scottish renewables

IN ASSOCIATION WITH

CATAPULT Offshore Renewable Energy

OFFSHORE WIND CONFERENCE, EXHIBITION & DINNER

29 & 30 JANUARY 2018 **GLASGOW**

areg Aberdeen Renewable Energy Group

Crown Estate Scotland Oighreachd a' Chrùin Alba

ECOSSE Subsea Systems ...because we think differently

HIE Highlands and Islands Enterprise Iomairt na Gàidhealtachd 's nan Eilean

INVEST IN FIFE

James Fisher Marine Services

NewWaves Solutions Marine & Environmental Services

Building the Future:
Carbon, Cost and Competitive Technology

Claire Mack, Chief Executive, Scottish Renewables

Paul Wheelhouse MSP, Minister for Business, Innovation and Energy, Scottish Government

Benj Sykes, UK Country Manager, Head of Programme Asset Management, Wind Power, Ørsted

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Update on the Sector Deal

Offshore Wind Industry Council

Scottish Renewables conference

30th January 2018

We want to be the integrated, green energy company of the future

Let’s create a world that runs entirely on green energy

Love your home

Our business transformation

One of the most profound industrial transformations in the European energy industry

Divested our oil and gas business and now focussed entirely on green energy

Danish Oil and Natural Gas (DONG) no longer stood for who we are

Inspired by the curiosity, dedication and interest in nature of one of Denmark's best known scientists

200 years ago, Hans Christian Ørsted helped lay the foundation for how we produce power today

Ørsted

Our ambition is to deliver a successful Sector Deal, and a world leading offshore wind industry

Today

- 6GW of generation capacity providing c.5% of the country’s electricity
- c.6,000* directly employed
- c.£290* million in exports

2030

- 30GW of generation, meeting c.35% of the electricity demand
- Enabling a up to 6% reduction in average electricity costs versus BAU**
- 13,000-20,000 directly employed
- £650-£2,500 million in exports per year

2050

- 50GW by 2050, meeting half of electricity demand
- Enabling up to 18% reduction in average electricity costs versus BAU**
- 27,000-36,000 directly employed
- £1,300-£4,900 million in exports per year

**current employment and export estimates are based on 2015 data*

***BAU is assumed to be a system based on natural gas with either a carbon price or CCS to account for the carbon externality*

A Sector Deal that delivers on the Industrial Strategy

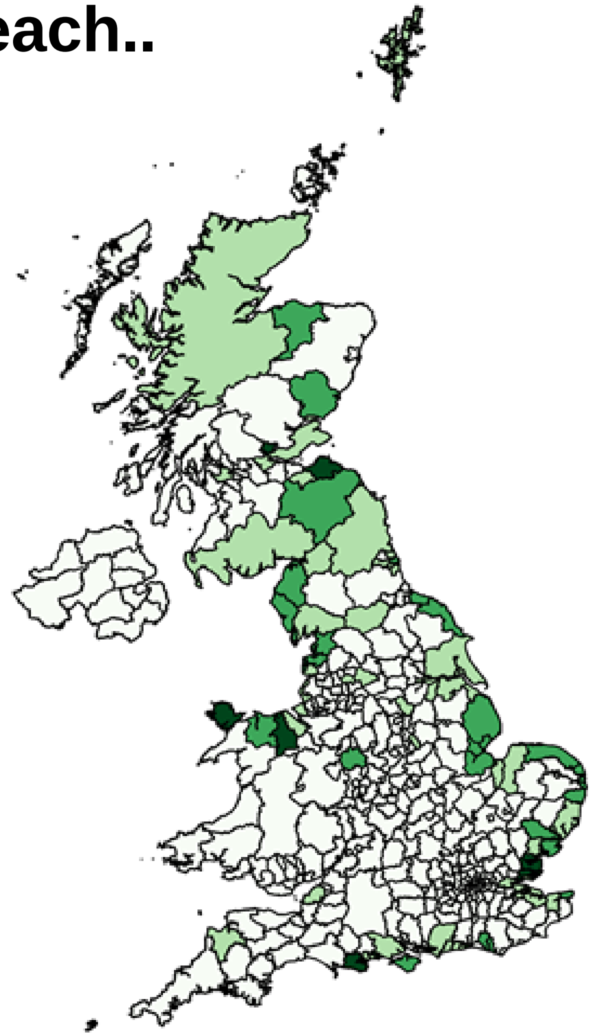
- Improving productivity, earning power and availability of good work
- Delivering Clear Leadership
- Representing breadth of the sector
- Based on Rigorous analysis of comparative strengths and weaknesses
- Truly transformational for UK Plc and our sector, with deliverable proposals

Across the 5 Foundations of the Industrial Strategy, the offshore wind sector deal will drive transformative change

The vision for an offshore wind sector deal

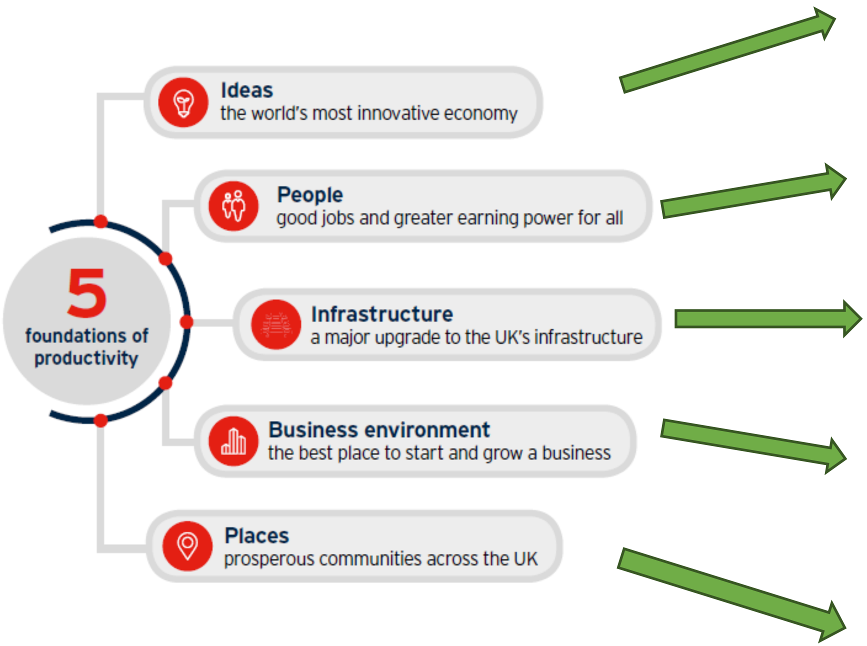
- **reduce cost** – including at the system level - to drive UK productivity and create source of competitive advantage
- support **increased productivity** and high quality jobs for communities across the UK
- upgrade and **decarbonise** the UK's electricity generation infrastructure at scale
- become the most attractive place to develop the OSW supply chain, and capture growing **export opportunities**
- transform economically challenged areas to **prosperous communities** built on a sustainable industry

Offshore wind can regenerate the places other sectors cannot reach..



OffshoreWind IndustryCouncil

The Sector’s proposal – emerging elements of the deal



Increased RD&D through co-funded initiatives, such as:
- Innovation Hub support for next-generation technologies
- Challenge Fund focused on integration at scale

Joined-up and scaled-up skills initiatives, such as:
- Standardised curriculum for (re) skilling
- Regionally focussed technology institutes

Accelerated build-out of the UK’s new energy infrastructure:
- Continued development of new sites around the UK
- Strong financing expertise to ensure low cost of capital

Support for a competitive supply chain, such as:
- Predictable market arrangements for supply and transmission
- SME advisory to increase export readiness

Local collaboration drive local advantages, such as:
- Clusters for knowledge sharing and shared infrastructure
- Increased community-industry partnerships

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Paul Wheelhouse MSP, Minister for Business, Innovation and Energy, Scottish Government

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INVEST IN FIFE

James Fisher Marine Services

NewWaves Solutions Marine & Environmental Services

Optimising Performance: Maximising the Existing Offshore Fleet

Session coordinated by

Catapult Offshore Renewable Energy

Chris Hill, Operational Performance Director, Offshore Renewable Energy Catapult

Paul Grimshaw, Software Systems Architect, Sennen

Peter Clive, Senior Scientist, Wood

Tom Clark, Technical Director, Octue

Wayne Mulhall, Regional Director, MHI Vestas Offshore Wind

Paul Grimshaw, Software Systems Architect, Sennen

Slides unavailable for publishing

Peter Clive, Senior Scientist, Wood

The Digital Convergence Opportunity

Session 2A: Optimising Performance: Maximising the Existing Offshore Fleet
Scottish Renewables Offshore Wind Conference, 30th January 2018

facts…

A new global leader in technical, engineering and project services

$10BN

over $10bn revenue

60+

Operating in more than 60 countries

160

Over 160 years' experience

facts...

great

alignment

asset
light

flexible
contracts

strong
partnerships

facts...

great

outlook

innovative
spirits

global
experience

deep
heritage

facts…

great

combination

outstanding
talent

enhanced
capability

greater
scale

purpose…

we deliver performance-driven solutions throughout the asset life cycle, from concept to decommissioning across a broad range of energy and industrial markets

range...

comprehensive support for the life of an asset

Design

Studies
Concept
FEED
Detail design

Build

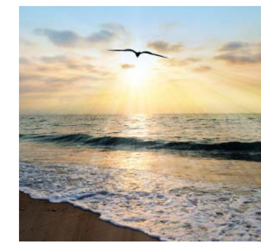
Procurement
Construction
Commissioning
Start-up

Operate

Operations
Maintenance
Repairs
Manpower

Improve

Modifications
Upgrades
Optimisation
Project management



Decommission

Late life
Shutdown
Disposal
Monitoring

from development to decommissioning

range...

deeper capability in specialist support

Automation

Control systems
System integration

Digital Solutions

Collaborative solutions
Virtual Reality
Digital workflow

Asset integrity

Specialist engineering
Professional services
Vibration and noise
Corrosion

Subsea

Engineering
Pipelines
Risers
Flowlines

Environment

Monitoring
Analysis
Compliance
Remediation

high technology and highly specialised

CPI monitoring

condition

performance monitoring:

- statistics, e.g.
    - power curves
    - yield deficit
- events and alarms
- relationships and responses
- opportunities for optimisation

condition monitoring:

- high frequency data, e.g.
    - accelerometers
    - strain gauges
- particle analysis
- lubricant and bearing temperatures
- components and systems

monitoring
asset health

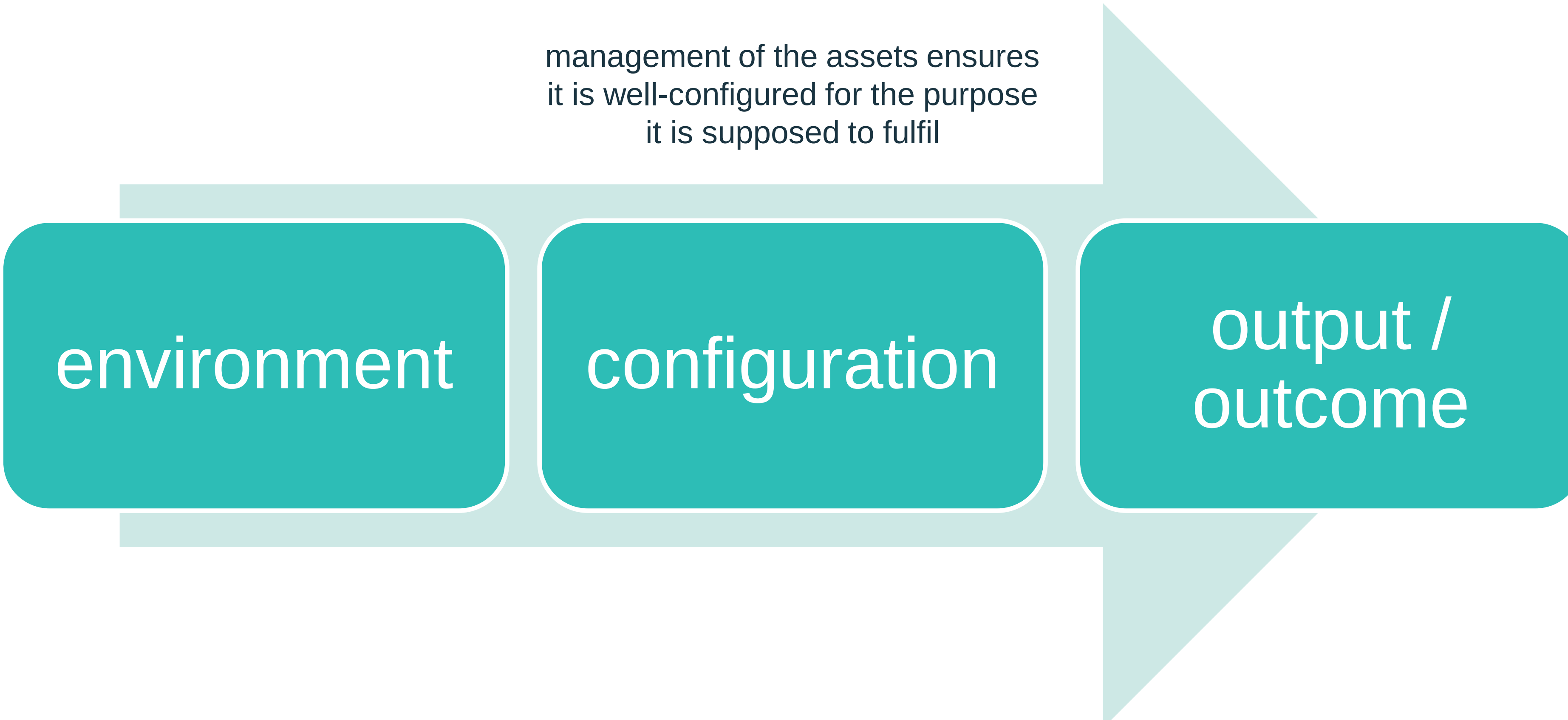
performance

integrity management:

- inspections and records
- repair and maintenance
- HSE and risk assessments
- opportunities for life extension

integrity

ECO conditions



some of the clean energy markets we work in


Onshore wind


Offshore wind


Solar


Wave & tidal


Bio-energy


Hydro

selected project case studies

EPCM services for Edbridge Ontario

lender’s technical advisor for Borkum West II (200MW)

Germany’s first project financed offshore wind farm.

The digital convergence opportunity

- It is now possible to ***close the loop*** and achieve a complete understanding of project performance on which to base predictions and plan pro-active, preventative maintenance:
  - Well instrumented wind turbines, with CMS and SCADA data, provide a detailed picture of turbine status
  - Operational data can be used to validate “digital twin” simulated turbines
  - Simulated turbines can be embedded in modelled wind fields to predict production, loads, etc.
  - Wind models can be validated using detailed and precise scanning lidar measurements of the real world wind conditions
- A single unified approach may be applied throughout the asset lifetime
- The validated “digital twin” used for pre-construction estimates can be checked against the real thing post-construction

The digital convergence opportunity

- The technical innovation that enables convergence will be accompanied by organisational innovation:
  - Chaotic fragmentation of effort is currently mitigated by organisational and contractual arrangements
  - In future co-ordinated disaggregation of tasks in a process of managed collaboration will be based on a common understanding of shared challenges and overall objectives
  - This will be informed by aligned perspectives on technical challenges leading to unified data requirements focussing all stages of project delivery on long term productivity and reliability

O&M for Levenmouth demonstration offshore wind turbine (7 MW)

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O&M for Levenmouth demonstration offshore wind turbine (7 MW)

O&M for Levenmouth demonstration offshore wind turbine (7 MW)

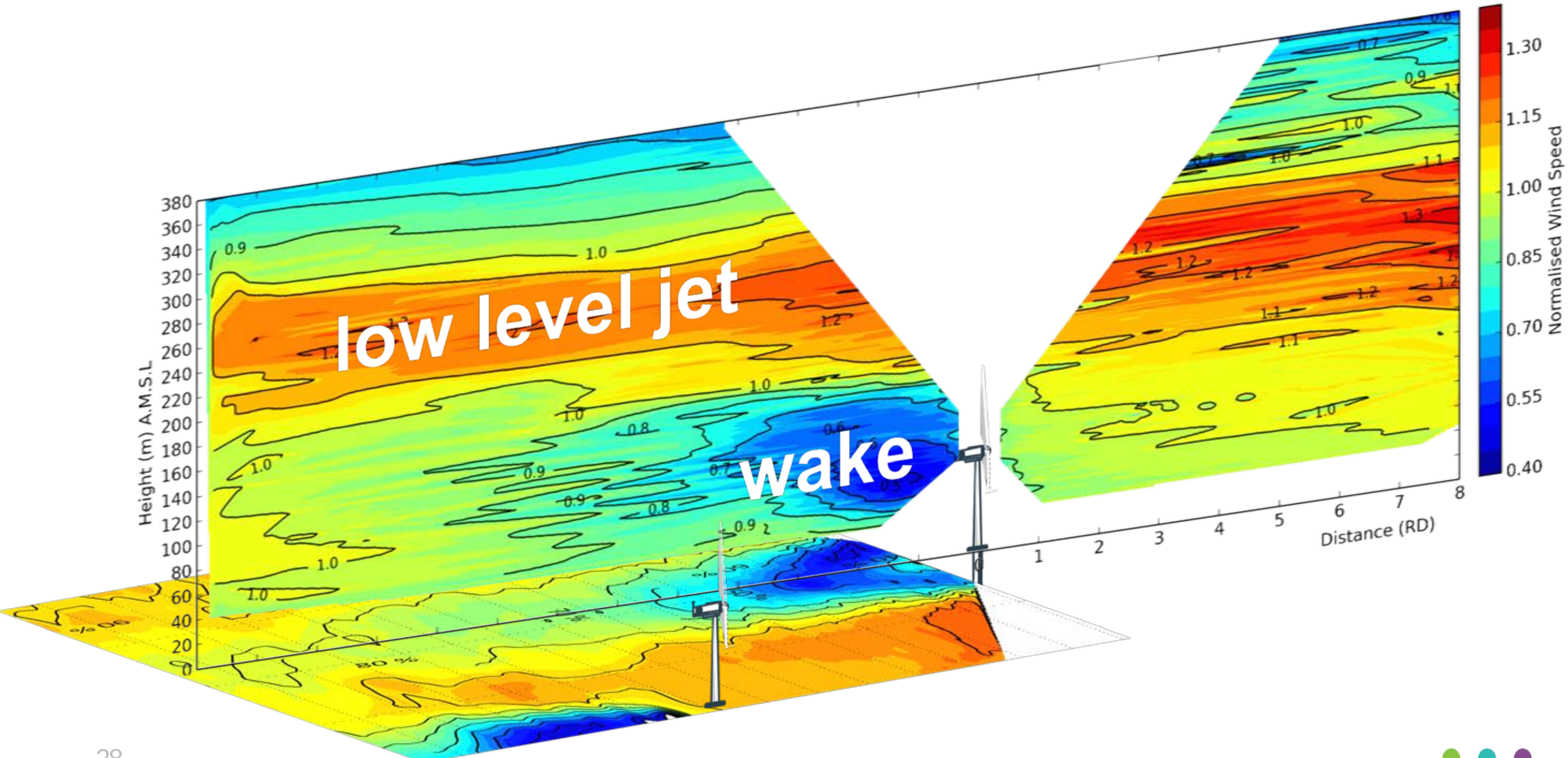
- operations and Maintenance
  - scheduled annual maintenance
  - inspection
  - performance reporting
  - spare parts
  - reactive maintenance, fault finding, upgrades
  - site management

- implementation of R&D projects
  - planning and Engineering
  - RAMS & Risk Workshops
  - pre-installation preparatory works
  - installation / assisting installation

