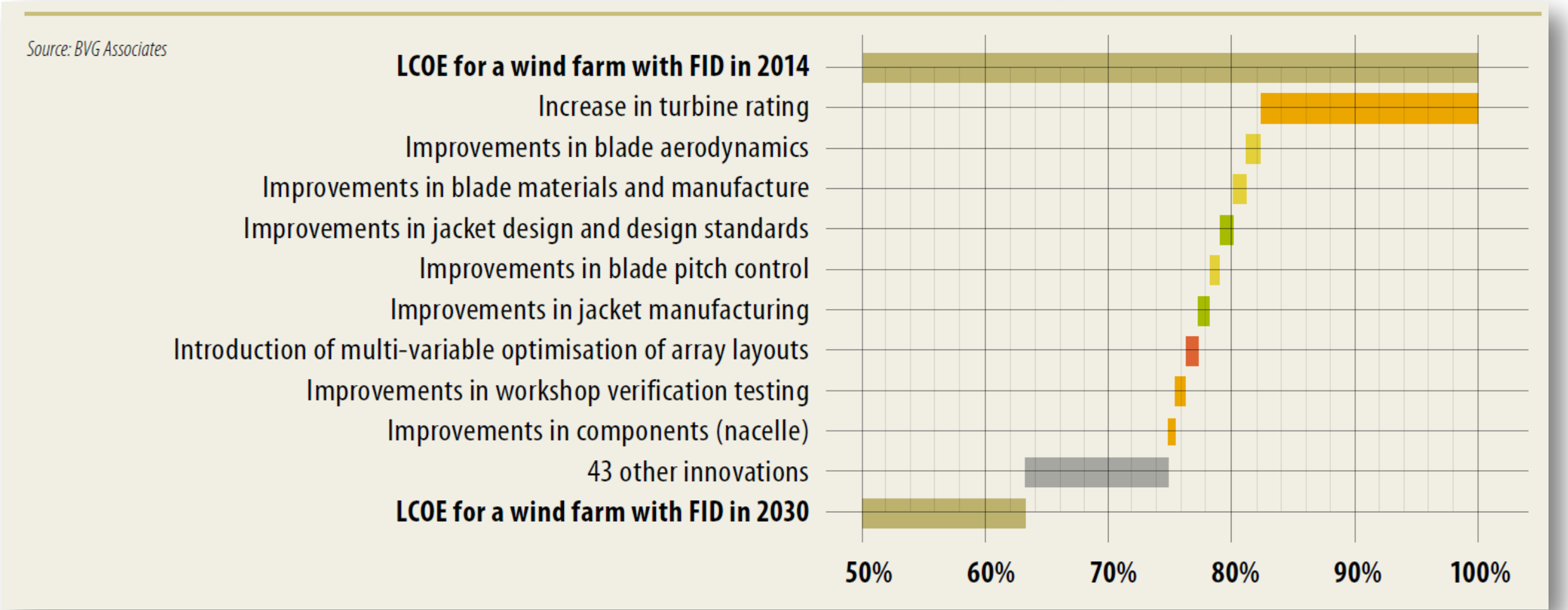
→Prioritize

→Invest

→Take decisions

→Serve as reference

2.1 Top contributing innovations

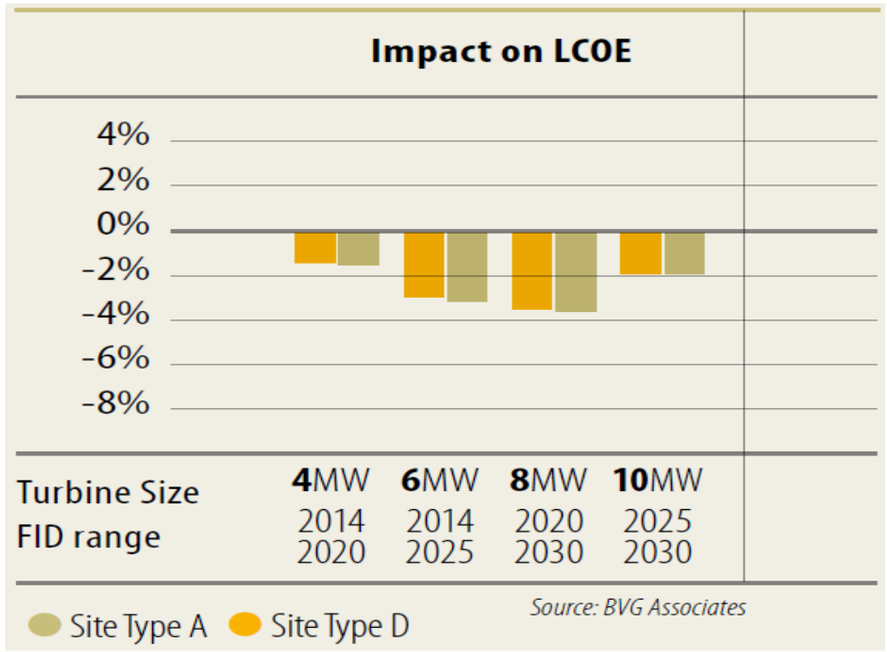


Anticipated impact of technology innovations for a wind farm using 10MW-Size Turbines with FID in 2030, compared with a wind farm with 4MW-Size Turbines with FID in 2014, both on Site Type D

2.2 Impact of innovation in nacelle

11 **innovations**