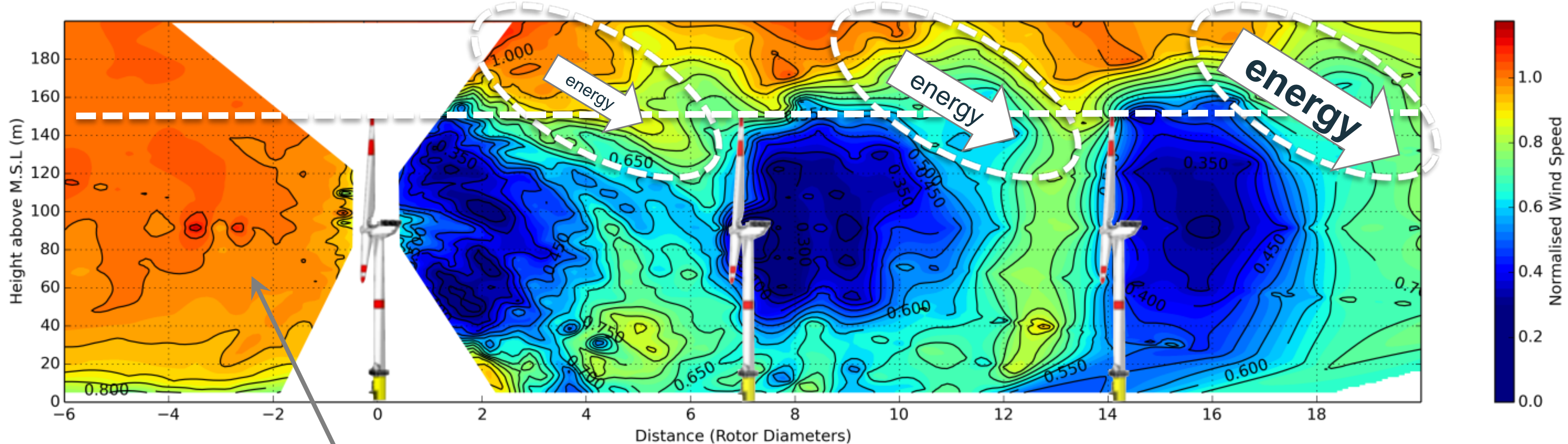
scanning lidar wake measurements at Hywind floating wind farm

- client: Hywind Scotland
- scope of work:
  - Galion Lidar supply, installation, O&M, data recovery & processing.
  - design and manufacture of motion compensation equipment (MCE).
- purpose: wake measurement from two turbines
- installation: October 2017
- duration: 4 years

scanning lidar wake measurements at Hywind floating wind farm

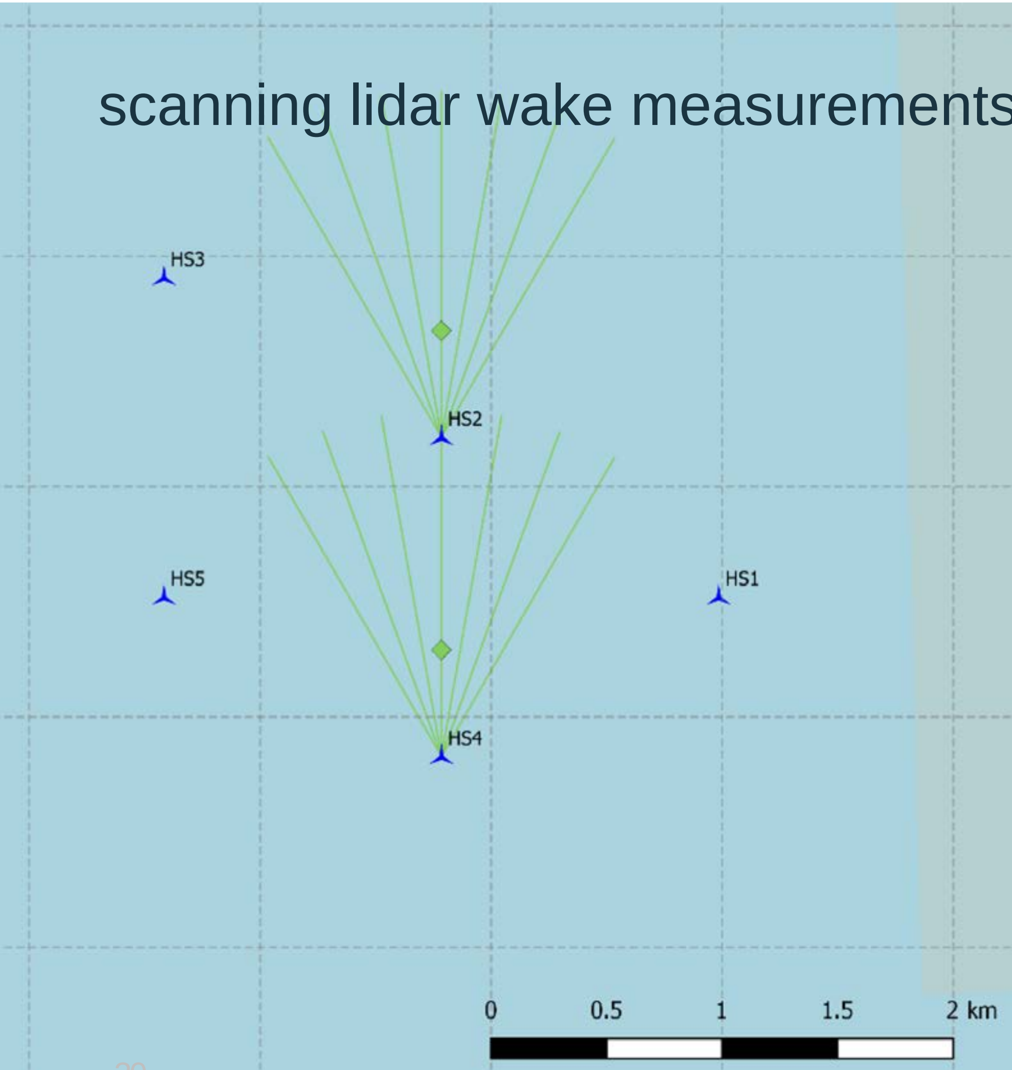


scanning lidar wake measurements at Hywind floating wind farm



N.B. compression zone

scanning lidar wake measurements at Hywind floating wind farm



STATOIL

HYWIND SCOTLAND

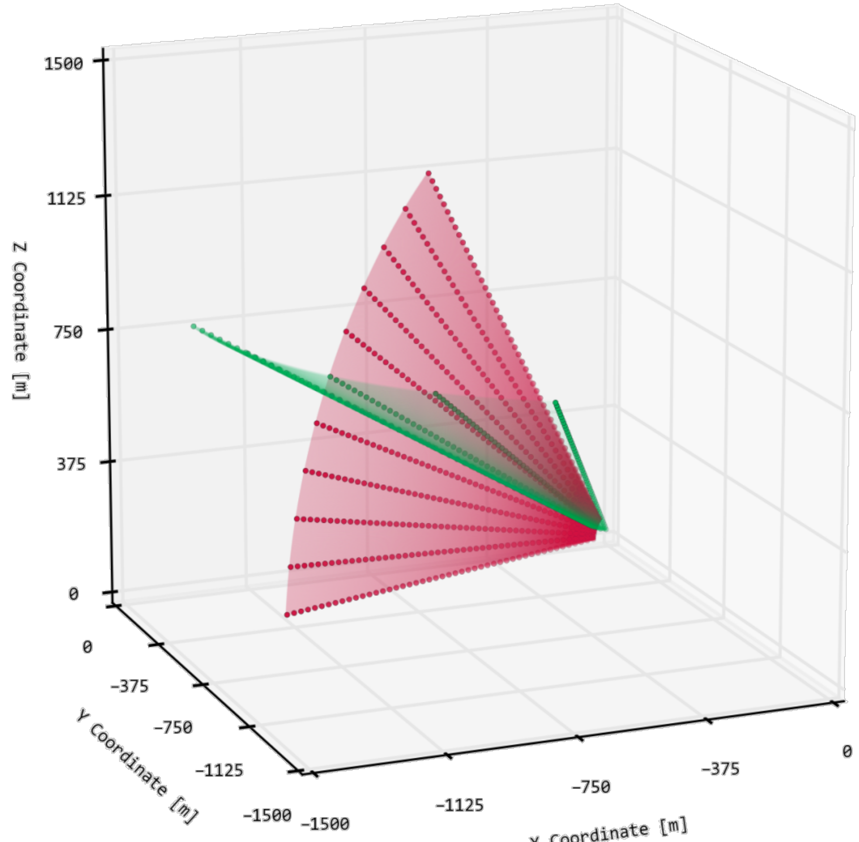
Hywind WTGs

3D Downwind Target

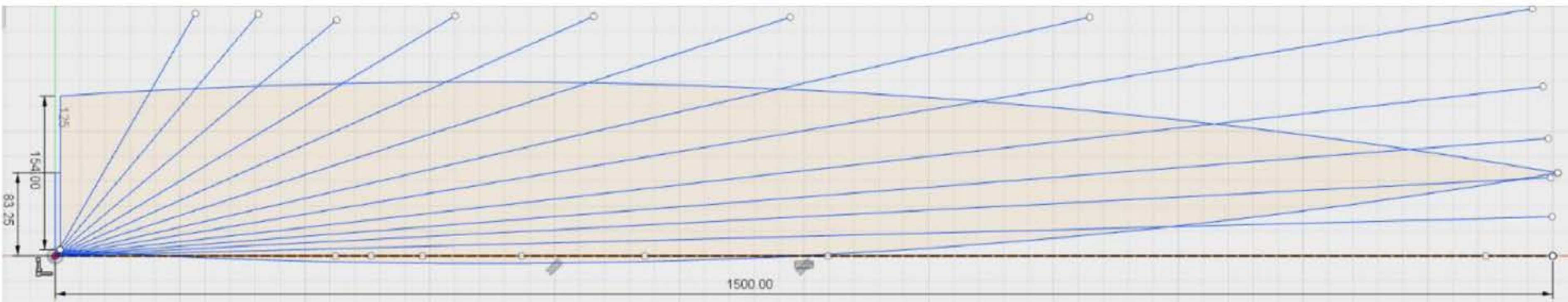
G128 Scan Geo

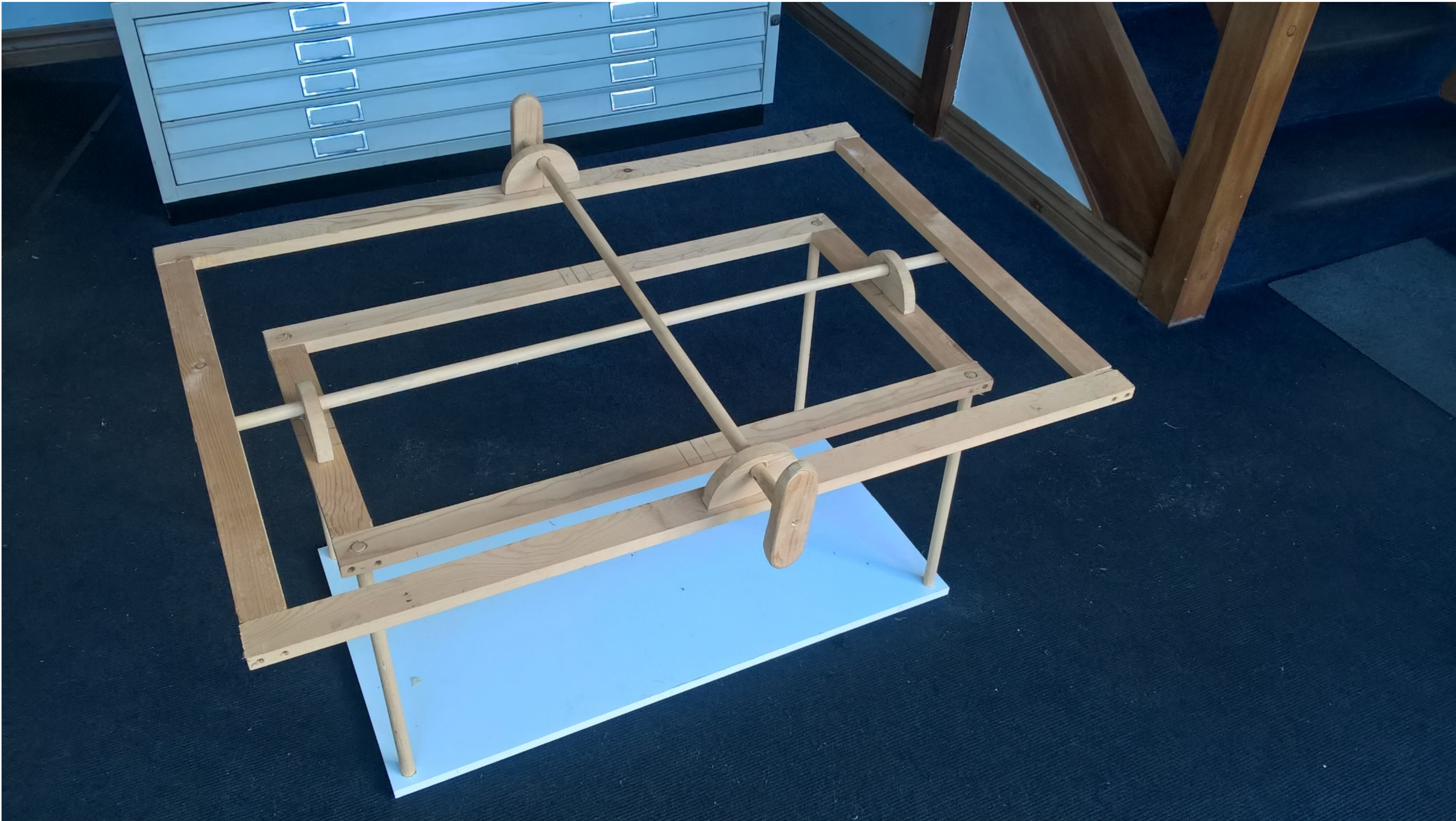
G128 Scan Geo

scanning lidar wake measurements at Hywind floating wind farm

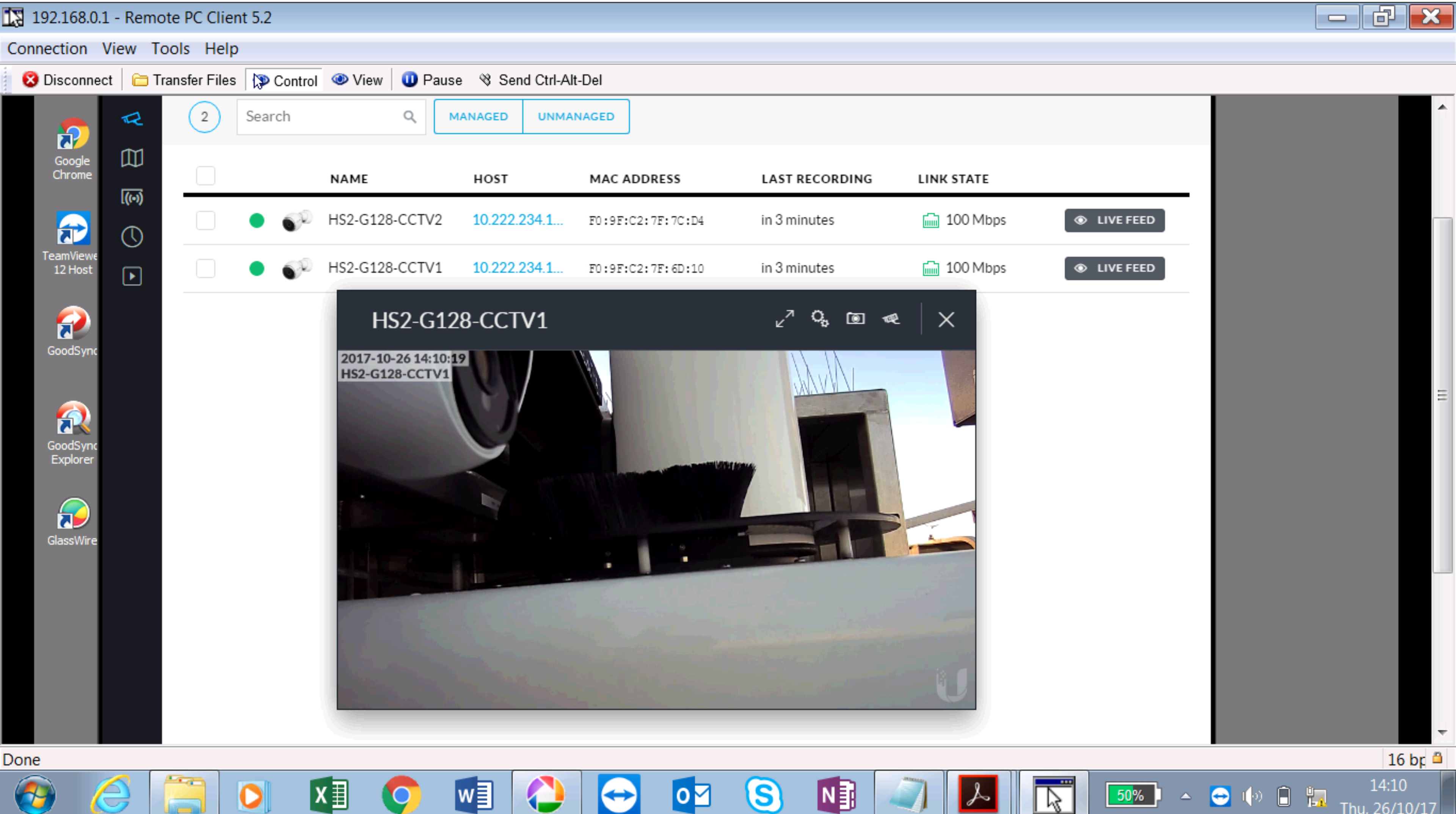


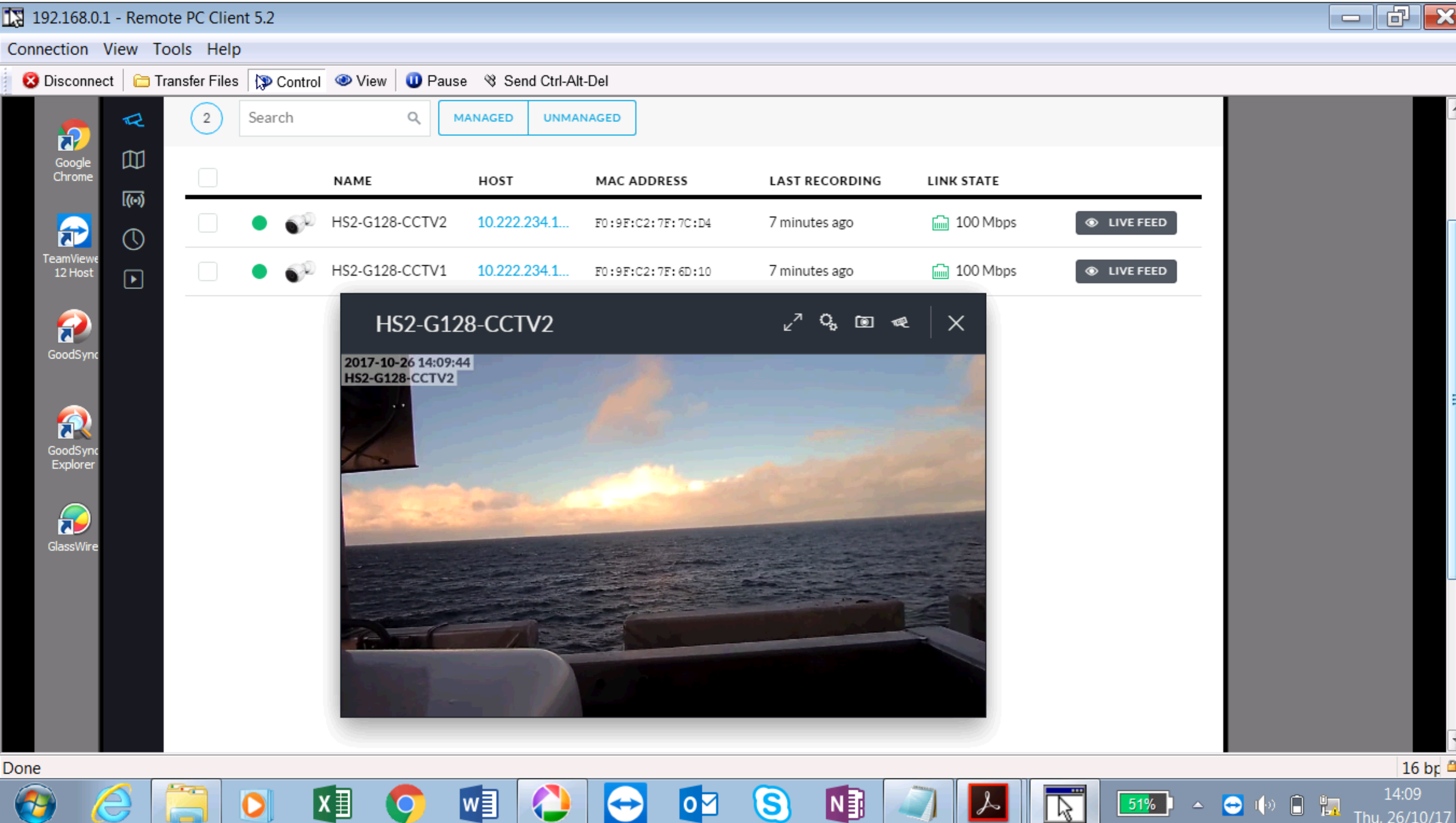
scanning lidar wake measurements at Hywind floating wind farm






Galion


192.168.0.1 - Remote PC Client 5.2
Connection View Tools Help
Disconnect
Transfer Files
Control
View
Pause
Send Ctrl-Alt-Del
Google Chrome
TeamViewer 12 Host
GoodSync
GoodSync Explorer
GlassWire
2
Search
MANAGED
UNMANAGED
NAME
HOST
MAC ADDRESS
LAST RECORDING
LINK STATE
HS2-G128-CCTV2
10.222.234.1...
F0:9F:C2:7F:7C:D4
in 3 minutes
100 Mbps
LIVE FEED
HS2-G128-CCTV1
10.222.234.1...
F0:9F:C2:7F:6D:10
in 3 minutes
100 Mbps
LIVE FEED
HS2-G128-CCTV1
2017-10-26 14:10:19
HS2-G128-CCTV1
Done
16 bp
50%
14:10
Thu, 26/10/17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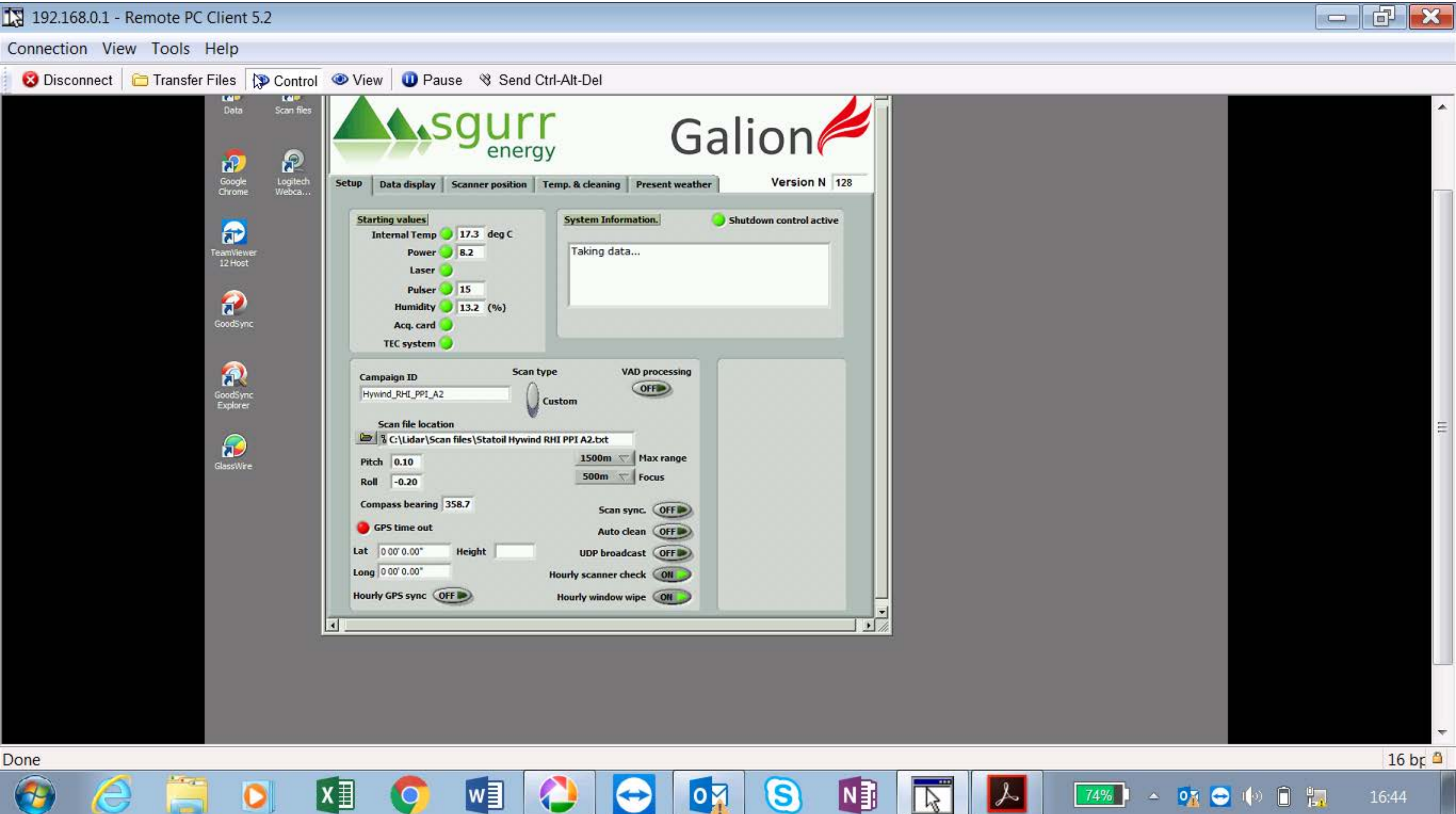
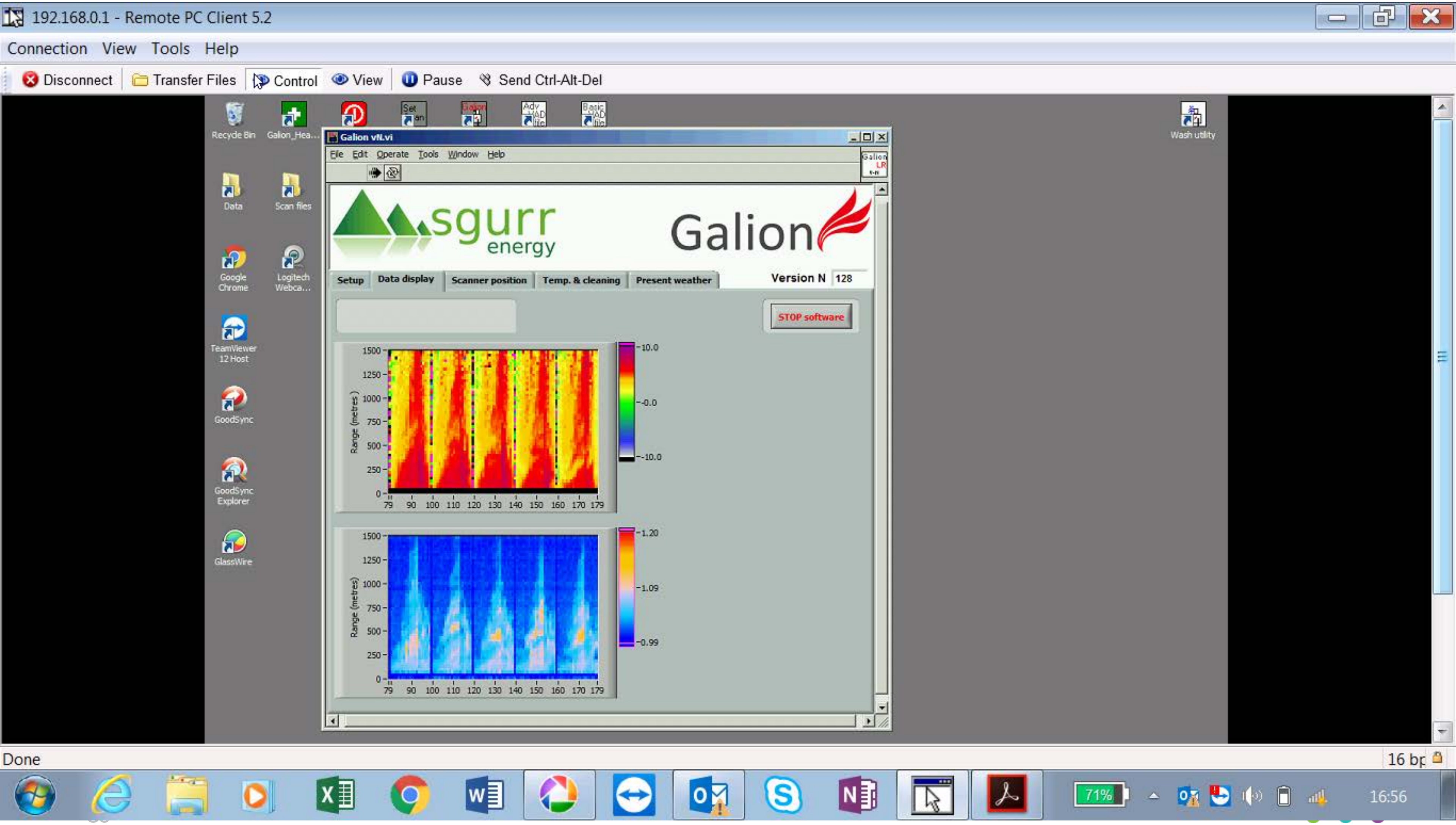
View
Pause
Send Ctrl-Alt-Del
Google Chrome
GoodSync
GoodSync Explorer
GlassWire
2
Search
MANAGED
UNMANAGED
NAME
HOST
MAC ADDRESS
LAST RECORDING
LINK STATE
HS2-G128-CCTV2 10.222.234.1... F0:9F:C2:7F:7C:D4 7 minutes ago 100 Mbps LIVE FEED
HS2-G128-CCTV1 10.222.234.1... F0:9F:C2:7F:6D:10 7 minutes ago 100 Mbps LIVE FEED
HS2-G128-CCTV2
2017-10-26 14:09:44
HS2-G128-CCTV2
Done
51%
14:09
Thu, 26/10/17


192.168.0.1 - Remote PC Client 5.2
Connection View Tools Help
Disconnect Transfer Files Control View Pause Send Ctrl-Alt-Del
Data
Scan files
Google Chrome
Logitech Webca...
TeamViewer 12 Host
GoodSync
GoodSync Explorer
GlassWire
sgurr energy
Galion
Setup
Data display
Scanner position
Temp. & cleaning
Present weather
Version N 128
Starting values
Internal Temp 17.3 deg C
Power 8.2
Laser
Pulser 15
Humidity 13.2 (%)
Acq. card
TEC system
System Information.
Shutdown control active
Taking data...
Campaign ID
Hywind_RHI_PPI_A2
Scan type
Custom
VAD processing
OFF
Scan file location
C:\Lidar\Scan files\Statoil Hywind RHI PPI A2.txt
Pitch 0.10
Roll -0.20
1500m Max range
500m Focus
Compass bearing 358.7
GPS time out
Scan sync. OFF
Auto clean OFF
UDP broadcast OFF
Hourly scanner check ON
Hourly window wipe ON
Lat 0 00' 0.00"
Height
Long 0 00' 0.00"
Hourly GPS sync OFF
Done
16 bp
74%
16:44


192.168.0.1 - Remote PC Client 5.2
Connection
View
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Send Ctrl-Alt-Del
Recycle Bin
Galion_Hea...
Data
Scan files
Google Chrome
Logitech Webca...
TeamViewer 12 Host
GoodSync
GoodSync Explorer
GlassWire
Wash utility
Galion vN.vi
File
Edit
Operate
Tools
Window
Help
sgurr
energy
Galion
Setup
Data display
Scanner position
Temp. & cleaning
Present weather
Version N
128
STOP software
Range (metres)
1500
1250
1000
750
500
250
0
79
90
100
110
120
130
140
150
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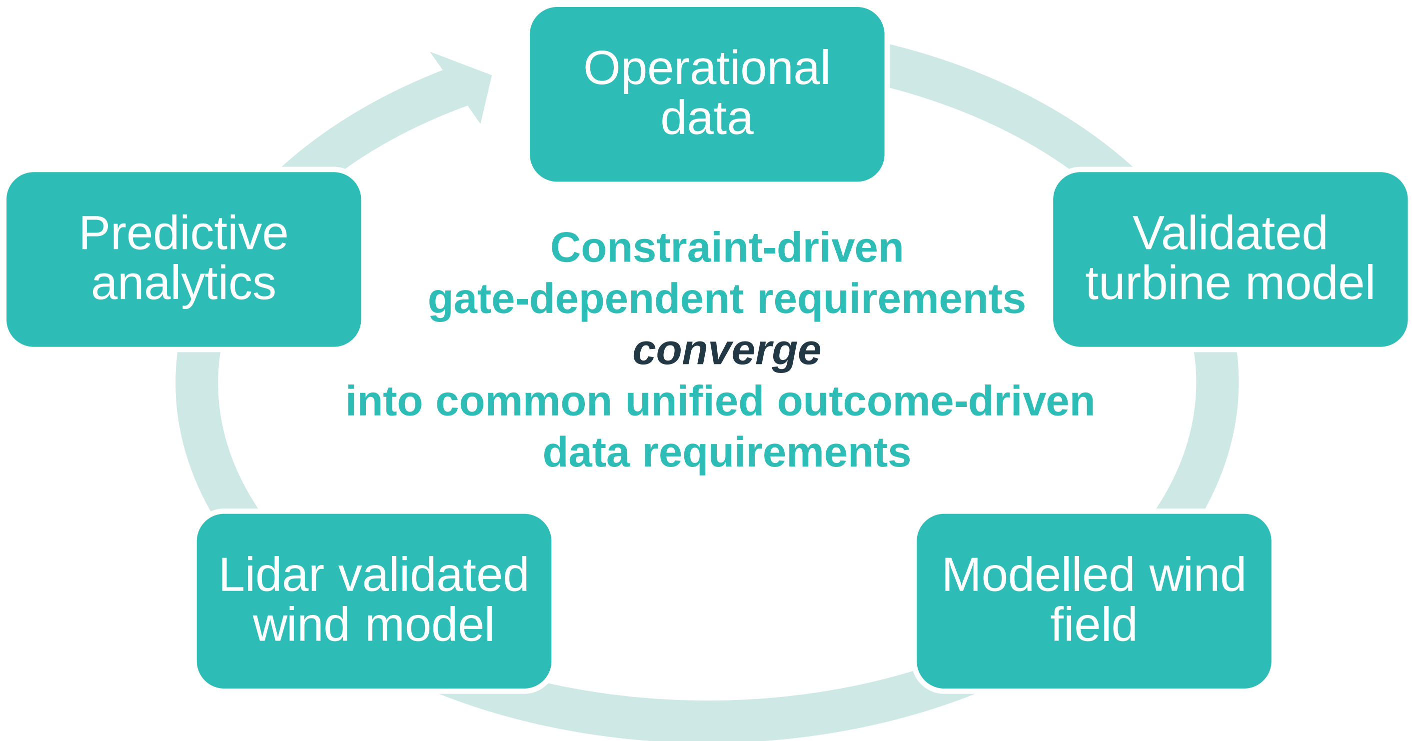
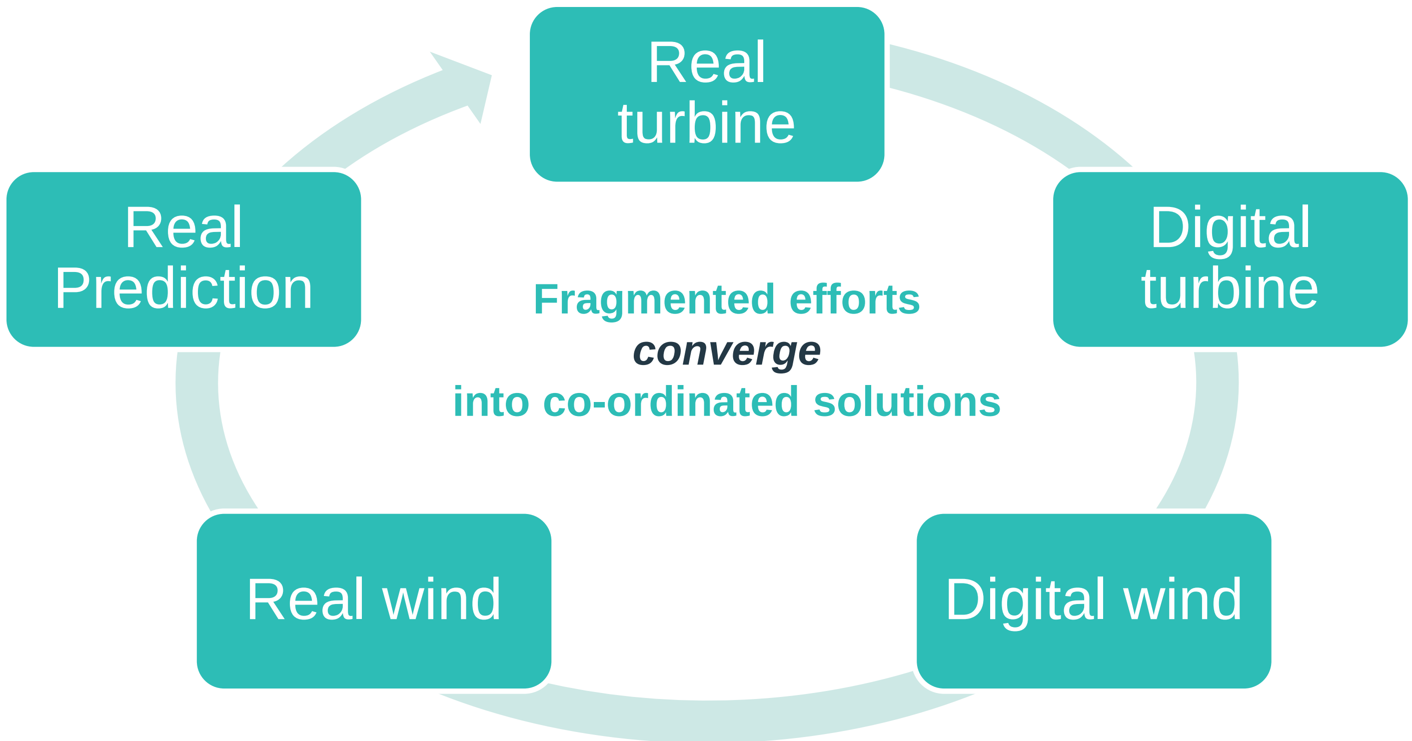
170
179
10.0
-0.0
-10.0
1.20
1.09
0.99
Done
16 bp
71%
16:56

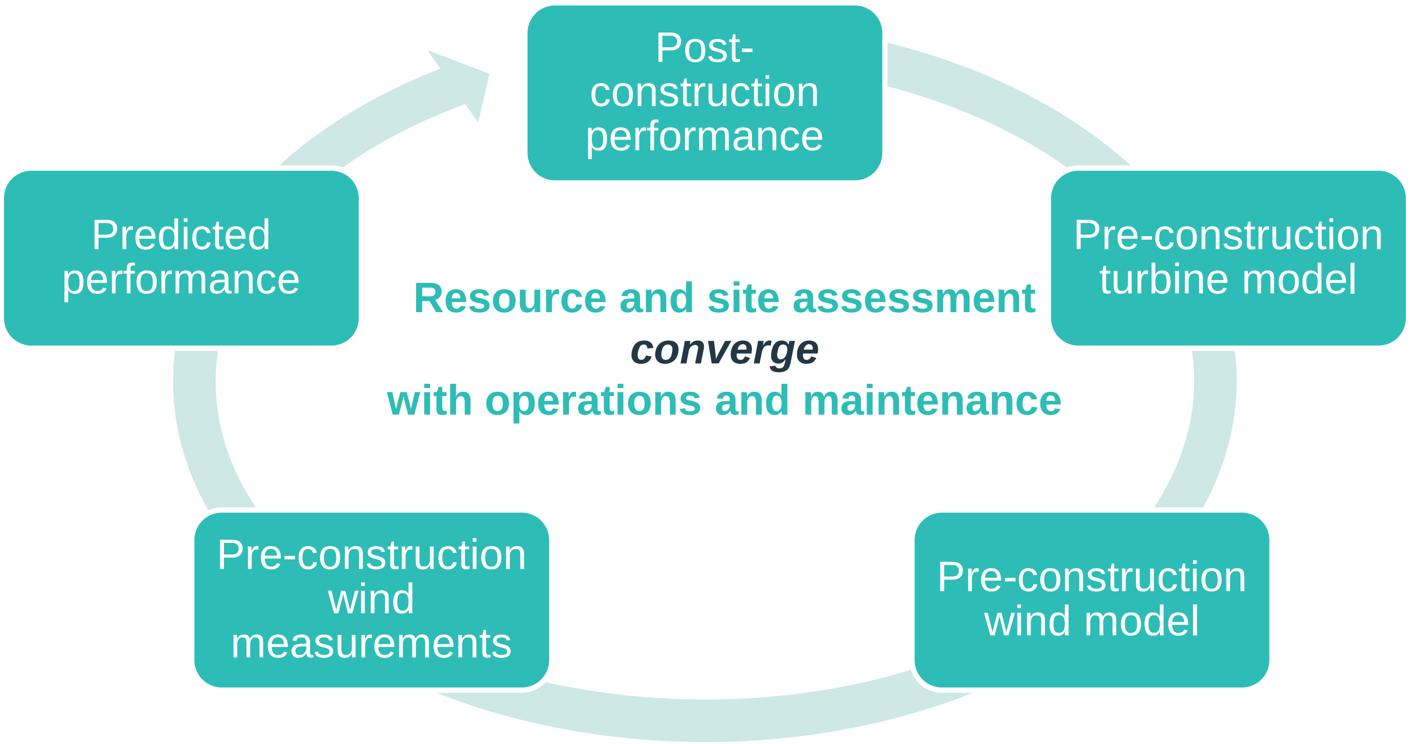
The digital convergence opportunity



The digital convergence opportunity



The digital convergence opportunity



asset optimisation

digital convergence means you don’t have to wait for the consequences of suboptimal operation to begin to optimise your assets …