-6% **from present to 2030**



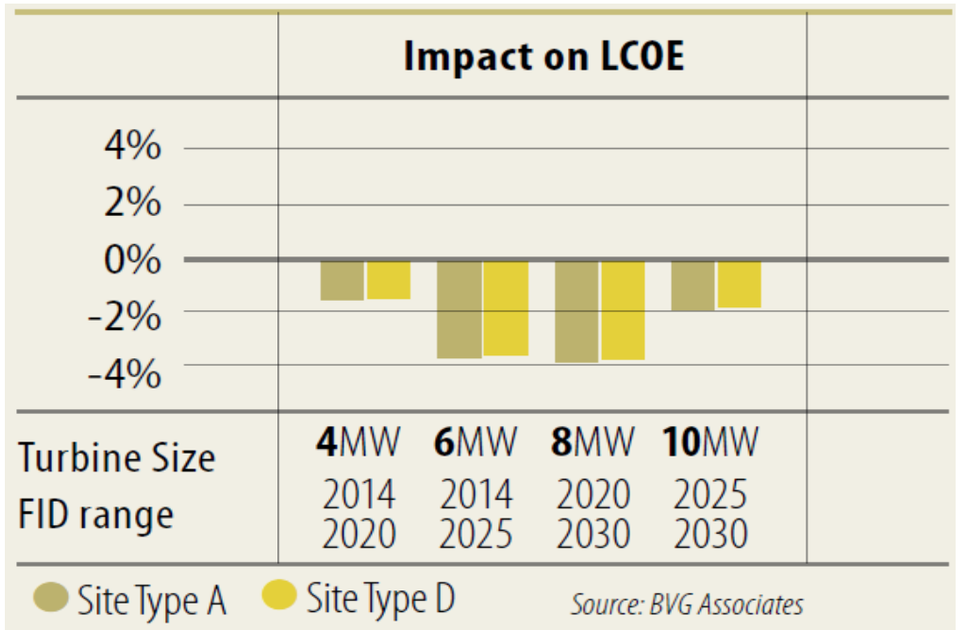
Highlights:

Improvement in drive trains	Improvement in components
Many different types of possible drive trains: DC, mid-speed, continuous, superconducting Only some will be taken up by the market, but overall improvements in drive train will be large	Non-offshore-wind specific innovation (metallurgy, tribology) Offshore-wind specific innovation in component design