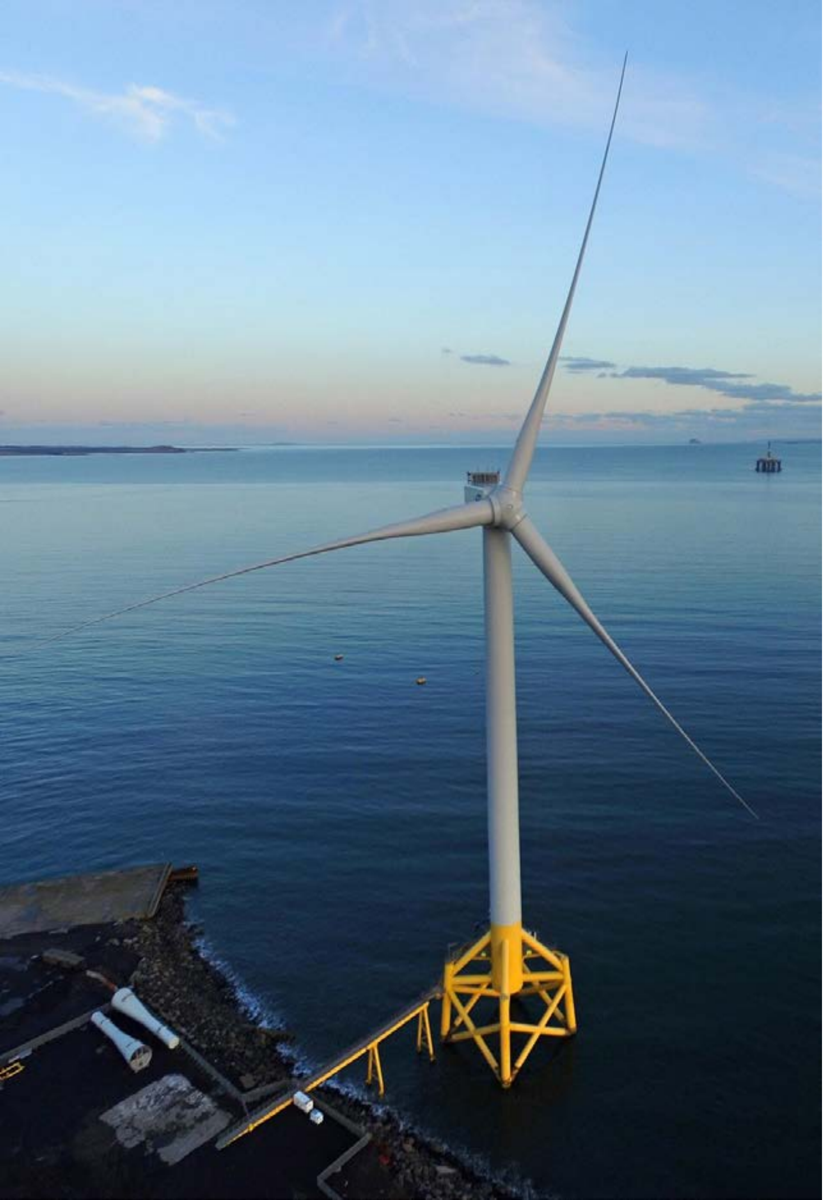
… aligned perspectives, shared understanding, common objectives and unified data requirements mean you can start optimisation from ***day one***

Tom Clark, Technical Director, Octue

Digital Twins:

Physics, AI and thorny commercial problems

Dr Tom Clark,
Technical Director Octue
30 January 2018



Octue · Catapult Offshore Renewable Energy · Innovate UK

Simulation for Asset Life Extension (The SALE Project)

LiDAR in turbulence analysis

Unsteady loading from environmental turbulence

Technical feasibility for use of AI in wind farm control

Digital Twin

noun

A computational representation of a physical asset, which uses AI (with operational data from that and similar assets), or simulation (physical modeling), or both, to provide a predictive model of performance or behaviour."

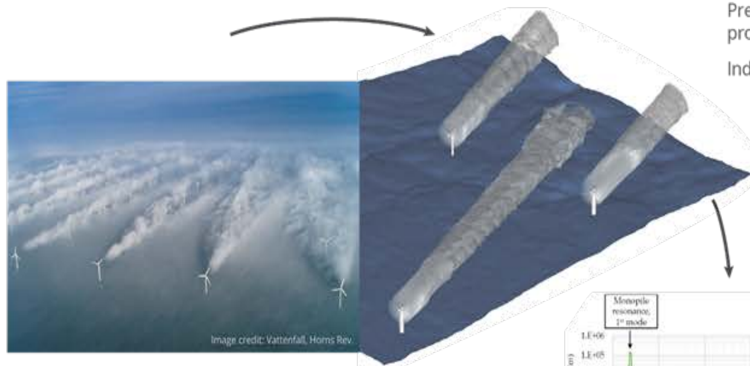
This example of a Digital Twin integrates all the components necessary to understand the trade-off between O&M cost and production revenue in wind farms. This enables safe, effective whole-farm control and informs strategic decision making.

An app for each component in the cycle, and the pipeline of data between them, is managed by Octue.

Digital Twin (Octue TurbineGRID):

Aerodynamic and control model.
Predicts turbine interactions, production and fatigue loadings.

Independently validated with OREC.



Real Operational Data

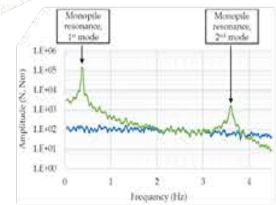
Take survey, Met Mast, LiDAR, component sensor and production data from a site.

It will be used to continually validate the digital twins against real-world unsteady loading data.

Easily manage data schema

Establishing common formats for data files and configuration parameters takes huge engineering overhead.

Octue platform cuts this overhead, with consistent, shareable, schema spec.



Predict and Optimise

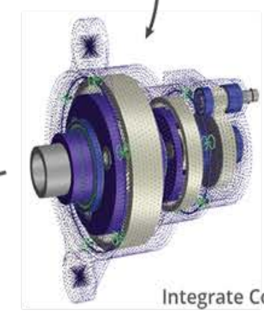
The twin delivers enhanced metrics for strategic decision making.

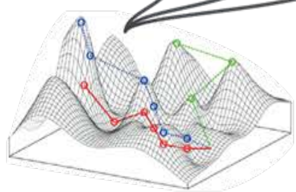
The twin is used to build a recom-mendation system (for array control) to maximise profit.

Create analysis pipelines

Pipelining data between apps is made easy with smart data manifesting and tagging.

Universally Unique IDs make everything auditable.





Recommendation Engine

An AI-based model, trained using the validated digital twins and coupled with a global optimiser.

Provides lightning-fast analysis and recommendations for changes in farm-wide control and operational strategy, to maximise profit.

Cost Models

Add models for O&M costs and production revenue. These determine profitability and Levelised Cost of Energy.

Accept production, lifetimes, O&M intervals and costs from the digital twins.

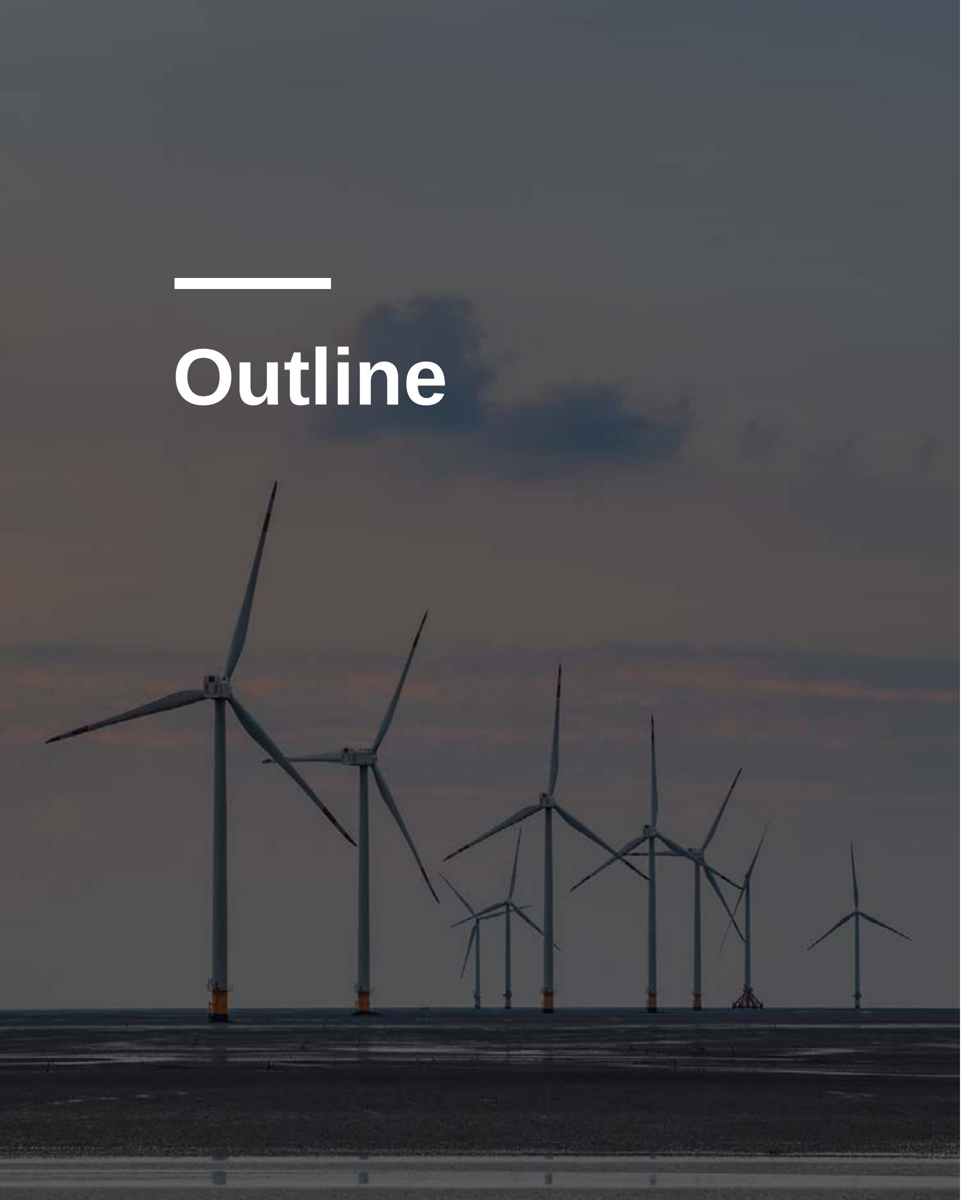
Integrate Component Digital Twins

Add custom physics and/or AI based models at component or substructure levels.

For example, Romax Insight (TM) analyses and optimises drivetrain lifetimes, O&M intervals and costs.

https://www.octue.com/content/documents/1/octue-whitepaper-wind-farm-twin-a3.pdf

Outline



[Architecture]()

[Physics vs. AI?]()

[Collaboration & permissions]()

Architecture
01

Many stakeholders means many submodules.

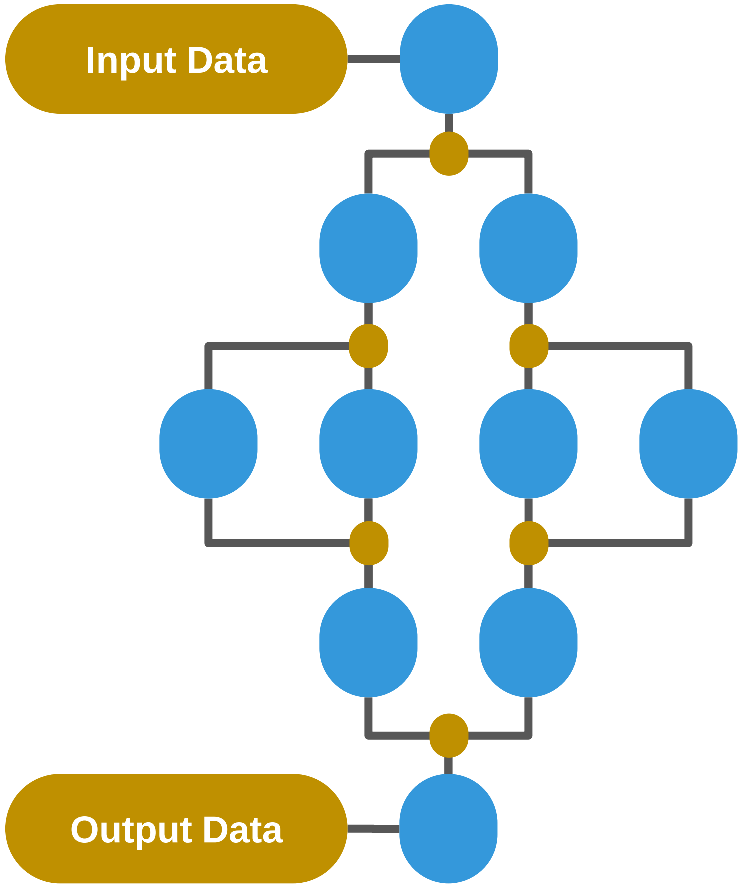
Keeping confidential data siloed becomes complex. And AI isn't generalisable, so twins can't be reused.

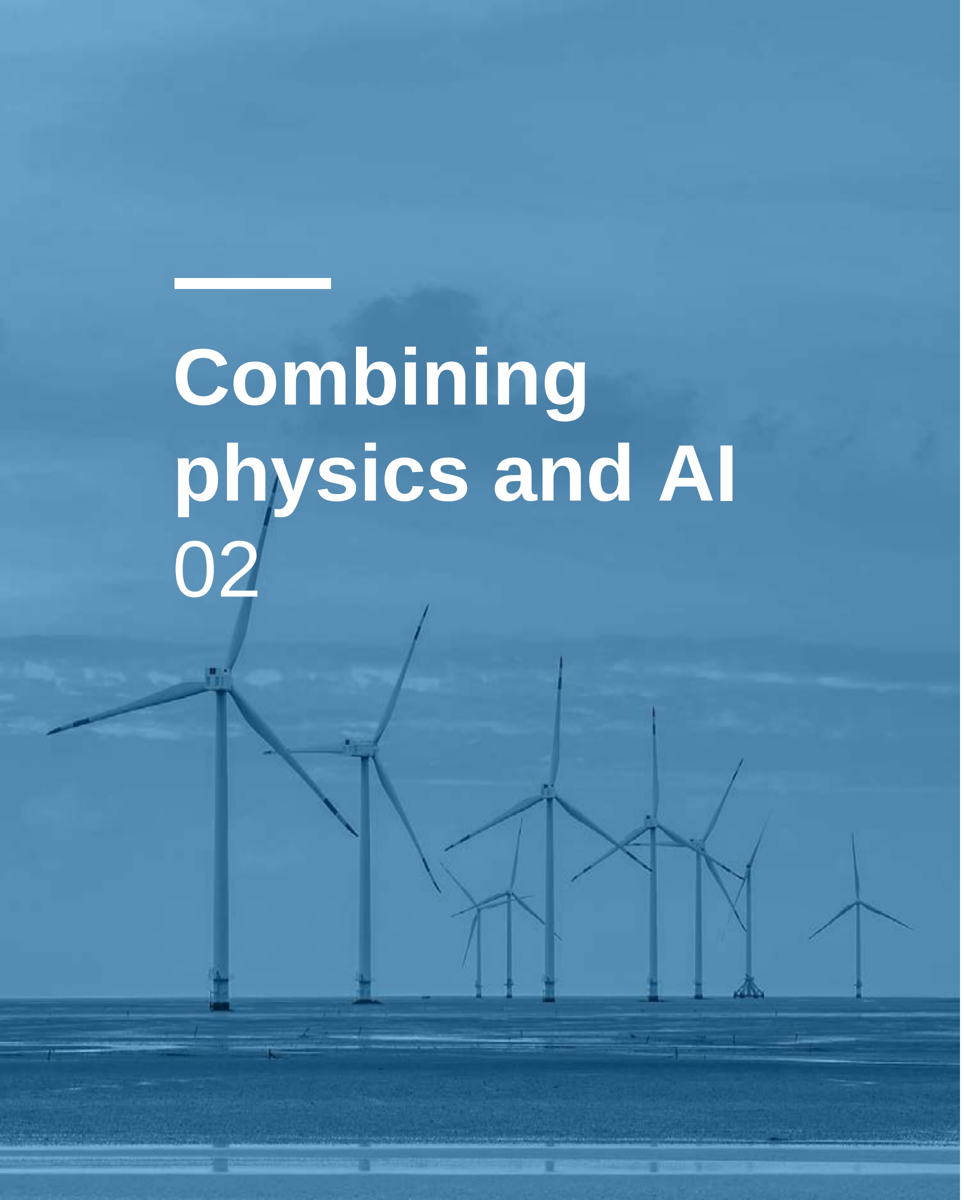
Component hierarchy

Twins within twins within twins

Each managed by a single stakeholder, with its own siloed data

Modules can be swapped to overcome generalisation problems





Combining physics and AI
02

Big data often isn’t that big.

With extreme high dimensional problems, AI just can’t work without trillions of data points.