2.3 Impact of innovation in rotor

9 innovations

-7.4% from present to 2030



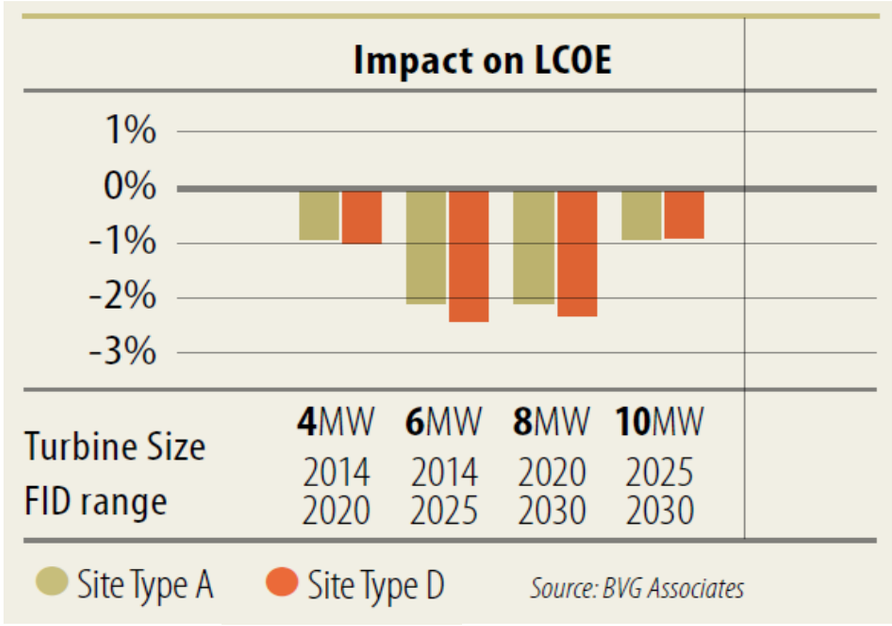
Highlights:

Blade aerodynamics	Blade manufacture
Blades enabling additional energy production with some cost increase	Blades with lower cost or higher quality through novel materials and processes

2.4 Impact of innovation in plant development

6 **innovations**

-3.1% **from present to 2030**



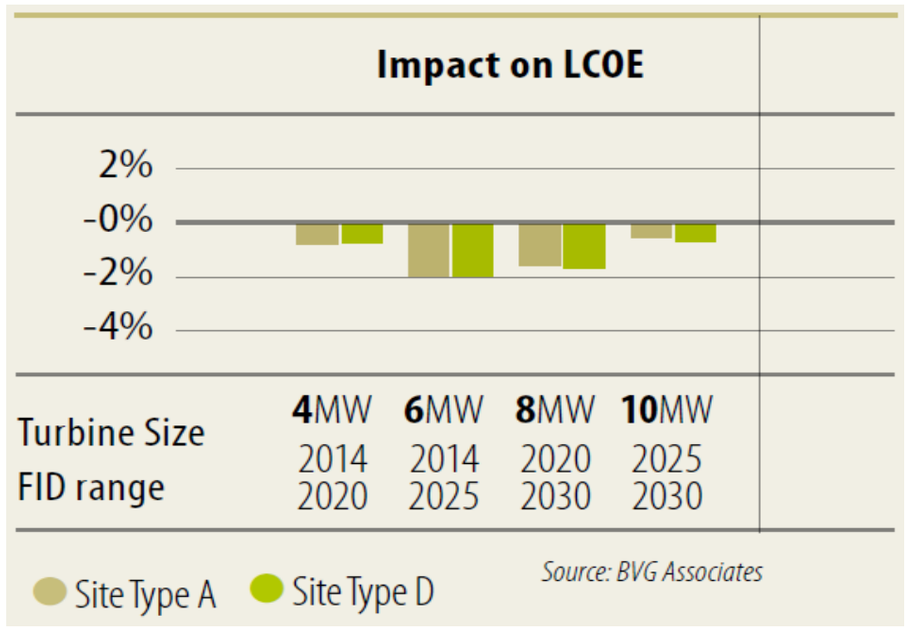
Highlights:

Array layout	Greater focus on optimisation during FEED
Decreased LCOE through multi-variable optimisation of array layout	Improved decision making through more detailed design

2.5 Impact of innovation in BoP

8 **innovations**

-3.8% **from present to 2030**



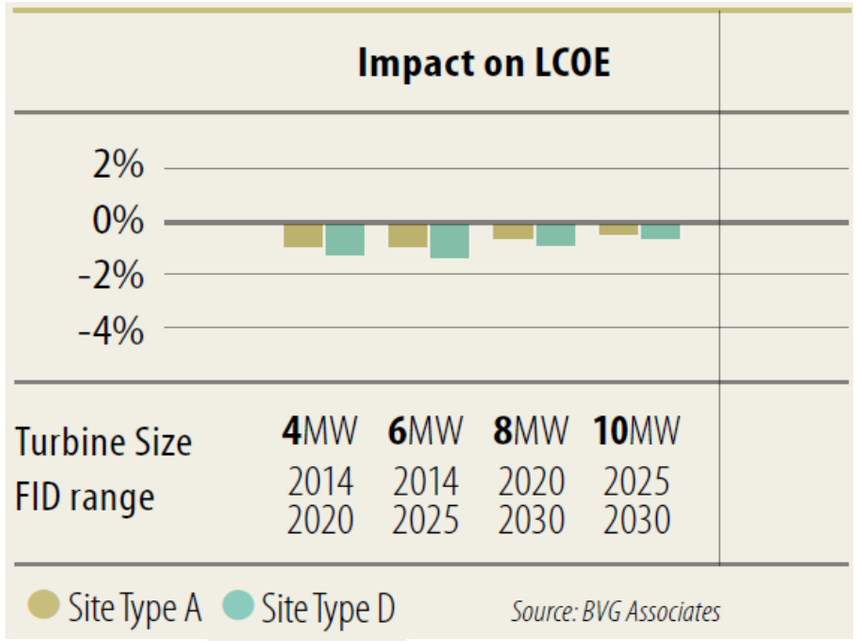
Highlights:

Improvement in support structure design	Improvement in jacket manufacturing
For all foundation types, design can reduce cost.	For jacket support structures in particular, innovation in manufacturing for modular and pre-fabricated construction is vital.

2.6 Impact of innovation in construction

8 innovations

-2.3% from present to 2030



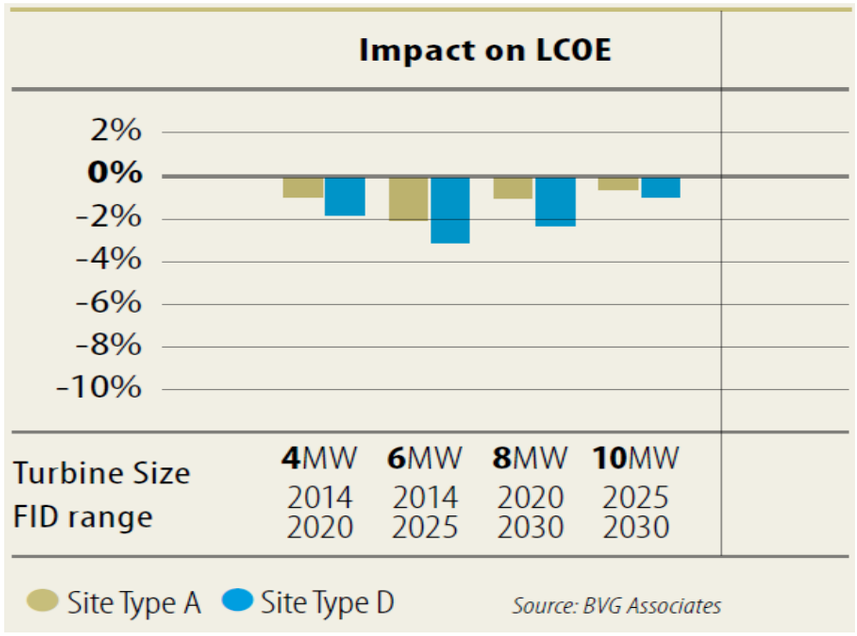
Highlights:

Working conditions for vessels	Jacket installation
Enabling vessels to work in more extreme weather conditions	Vessel cost and carrying capacity optimised for jacket installation

2.7 Impact of innovation in OMS

9 innovations

-4% from present to 2030



Highlights:

Personnel access	Condition based maintenance
Improved personnel access through far from shore techniques, walkways, lifting pods and transfer vessels	Focus maintenance where it is of most benefit