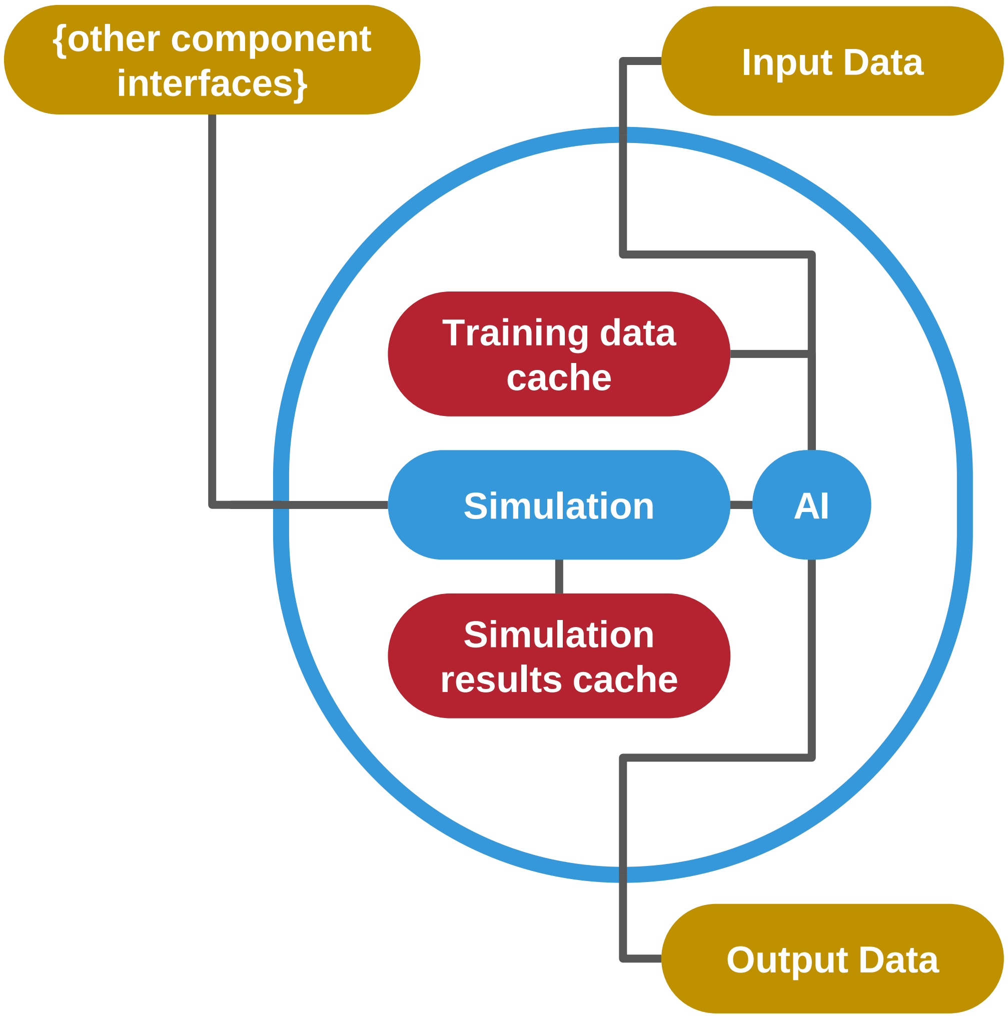
Component twin

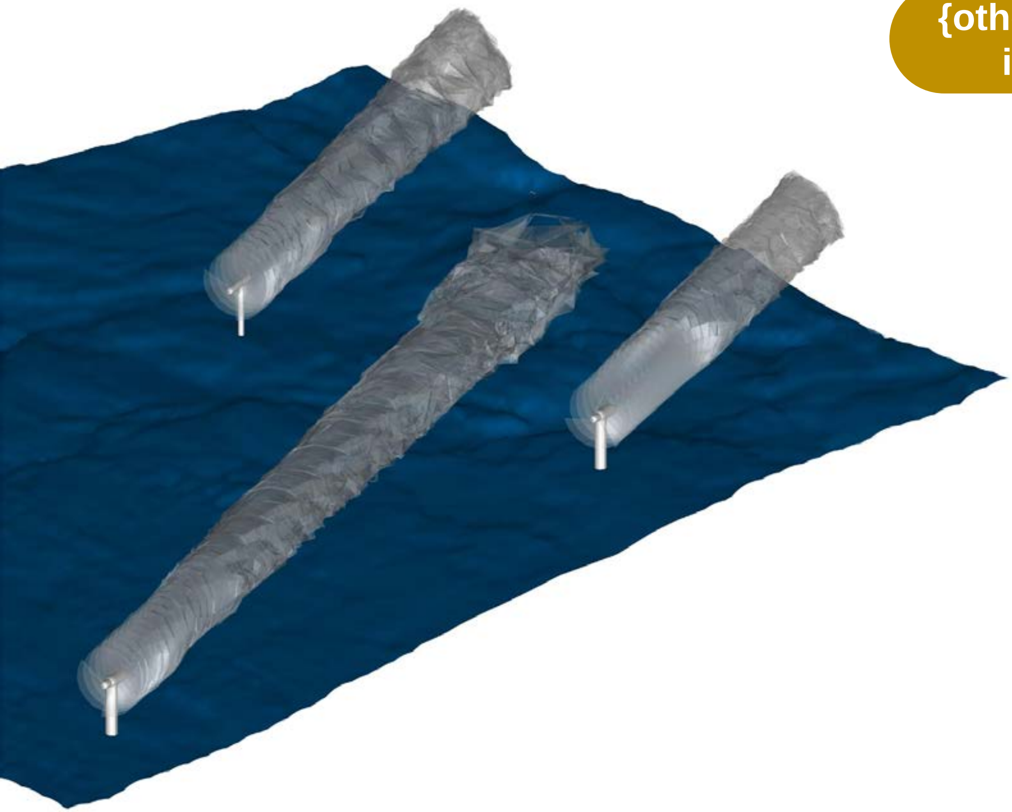
A re-usable module

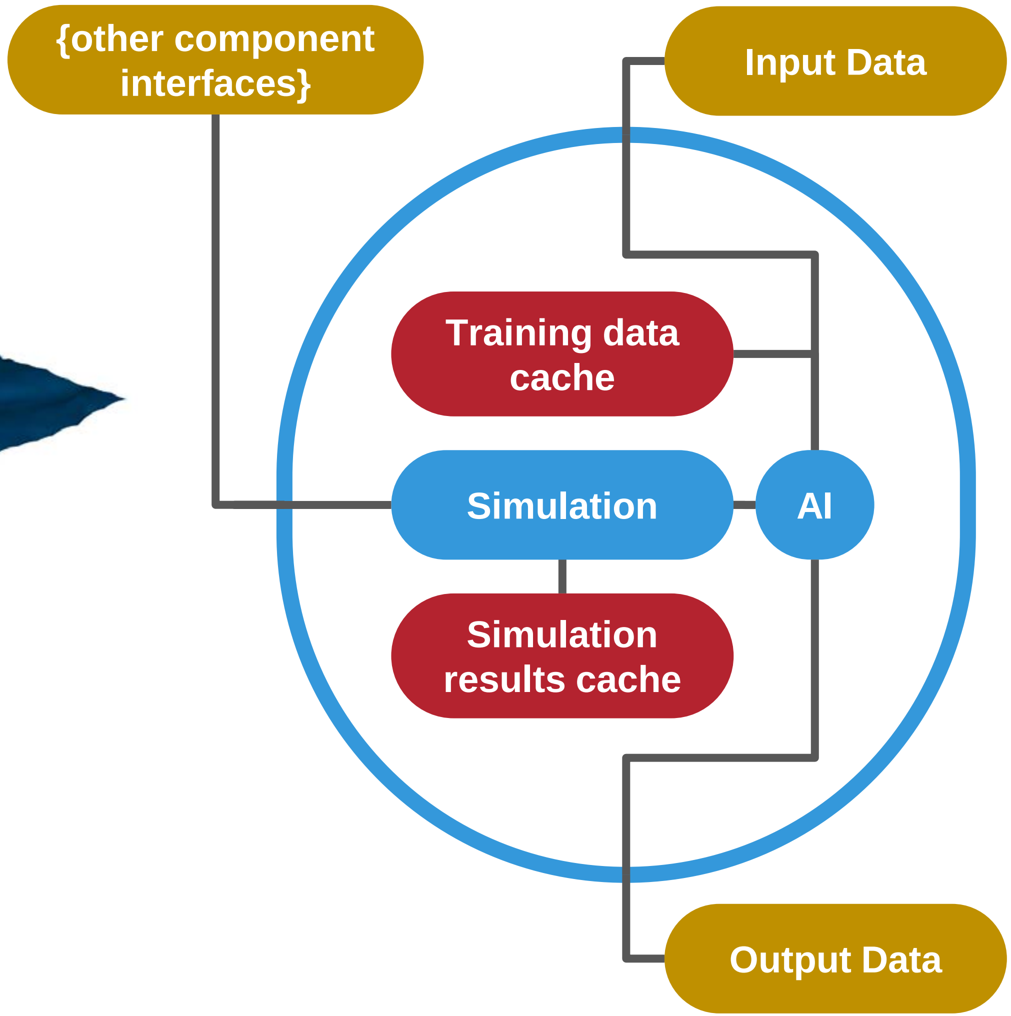
Representing a physical entity

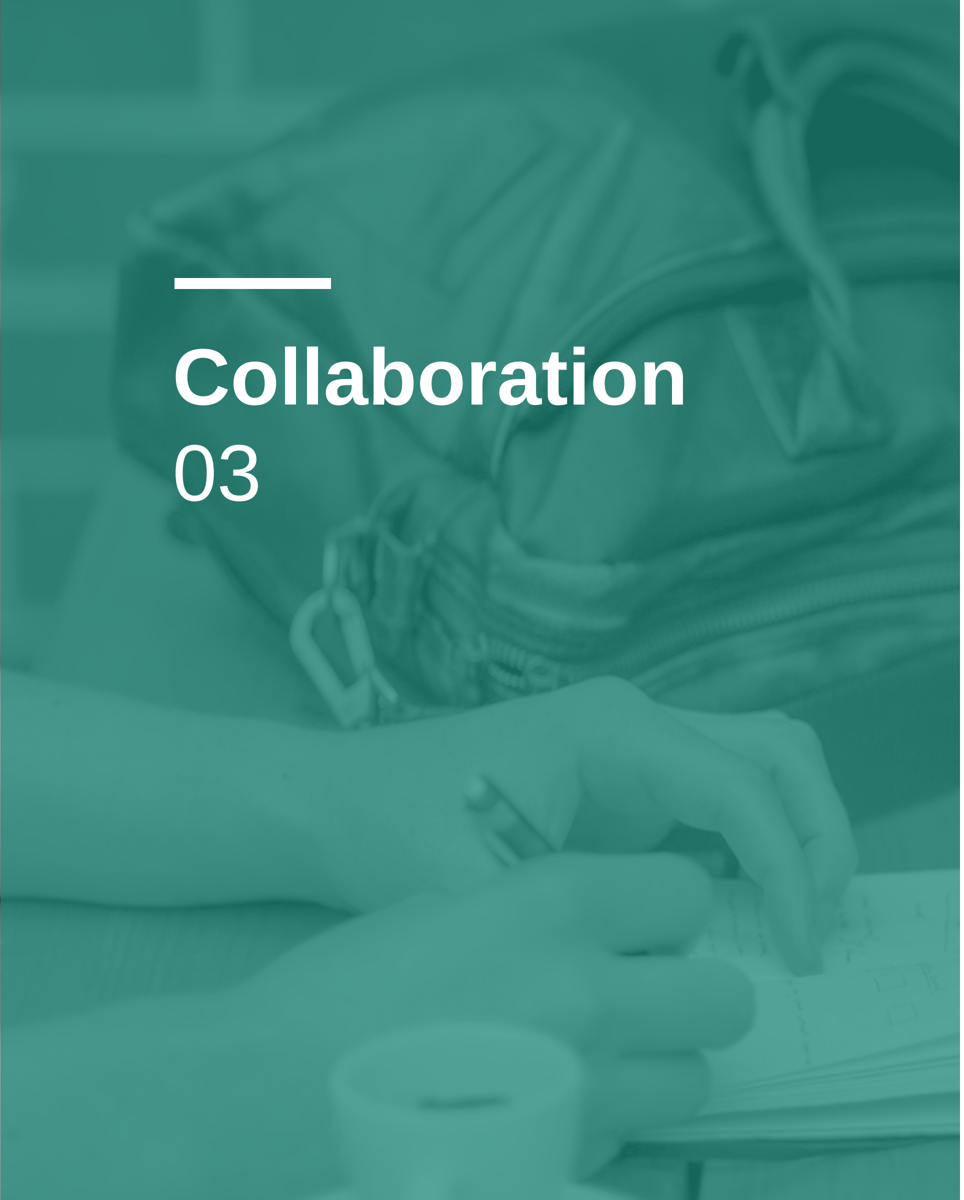
With its own, defined interface

Maintains isolated data / caches






{other component interfaces}
Input Data
Training data cache
Simulation
AI
Simulation results cache
Output Data



Collaboration
03

Collaboration is hard.

Understanding data requirements, exchanging and formatting data is a huge part of an engineer's day.

Component schema

Define inputs and outputs

Check and validate data

- http://json-schema.org

Use AI to parse data automatically!

Auto-generate docs and web APIs

```json
{
    "properties": {
        "max_iterations": {
            "description": "Maximum number of iterations used
            "type": "integer",
            "minimum": 2,
            "default": 64
        },
        "type": {
            "description": "Type (jpeg or png) of the image t
            "type": "string",
            "enum": ["jpg", "png"],
            "default": "png"
        },
        "x_range": {
            "description": "The x_min to x_max range of space
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    },
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Recap

1

Architecture

A hierarchy of components, allows assignment of responsibility, data siloing and generalisation

2

Physics and AI

Individual twins built from a simulation or analysis, with a thin AI wrapper trained from operational data.

3

Collaboration

Using schema specs, we can have all components talk to one another, and automatically process data.


Octue
monitor, predict, optimise
@octue

Wayne Mulhall,

Regional Director, MHI Vestas Offshore Wind

Innovation in Operations

Scottish Offshore Renewables - 2018

Wayne Mulhall

Agenda

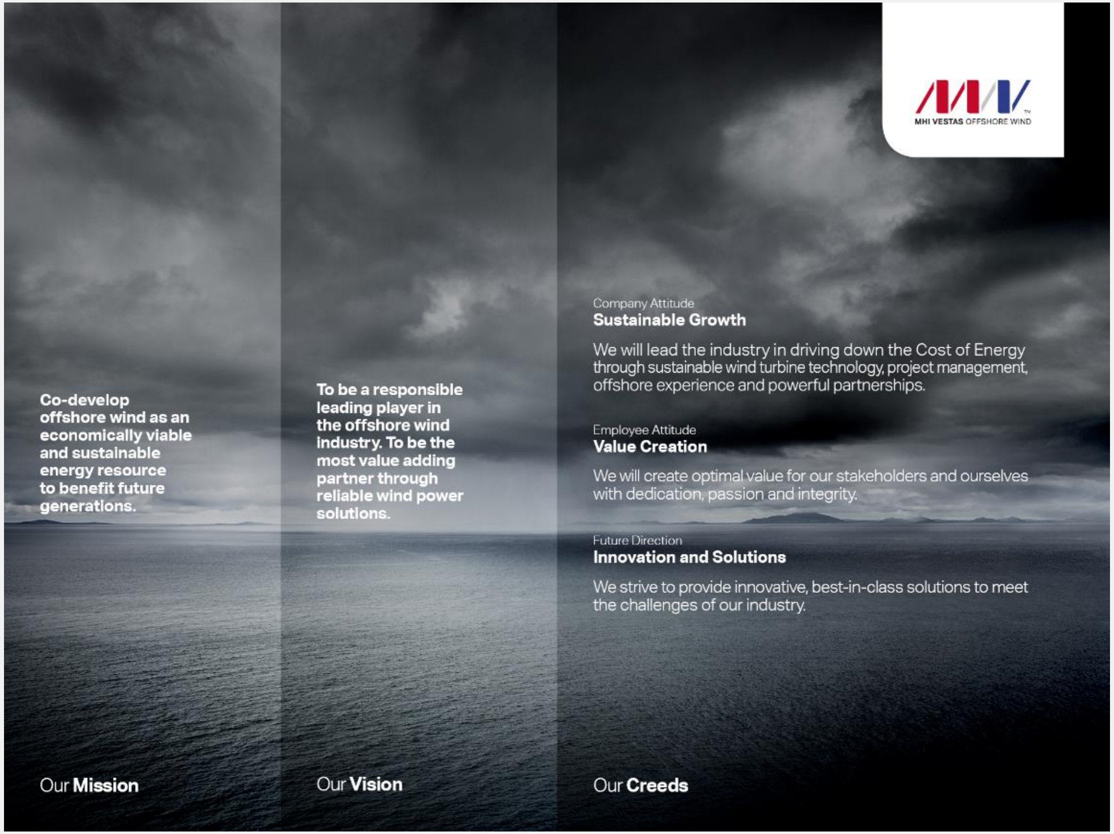
1. **Introduction**
2. **Offshore – Our World – Setting the scene**
3. **Innovation in our Creeds**
4. **Innovation in Technology**
5. **Innovation in Operations – HSE First**
6. **Innovation in Operations – Its in the detail**
7. **Q&A**

Innovation can be defined simply as a "new idea, device or method". However, innovation is often also viewed as the application of better solutions that meet new requirements, unarticulated needs, or existing market needs. Wikipedia

MHI VESTAS OFFSHORE WIND™

Innovation in Operations

Its in our DNA



MHI Vestas market leading technology driving rapid cost reduction

9.5 MW certified for IEC 1B conditions
Increased AEP of 11% compared to 8 MW

- 9.5 MW upgrade within margins of the current design, limited upgrades.
- Validated by continuous testing.
- Progress toward production:
  - Power Curve Verification Complete
  - Loads Verification Measurements Complete
  - 1st Gearbox assembled and under test
  - Gearbox HALT test agreement reached
- 1.8 GW of preferred supplier announcements
- MHI Vestas will continue to optimise the platform to support lowest Cost-of-Energy.

DNV·GL

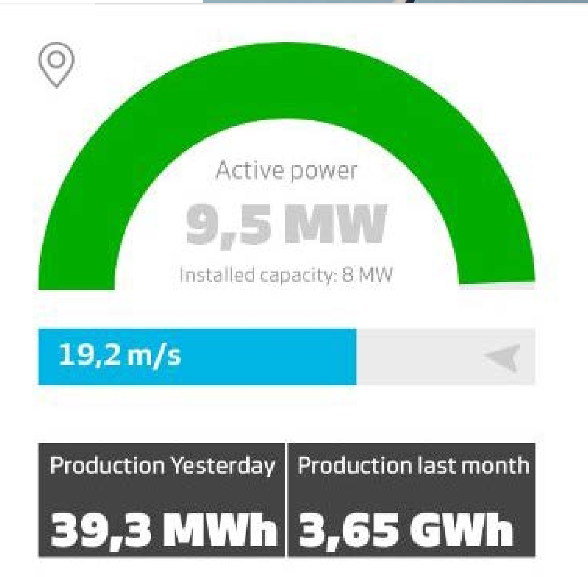
PROTOTYPE CERTIFICATE

Issued for:
V164-8.0/9.5 MW prototype
Specified in Annex 1

Issued to:
MHI Vestas Offshore Wind A
Dusager 4
DK-8200 Aarhus N

According to:
BEK 73:2013-01 Bekendtgørelse om tek
certificeringsordning for vindmøller
using
DNVGL-SE-0074:2014-12 Type and com
of wind turbines according to IEC 61400

Outstanding issues are listed in Annex 2.



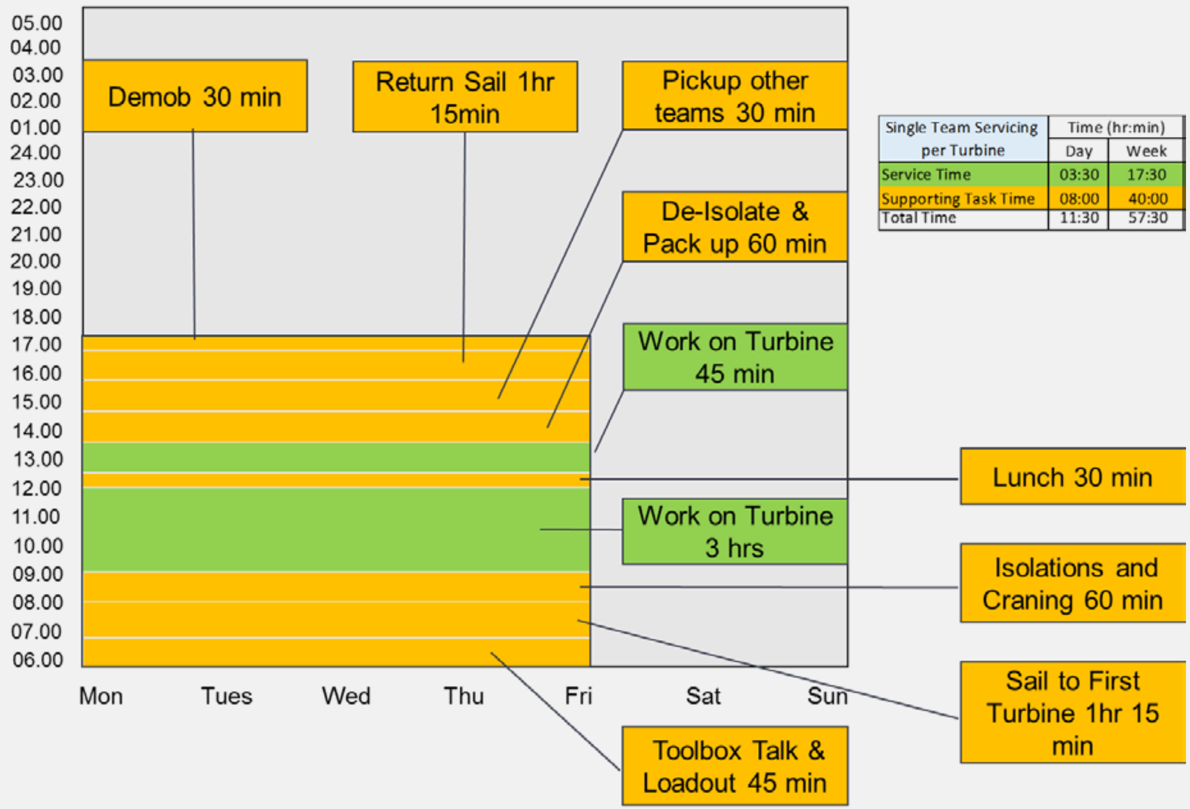
MHI VESTAS OFFSHORE WIND™

Innovation in Operations

The Advanced First Aid course builds on the skills acquired during the GWO Basic Safety Training First Aid course. It enables rapid intervention in the event of severe or life threatening trauma or illness by equipping technicians with the skills required to quickly stabilise a casualty. It also allows personnel to effectively monitor the casualty until specialist medical treatment arrives or they can be safely moved to appropriate medical facilities

MHI VESTAS OFFSHORE WIND™

Innovation in Operations – Its in the detail



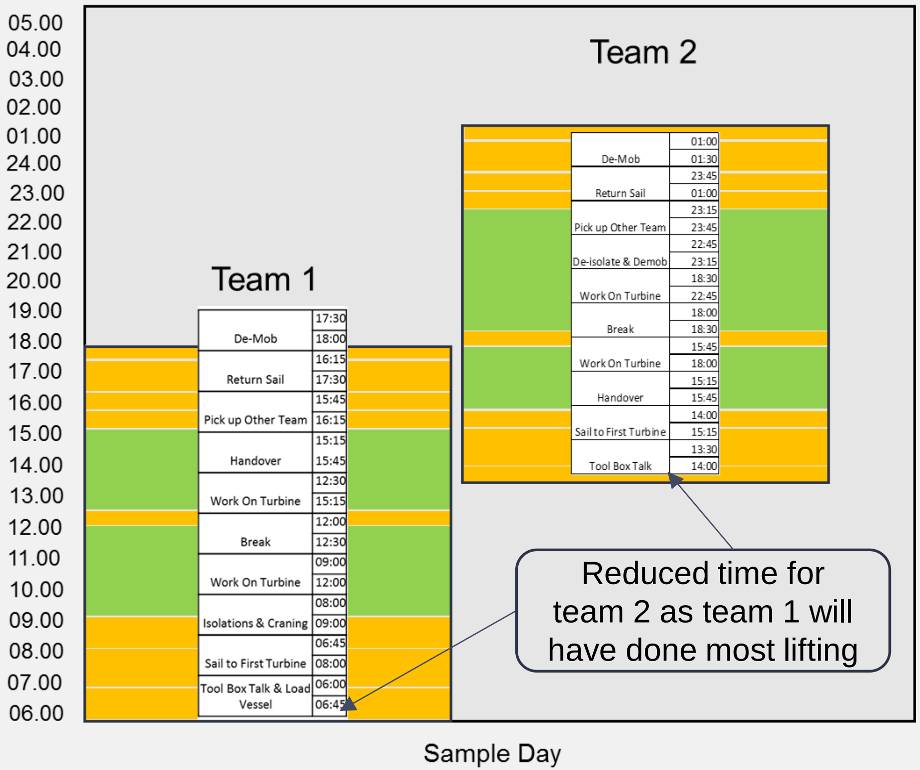
Single Team Servicing per Turbine	Time (hr:min)	
	Day	Week
Service Time	03:30	17:30
Supporting Task Time	08:00	40:00
Total Time	11:30	57:30

Comment

Poor ratio of Supporting Task time to Service time

In this model at least 2 hours / day can be lost during Isolations & Craning + De-Isolate & Packing Up. This could equate to 10 hours downtime over a 5 day week.

Innovations in Operations – Its in the detail



Sample Day

Team 1	Time (hr:min)	
	Day	Week
Service Time	05:45	28:45
Supporting Task Time	06:15	31:15
Total Time	12:00	60:00

Team 2	Time (hr:min)	
	Day	Week
Service Time	06:30	32:30
Supporting Task Time	05:30	27:30
Total Time	12:00	60:00:00

Total Team Working	Time (hr:min)	
	Day	Week
Total Service Time	12:15	61:15
Total Supporting Task Time	11:45	58:15
Total Time	24.00	119:30

Comments

In this model the team time on turbine nearly doubles / shift through efficiencies in reduced supporting tasks and time.

Single Team Servicing per Turbine	Time (hr:min)	
	Day	Week
Service Time	03:30	17:30
Supporting Task Time	08:00	40:00
Total Time	11:30	57:30


Let’s move the horizon.
Q & A

Chris Hill, Operational Performance Director, Offshore Renewable Energy Catapult

Paul Grimshaw, Software Systems Architect, Sennen

Peter Clive, Senior Scientist, Wood

Tom Clark, Technical Director, Octue

Wayne Mulhall, Regional Director, MHI Vestas Offshore Wind

IN ASSOCIATION WITH

CATAPULT
Offshore Renewable Energy

scottish renewables

OFFSHORE WIND CONFERENCE, EXHIBITION & DINNER

29 & 30 JANUARY 2018 **GLASGOW**

areg Aberdeen Renewable Energy Group

Crown Estate Scotland
Oighreachd a' Chrùin Alba

ECOSSE Subsea Systems
...because we think differently

HIE
Highlands and Islands Enterprise
Iomairt na Gàidhealtachd 's nan Eilean

INVEST IN FIFE

James Fisher Marine Services

NewWaves Solutions
Marine & Environmental Services

Planning for Success:
A Consenting Framework Fit for Purpose?

Adam Ezzamel, Project Director – European Offshore Wind Deployment Centre, Vattenfall

Graham Black, Director, Marine Scotland

Robin Hutchison, Partner, CMS Cameron McKenna Nabarro Olswang LLP

Dr Richard Wakefield, Principal Marine Scientist, Atkins

Catarina Rei, Offshore Consents Manager, EDP Renewables

Lis Royle, Consents and Stakeholder Manager, and **Jonathan Wilson,** Lead Consent and Stakeholder Manager, SSE Renewables

Graham Black

Director, Marine Scotland

Robin Hutchison

Partner, CMS Cameron McKenna Nabarro Olswang LLP

Your World First

C/M/S/ Law . Tax

Offshore Wind Consenting in 2017

Robin Hutchison, Partner, CMS

Tuesday 30 January 2018

2017: The Whole of the Law

1. New EIA Regulations
2. Legal Challenges
3. Optimising Consents
4. More new EIA Regulations
5. Floating Offshore Wind

…and the Planning (Scotland) Bill

(1) New EIA Regulations

- Directive 2014/52/EU of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment
- Required to be implemented by Member States by 16 May 2017
- Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017
- Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017
- The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017
- Some key changes, but much staying the same

(1) New EIA Regulations

1. Front-loaded screening
2. Binding scoping opinion
3. New assessment topics
4. Reasoned conclusion
5. Increased emphasis on mitigation and monitoring

(1) New EIA Regulations

Monitoring measures

22.—(1) Where an EIA application is determined by the Scottish Ministers and the decision is to grant Electricity Act consent, the Scottish Ministers must consider whether it is appropriate to require monitoring measures to be carried out.

(2) When considering whether to require monitoring measures to be carried out, and the nature of any such monitoring measures, the Scottish Ministers must consider—

[…]

(c) if monitoring measures are to be required, whether provision should be made to require appropriate remedial action

(2) Legal Challenges

(2) Legal Challenges

Ruffling Feathers

The RSPB's legal challenge over an offshore wind farm is anti-democratic

The Royal Society for the Protection of Birds (RSPB) is stepping outside its charitable brief in mounting a legal challenge to Scottish ministers over their decision to approve the Firth of Forth offshore wind farm. It opposes the development, not because it believes it would kill thousands of seabirds, but because it says the basis on which the government reached its decision is wrong.