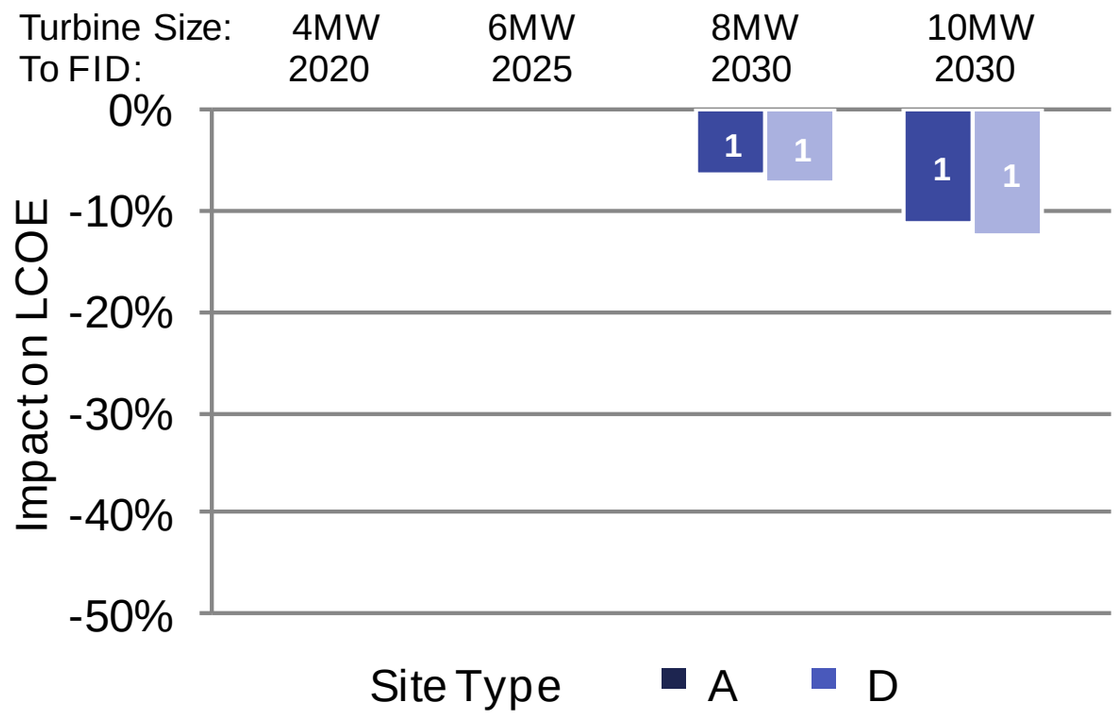
3.1 Summary & conclusions

1

Inherited

Cost reduction coming from innovation developped on previous WTG series

Comparison to WF with 4 MW WTG – site type A – FID 2014



3.1 Summary & conclusions

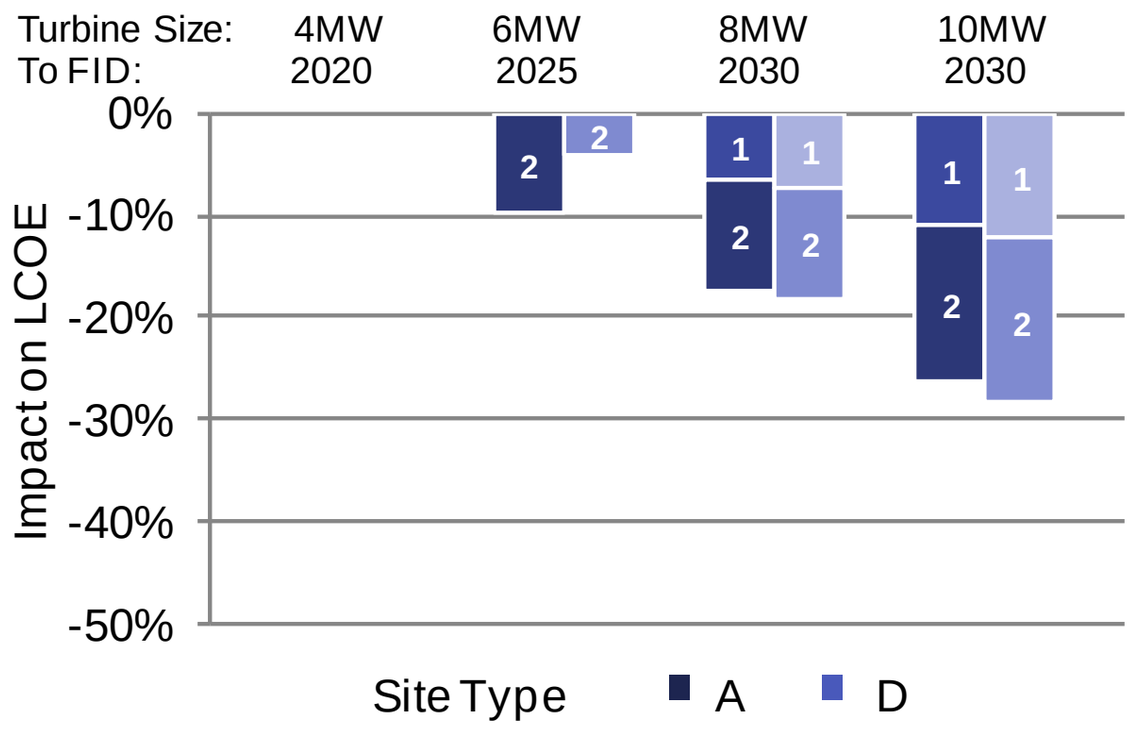
1 **Inherited**

Cost reduction coming from innovation developped on previous WTG series

2 **Power**

Cost reduction due to increase in WTG power rating

Comparison to WF with 4 MW WTG – site type A – FID 2014



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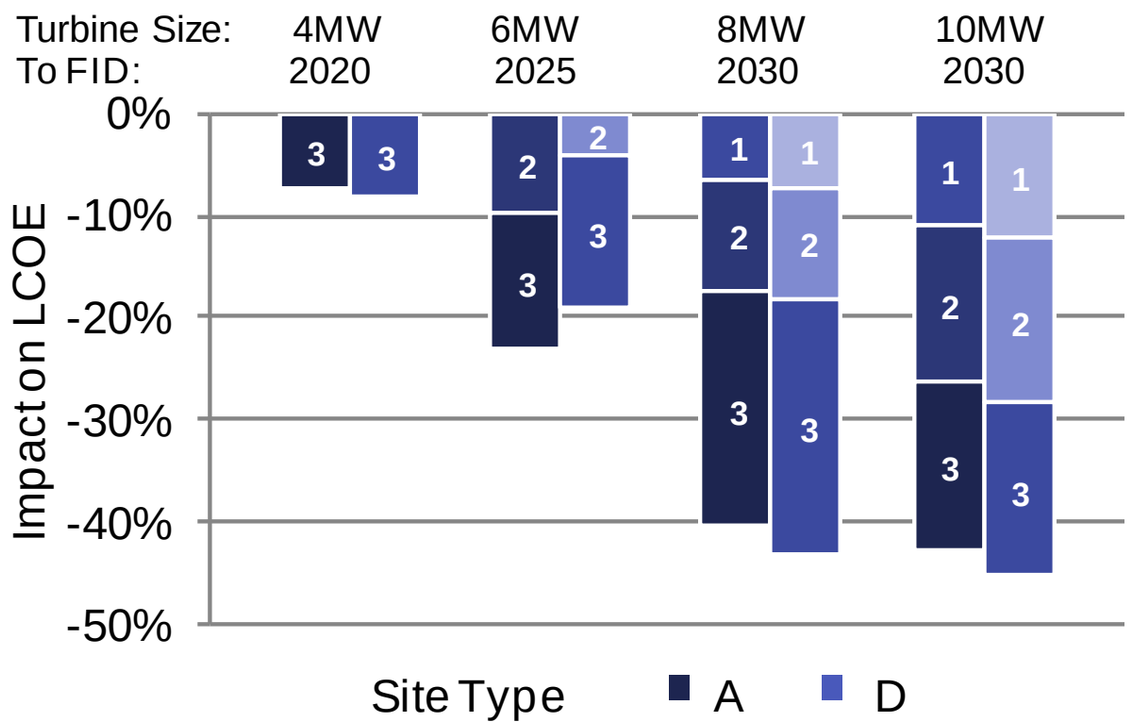
3.1 Summary & conclusions

1 Inherited
Cost reduction coming from innovation developped on previous WTG series

2 Power
Cost reduction due to increase in WTG power rating

3 New
Cost reduction due to impact of innovation on the specific WTG

Comparison to WF with 4 MW WTG – site type A – FID 2014



3.2 Summary and conclusions

Hot topics:

• Turbines with a higher rated capacity and more efficient rotors that are more reliable and deliver increased energy production

• Mass-produced support structures for use in deeper water

• Enhanced construction and OMS methods using bespoke vessels and equipment which can operate in a wider range of conditions, and

• Greater upfront investment in wind farm development, both in terms of site investigations and engineering studies.

These hot topics show how the industry is maturing in its approach to innovation.

Game-changing innovations could reduce the cost of energy further if they can incorporate lessons from conventional offshore wind and use the current supply chain.

Thank you
Any questions?

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