In effect it is seeking to oppose the rights of parliament in environmental matters and give them to the courts instead. The charity has lost that argument at the Inner House of the Court of Session — the highest court in the land — and now intends taking it to the Supreme Court in London, seeking leave to appeal against the decision. It is likely to receive a dusty answer from judges there but the more serious question is why it is spending thousands of pounds, both of its members' subscriptions and public funds (for it receives government money as well), to take on a political issue.

The RSPB is a charity set up to protect birds. It operates — or should do — within the normal parameters of the law, and is entitled to raise any issue if it believes that bird life is at risk. It would of course be justified in objecting to a wind farm if it believed that it lay in the flight path of wild birds — perhaps on their migratory route — and could produce hard evidence to show that many birds would be harmed. In this case the research conducted by the highly respected British Trust for Ornithology on behalf of the Neart na Gaoithe wind farm off the east coast of Scotland has determined that the damage would be minimal. By reducing the original number of turbines to 64, the estimate is that perhaps a hundred gannets a year might suffer.

The RSPB does not directly challenge that, but argues that the scheme is the thin end of a larger wedge; that other wind farms may be approved in the area; and that ministers did not take these wider issues into account when they reached their decision. "Our concerns with the manner in which Scottish ministers took their decisions in 2014 remain undiminished," the RSPB's statement said yesterday. In effect it wishes to persuade the Supreme Court to rewrite the planning process to give the RSPB the role of a statutory adviser to the Scottish government, and to put the courts rather than parliament in the role of decision-maker.

In dismissing that line of argument, Lord Carloway, the lord president of the Court of Session, said: "The decision is one made by [the Scottish government] who operate in a political context, albeit constrained by the environmental and regulatory regime."

Quite why the RSPB thinks he is wrong, and quite how it thinks its action reflects the public interest, is hard to understand. What is clear, however, is that nothing in the charitable guidelines within which it operates sanctions this kind of campaigning. The government is in favour of green energy; it backs offshore wind farms because they reduce carbon emissions; it believes that they provide jobs and are an important boost to the Scottish economy.

If the Scottish people do not believe any of that, they have the right to make their views known at the ballot box. What is not acceptable is for an unelected body, unaccountable to the public, to use the courts as its alternative to the normal democratic procedures of the land.

(2) Legal Challenges

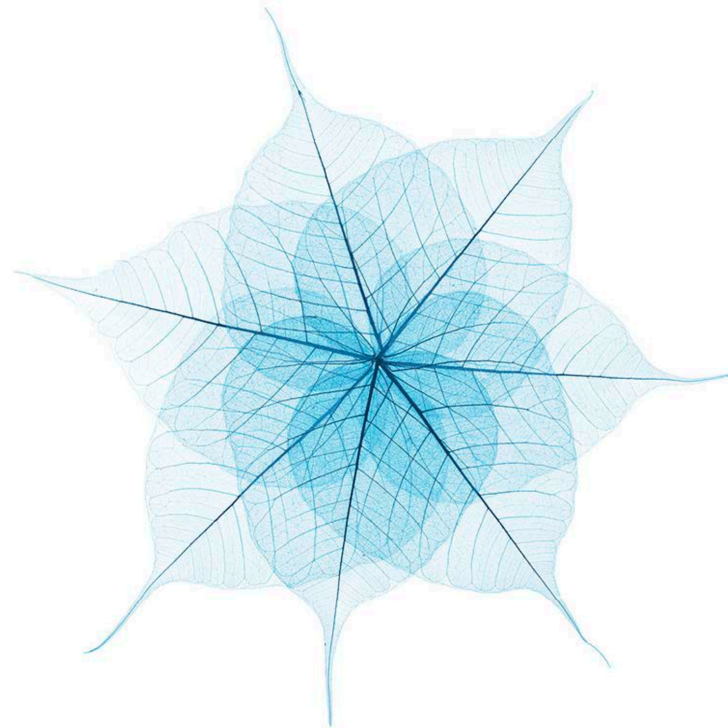
Date	Stage
October 2014	Consents granted
January 2015	Petition for Judicial Review lodged
May / June 2015	Outer House hearing
July 2016	Outer House decision
February 2017	Inner House hearing
May 2017	Inner House decision
August 2017	Leave sought to appeal to Supreme Court
November 2017	Supreme Court disposal

(2) Legal Challenges: Changes to Rules

1. **Statutory Appeal / Judicial Review**
2. **Permission Stage**
   - Sufficient interest in the subject matter of the application; and
   - real prospect of success
3. **Permission to Appeal to the UK Supreme Court**
   - If the appeal raises an arguable point of law of general public importance which ought to be considered by the Supreme Court at that time.

(3) Optimising Consents

1. Section 36 Consents
    a) Section 36C Variation
    b) New consent
2. Marine Licences
    a) Section 30 Variation
    b) New licence
3. Planning Permission
    a) Section 42 vs Section 64
    b) Certificate of lawfulness
    c) Permitted development
    d) New consent
4. Condition Discharges?



(4) More new EIA Regulations

The Electricity Works (Environmental Impact Assessment) (Scotland) Amendment Regulations 2017

“As a result of the amendment, only variation applications where the changes proposed by the variation may cause significant adverse environmental effects will require an EIA is carried out.”

(5) Floating Offshore Wind

– Hywind, 30MW (October 2015)
– Dounraey Try, 12MW (March 2017)
– Kincardine, 50MW (March 2017

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Dr Richard Wakefield

Principal Marine Scientist, Atkins

KOWL

Kincardine Offshore Windfarm Limited

Consenting Summary

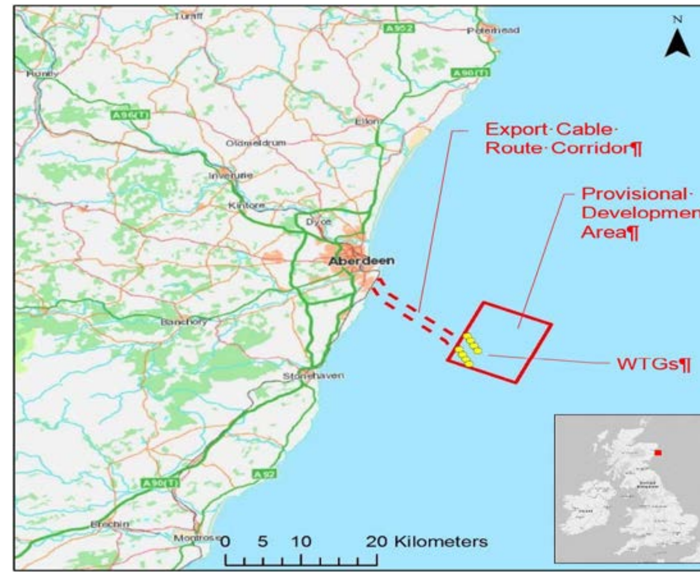
ATKINS

Member of the SNC Lavalin Group

KOWL

Introduction

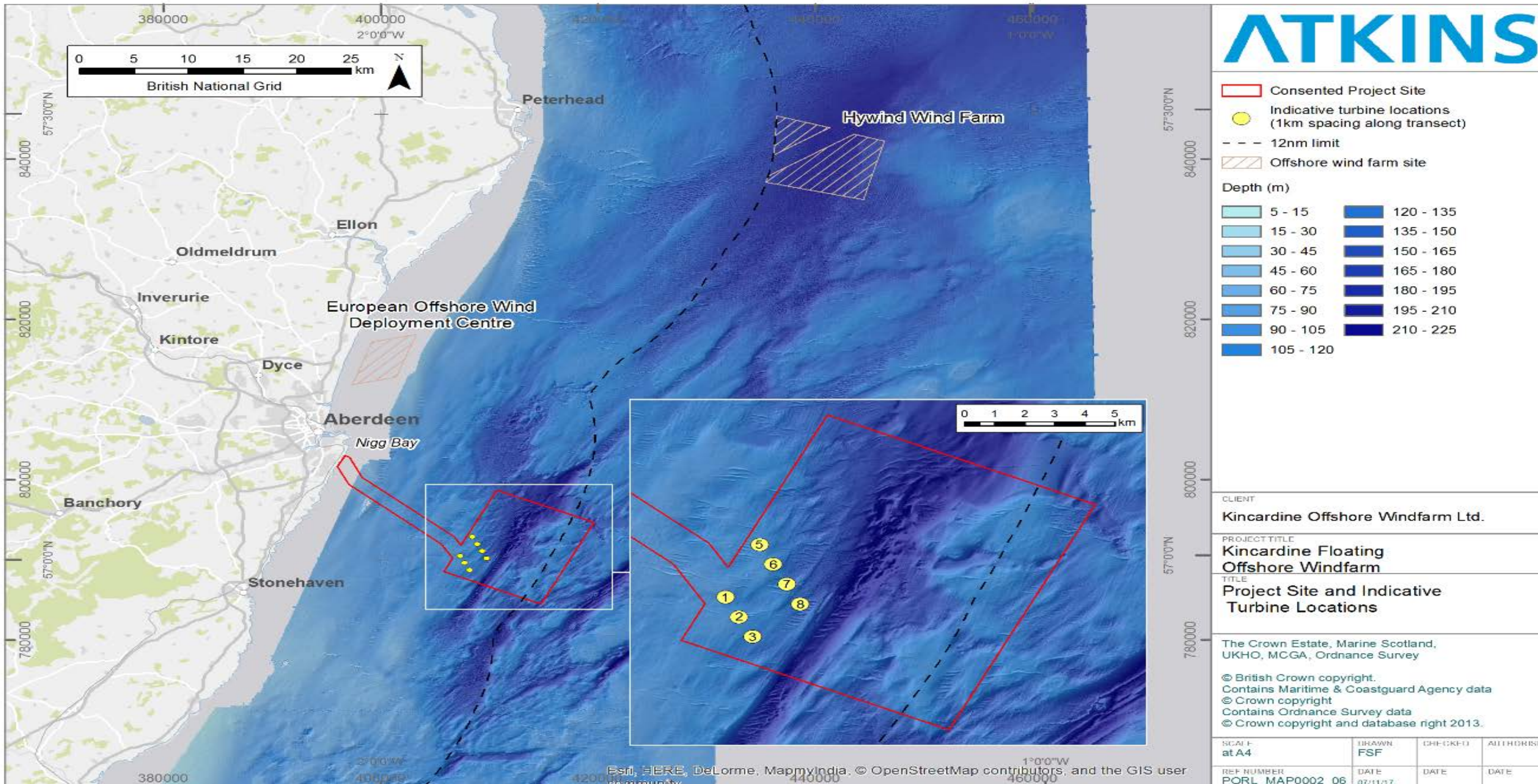
1. Project summary
2. Project consenting timelines
3. Current consent
4. Section 36 Variation
5. Marine Licence Variation
6. Consenting Challenges



ATKINS
Member of the SNC Lavalin Group

Location of Site

KOWL



Consenting Timelines for KOWL

KOWL

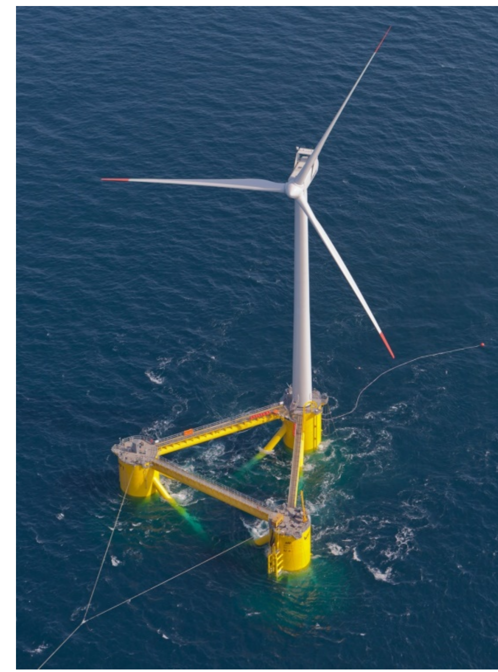
- Scoping Report submitted April 2014
- Scoping Opinion returned August 2014
- Application submitted April 2016
- Addendum submitted September 2016
- Determination March 2017
- Section 36 Variation submitted November 2017
  - Public consultation ended 12th January

ATKINS
Member of the SNC Lavalin Group

Section 36 Variation

KOWL

- No material changes to the environmental impact from the development;
- Changes:
  - Reduction in larger turbines from eight to six;
  - Introduction of a smaller 2 MW turbine;
  - Reduction in footprint of development;
  - No change to modelled bird collision impact; and
  - Reduced construction activities on site



Marine License Variation

KOWL

- KOWL are first offshore windfarm to go through this amended process – no requirement to submit new Marine license application
- Similar to Section 36 Variation approach, where no additional significant impact is identified.
- It will allow greater flexibility moving forward for all offshore projects.
- Support from Marine Scotland LOT throughout process

ATKINS

Member of the SNC Lavalin Group

Consenting Challenges

KOWL

- Screening/scoping – seek to remove all nonsignificant issues from the assessment process.
- Utilise current and growing body of evidence to support this approach to limit scope of EIA.
- Resist scope creep for all parties – Developers, stakeholders, lawyers, licensing authority etc.
- Timelines for processing consent
- How does the consenting system keep up with significant project change when assessing cumulative impact?

ATKINS

Member of the SNC Lavalin Group

KOWL

KINCARDINE OFFSHORE WINDFARM LIMITED

Dr Richard Wakefield FIMarEST, CSci, CMarSci

Consent and Environment Manager

Richard.Wakefield@atkinsglobal.com

0141 220 2437 / 07713 652 480

ATKINS

Member of the SNC Lavalin Group

Catarina Rei

Offshore Consents Manager, EDP Renewables

OFFSHORE DEVELOPMENT IN SCOTLAND WITH EDPR

SR Offshore Wind Conference

Environment & Consents

30 January 2018

edp renováveis

Overview of Presentation

1. Introduction to EDPR
2. Moray East Offshore Wind Farm
   - Project Overview
   - 2017 Review
   - 2018 Look Ahead
3. Moray West Offshore Wind Farm
   - Project Overview
   - 2017 Review
   - 2018 Look Ahead
4. Future Offshore Development Opportunities

renewables

Introduction – EDP Renewables

EDPR is present in 12 countries with a top quality and diversified portfolio of >10 GW

edp renewables

EDP Renewables & Offshore Development

UK

PARTNERSHIP

edp 77% | ENGIE 23%

PROJECT LEVEL

MORAY EAST OFFSHORE WINDFARM

Moray East 1,1GW

100% Ownership

EDP RENOVAVEIS S.L

edp 100%

EDPR UK Ltd.

PROJECT LEVEL

MORAY WEST OFFSHORE WINDFARM

Scoping – up to 750 MW

France

PARTNERSHIP

edp 43% | ENGIE 47% | Groupe Caisse des Dépôts 10%

CURRENT PIPELINE: 1 GW

PROJECT LEVEL

Le Tréport 500 MW

Ile d'Yeu et Noirmoutier 500 MW

PARTNERSHIP

edp | ENGIE | Groupe Caisse des Dépôts

PRINCIPLE renewable energy delivered | EIFFAGE | GE

PROJECT LEVEL

Leucate 24 MW

Portugal

PARTNERSHIP

edp 25% | REPSOL 25%

Portugal Ventures 13% | A. Silva Matos 13% | Others 24%

PRINCIPLE renewable energy delivered

WINDPLUS

Windfloat 1 2 MW

Windfloat Atlantic 25 MW

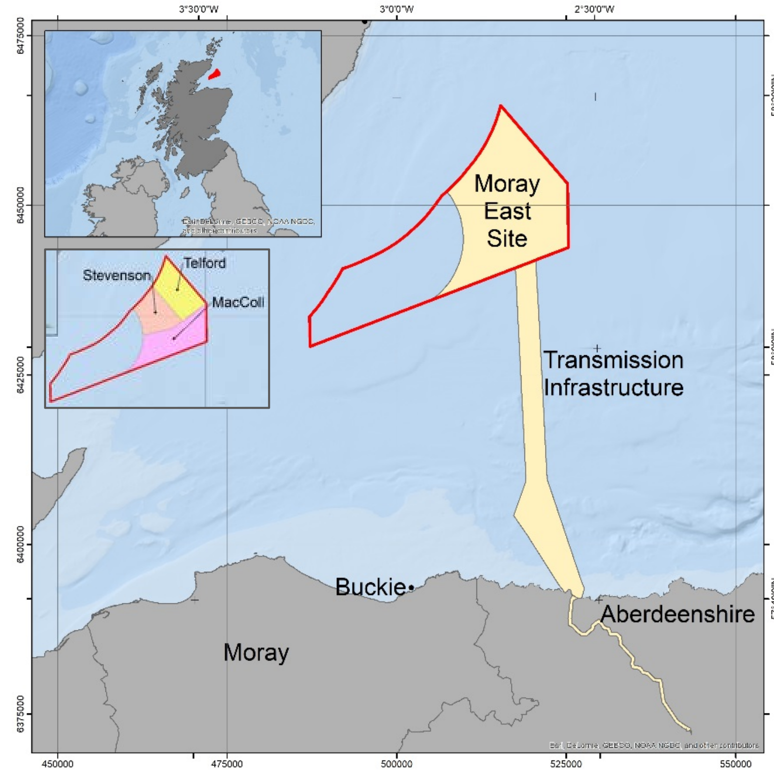
edp renewables

Moray East Offshore Wind Farm

MORAY EAST OFFSHORE WINDFARM

Brief outline

- The wind farm is located in the Outer Moray Firth, NE Scotland (Eastern part of Zone 1 – Moray Offshore Zone).
- Approximately 22 km from Caithness coast.
- Covers an area of 295 km^2, in areas of water depths between 37-57 m.
- Landfall and onshore substation in Aberdeenshire.
- Development of the Moray East site started in 2010, applications were submitted in 2012 (OWFs) & 2014 (ModTI), construction due to start in 2019, fully operational in 2022.
- Preparing for FID and pre-construction engineering.



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Moray East – Review of 2017

MORAY EAST
OFFSHORE WINDFARM

Challenges:

- Uncertainty over project timescales
- Management of **9 consents** (S36 consents, MLs, PPP) – **356 consent conditions**
- Update of 'standard conditions wording'
- Site investigations
- Drafting & approval of project procedures
- Managing of consenting risk through contractual obligations
- Preparing for construction

Successes:

- **CfD Award (Sep 2017)**
- Initial discharge of consent conditions
- Positive engagement with stakeholders / regulator
- Research projects
- Development of compliance tools

edp renewables

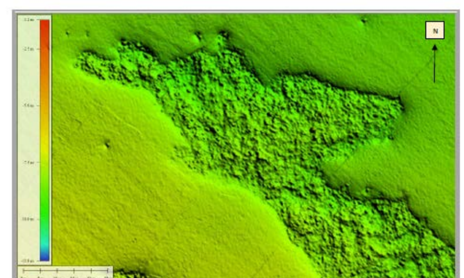
Moray East – Looking Forward 2018

Challenges:

- Discharge of consent conditions programme (offshore and onshore)
- Satisfy due diligence process to complete FID
- Integration of new staff into the Project

KPIs:

- Completion of pre-construction site investigations & environmental surveys
- FID
- Achieve strong delivery team

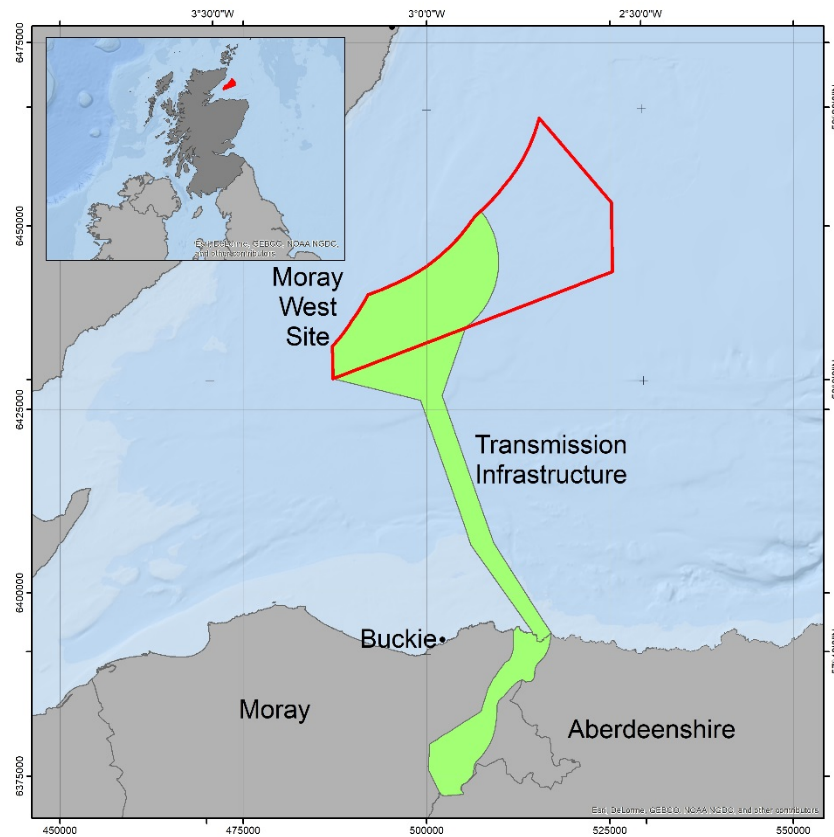


Moray West Offshore Wind Farm

MORAY WEST
OFFSHORE WINDFARM

Brief outline

- The wind farm is located in the Outer Moray Firth, NE Scotland (Western part of Zone 1 – Moray Offshore Zone).
- Covers an area of 225 km^2, in areas of water depth between 35-53 m.
- Development work started in 2016 (offshore scoping report).
- Connection point at Blackhillock.
- Applications to be submitted in Q1 2018.



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Moray West – Review of 2017

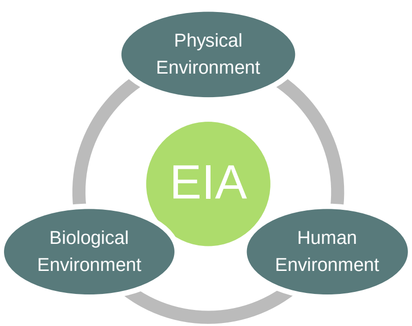
MORAY WEST
OFFSHORE WINDFARM

Challenges:

- Project timescales – unclear CfD timetable
- Design Envelope definition – e.g. inclusion of monopiles
- Cumulative complexity

Successes:

- Grid connection agreement
- OFTO scoping completed
- Baseline data collection
- Good relationship with supply chain
- Start of impact assessment work



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Moray West – Looking Forward 2018

MORAY WEST
OFFSHORE WINDFARM

Challenges:

- Project timescales – applications to be submitted to meet CfD timescales
- Grow dedicated Project team

Aims:

- Timely submission of applications
- Fit-for-purpose information provided in ER

Transfer of lessons learned from Moray East to Moray West

edp renewables

Future Development Opportunities

Offshore Wind is key within EDPR's business strategy. Therefore EDPR will seek development opportunities where Governments will work with us to lower the cost of low carbon energy.

Announcements

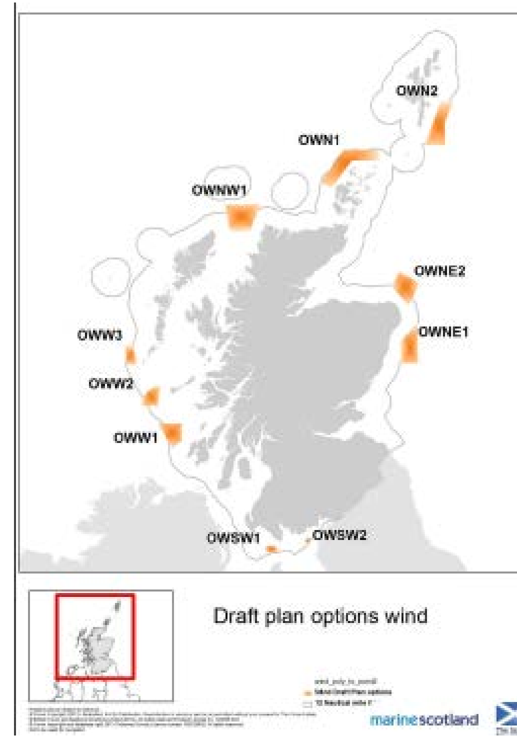
- On 7th November 2017, both The Crown Estate UK (TCE) and Crown Estate Scotland (CES) announced their intention to start discussions with industry, government and other stakeholders to prepare for potential new offshore wind leasing for sites to operate from the late 2020s and beyond. This includes both fixed and floating.

Unknowns

- Uncertainty over selection of sites and process for award of development rights.
- How the processes will work north and south of the border to meet UK energy policy.

Going forward

- Consenting process must not make projects in Scotland less competitive, higher risk or slower.



Strategic Offshore Wind areas from 2014: to be updated.

edp renewables

powered by nature

Lis Royle

Consents and Stakeholder Manager

Jonathan Wilson

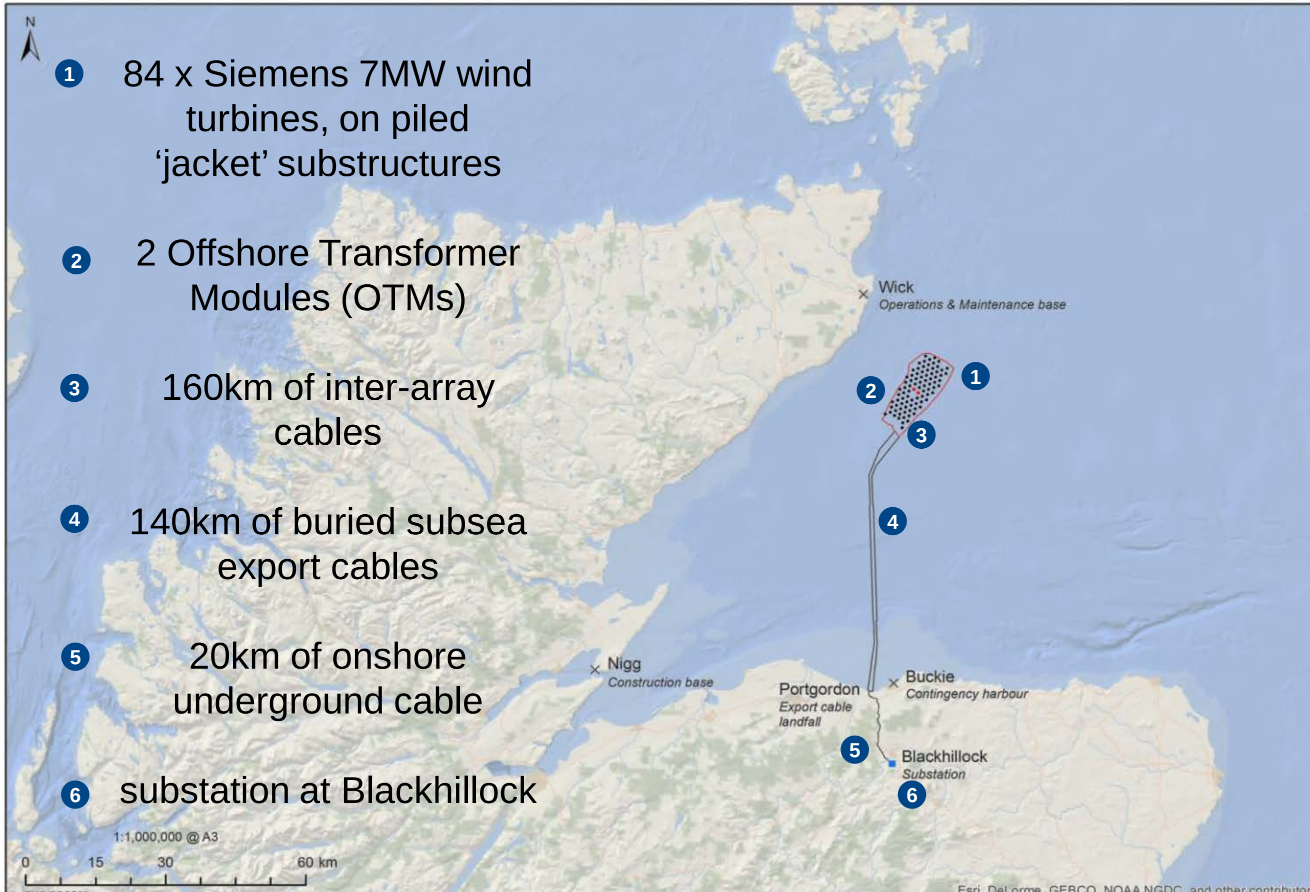
Lead Consent and Stakeholder Manager

SSE Renewables

BOWL Consenting and Consent Discharge

Jonathan Wilson, Lead Consents Manager (SSE)
Lis Royle, Consents and Stakeholder Manager (BOWL)

Project Description



Project Overview

- 588MW
- £2.6bn
- Joint venture with - SSE Renewables (40%), Copenhagen Infrastructure Partners (35%) and Red Rock Power (25%)
- May 2016 - Financial close
- March 2017 - Start of construction
- Late 2019 - Fully operational
- c. £680m into the UK and Scottish economy during the construction phase
- c. £400-£525m during the 25 year operational phase

Lessons Learned?

Beatrice
Offshore Windfarm Ltd

- Flexible consent versus flexible engineering
- Consistency of terminology
- Stakeholders

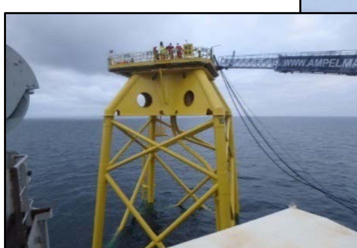
Consent Discharge

- Phased discharge of conditions
  - Project design
  - Project milestones
  - Construction commencement
- 20 consent plans
- Protocol agreement between BOWL and MS-LOT
- Stakeholder Engagement

Moray Firth Regional Advisory Group – Marine Mammal Sub Group, June 2017 (photo courtesy of University of Aberdeen)

Consent Discharge Cont.

- Considerations for future developments
  - Concise Consent Plans
  - Multi stage consenting



Beatrice Offshore Windfarm Ltd

Any Questions?

Adam Ezzamel, Project Director – European Offshore Wind Deployment Centre, Vattenfall

Graham Black, Director, Marine Scotland

Robin Hutchison, Partner, CMS Cameron McKenna Nabarro Olswang LLP

Dr Richard Wakefield, Principal Marine Scientist, Atkins

Catarina Rei, Offshore Consents Manager, EDP Renewables

Lis Royle, Consents and Stakeholder Manager, and **Jonathan Wilson,** Lead Consent and Stakeholder Manager, SSE Renewables

The Wind Farms of the Future

Session coordinated by

CATAPULT
Offshore Renewable Energy

Dr Steve Wyatt, Research and Innovation Director, Offshore Renewable Energy Catapult

Professor Paul Weaver, Professor in Lightweight Structures, University of Bristol

Simon Heyes, CEO, Kite Power Systems

Andy MacDonald, Senior Innovation Manager, Offshore Renewable Energy Catapult

Sebastian Bringsvaerd, Head of Floating Wind Development, Statoil ASA

Professor Paul Weaver, Professor in Lightweight Structures, University of Bristol

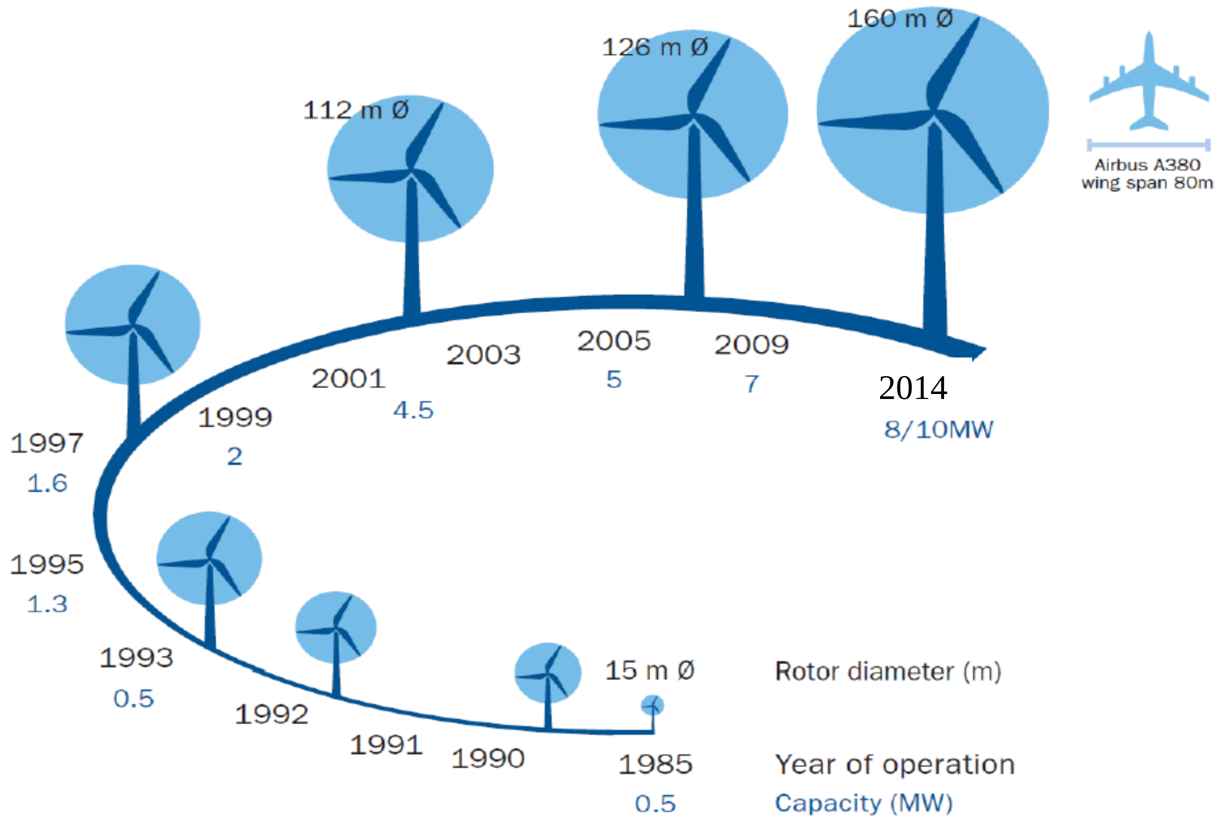
Wind Farms of the Future
- *Turbine Blade Design and Manufacture*

Paul Weaver

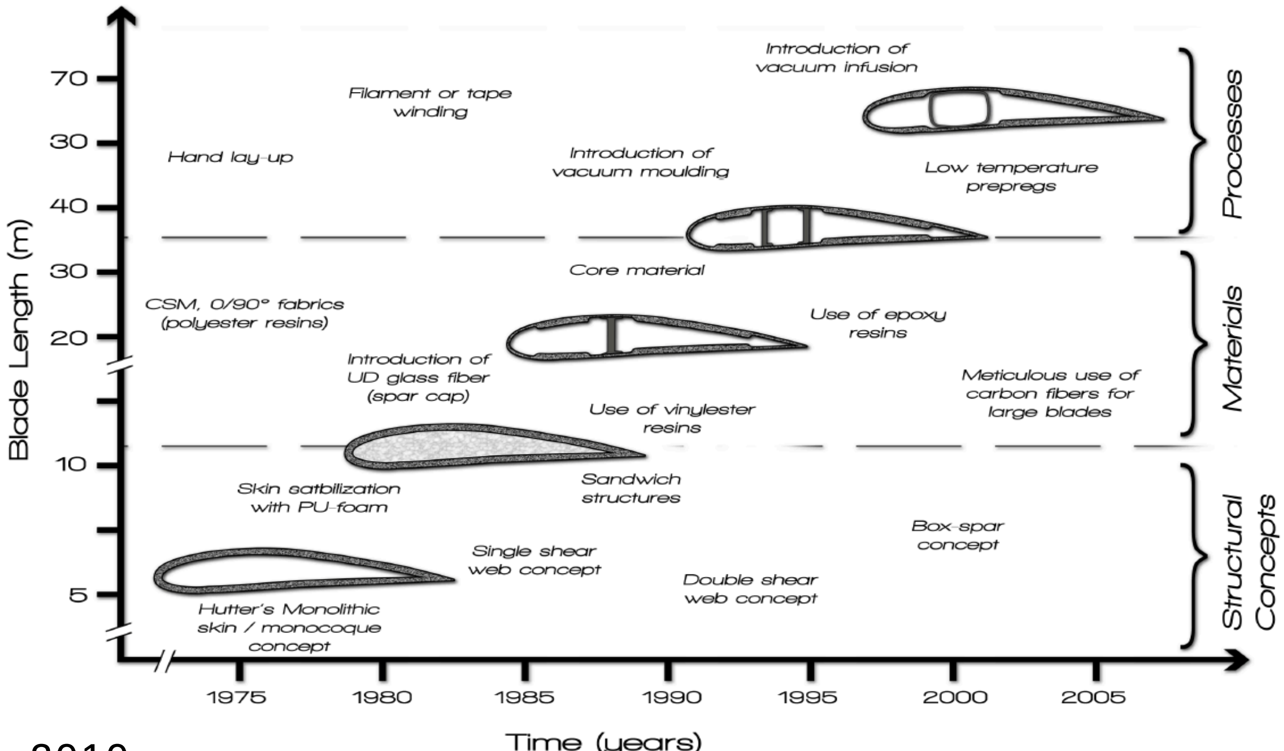
Bernal Chair in Advanced Composites, University of Limerick

Professor in Lightweight Structures, University of Bristol

Growth of Rotors

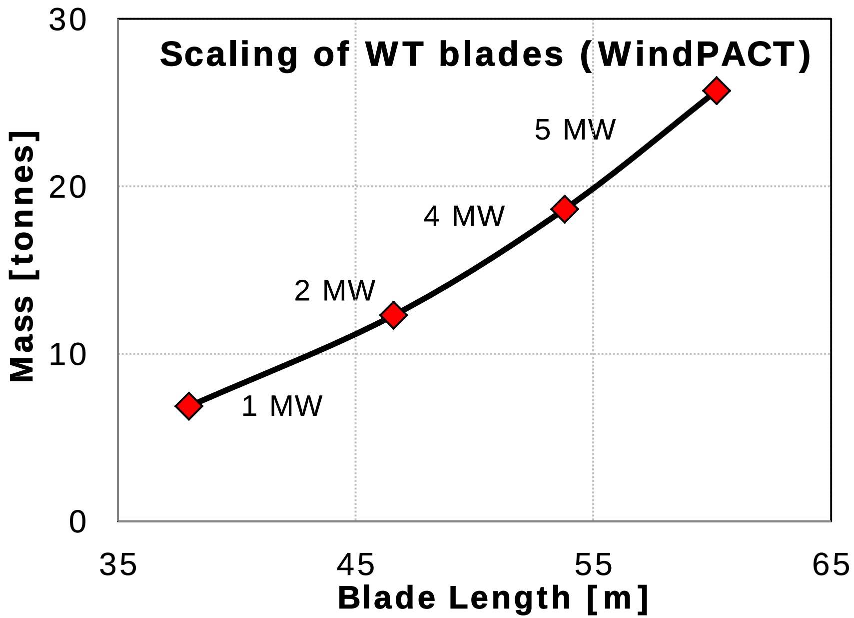


Evolution of Materials, Structure and Manufacturing

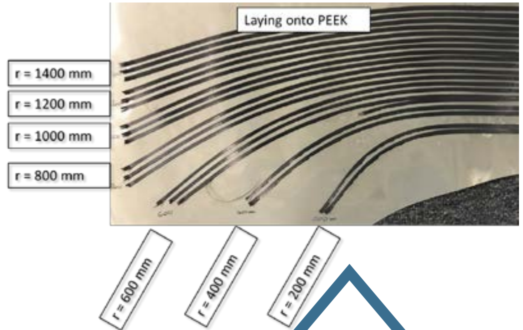


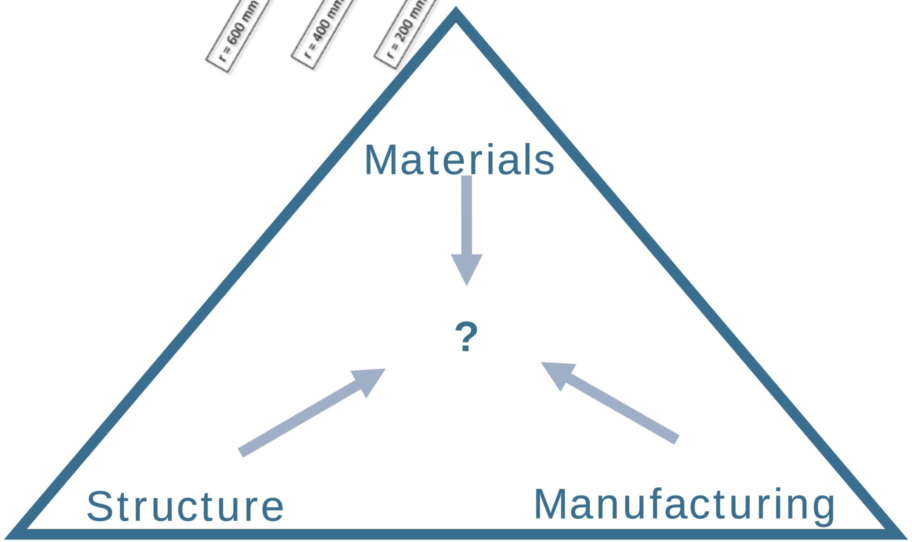
Joncas, 2010

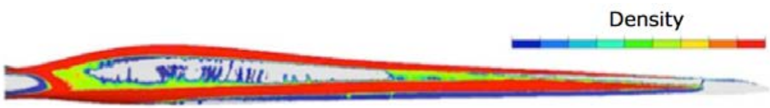
Square - cube law



Integration of Materials, Structures and Manufacturing







Future Blade Designs

- New structural concepts for blades
- Reduce loads (Active and passive)
- Enhanced manufacturing and materials.

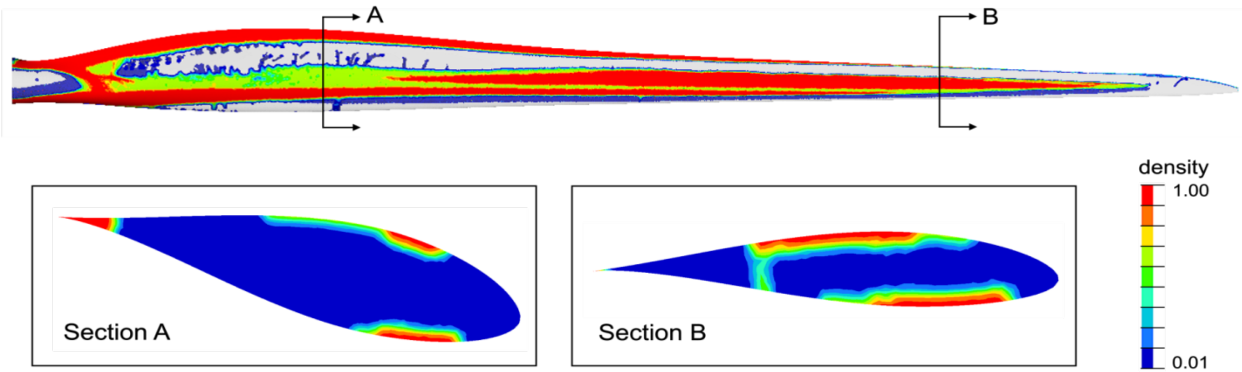
Lesson to be learned

Larger Blades require new, efficient structural geometries

Topology Optimisation

Finite element-based topology optimisation

- Produces an optimal material distribution
- Seven key load cases
- Result is a topology which varies along the blade

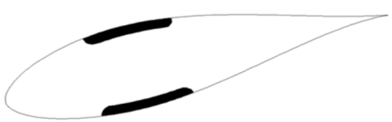


Trailing edge reinforcement

Offset Spar Caps

The topology is altered by varying a fictional element density

- Density of 1 indicates material is present
- Density of 0 indicates void regions

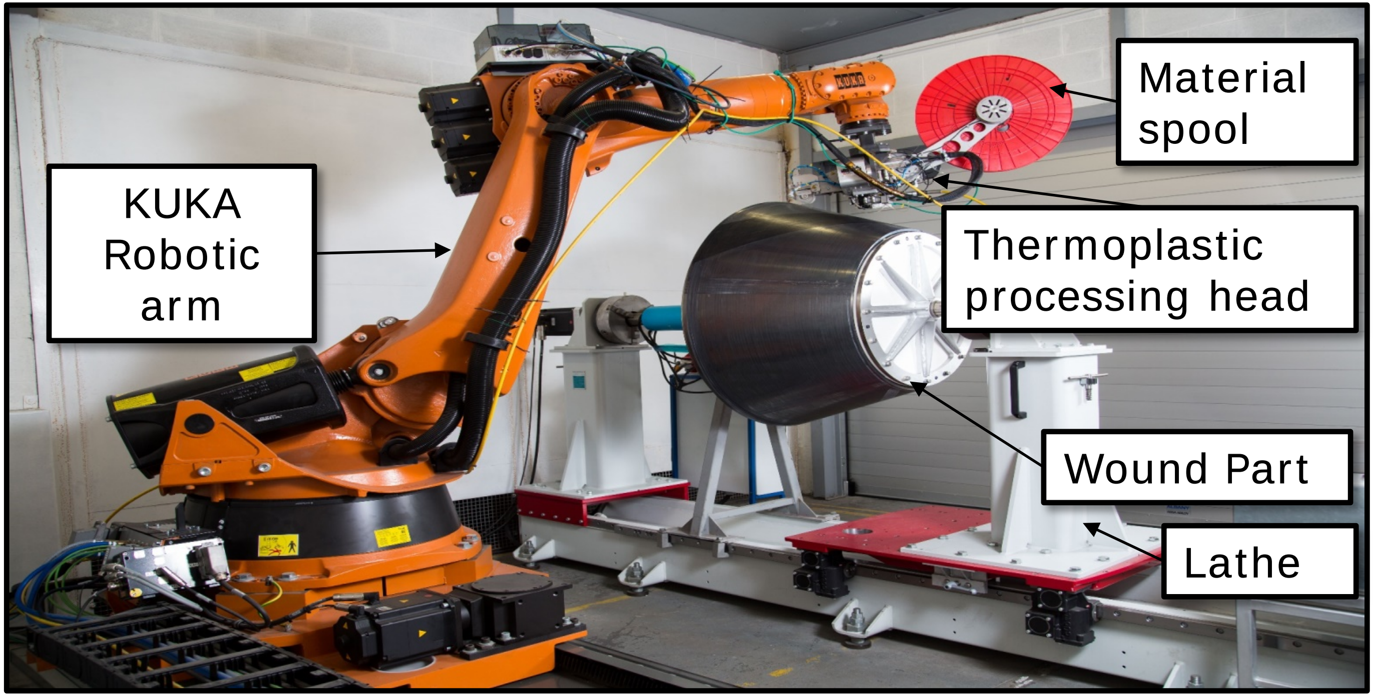


Conventional

TE reinforcement

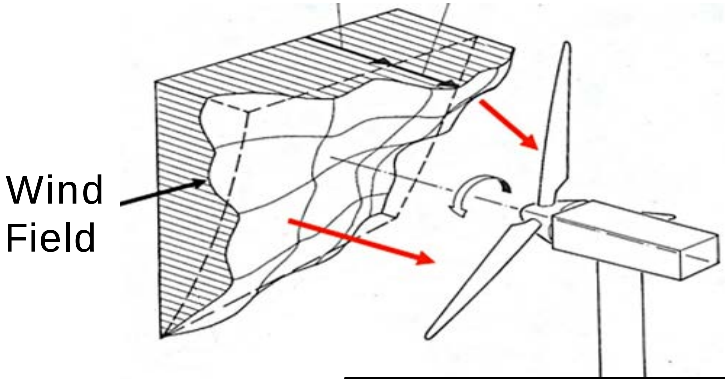
Manufacturing

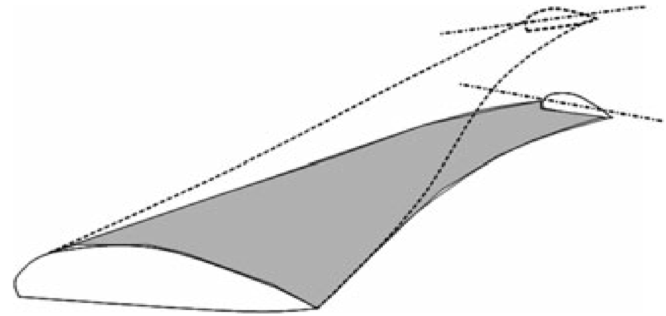
- In-situ, oven-free manufacturing using thermoplastic composites

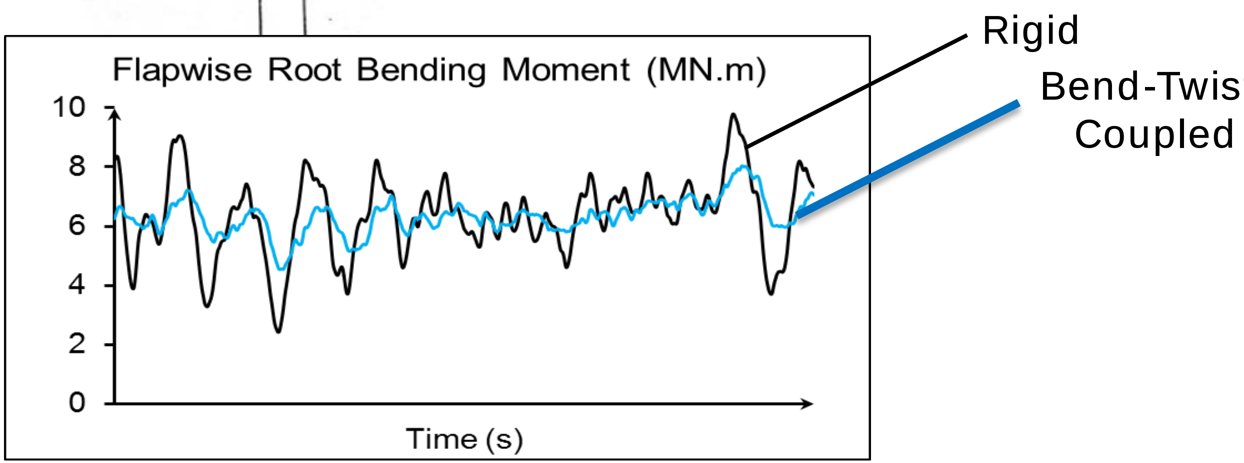


Gust load alleviation

- Bend-twist can alleviate blade loads → Lighter, Cheaper





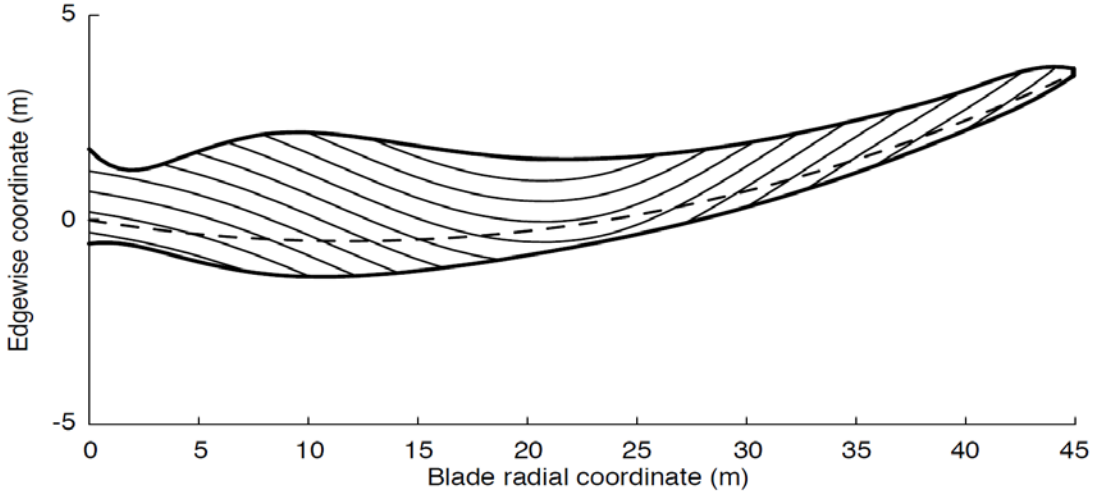


Blades - bend/twist or sweep coupling

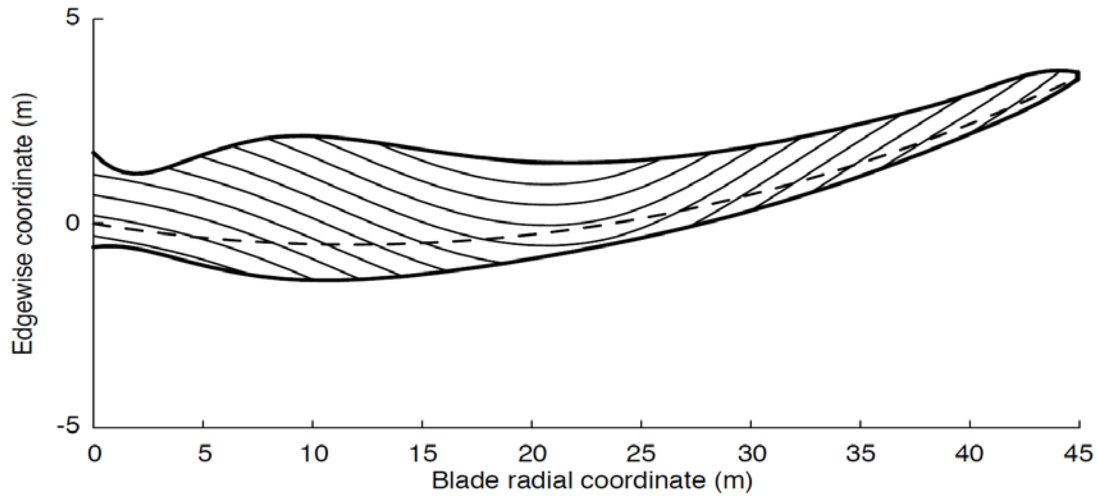
Swept Blade Demonstrator

Ashwill, T. Et al., 2010. Development of the sweep-twist adaptive rotor (STAR) blade.

2014 –Capuzzi et al. Adaptive blade combining material and sweep coupling.

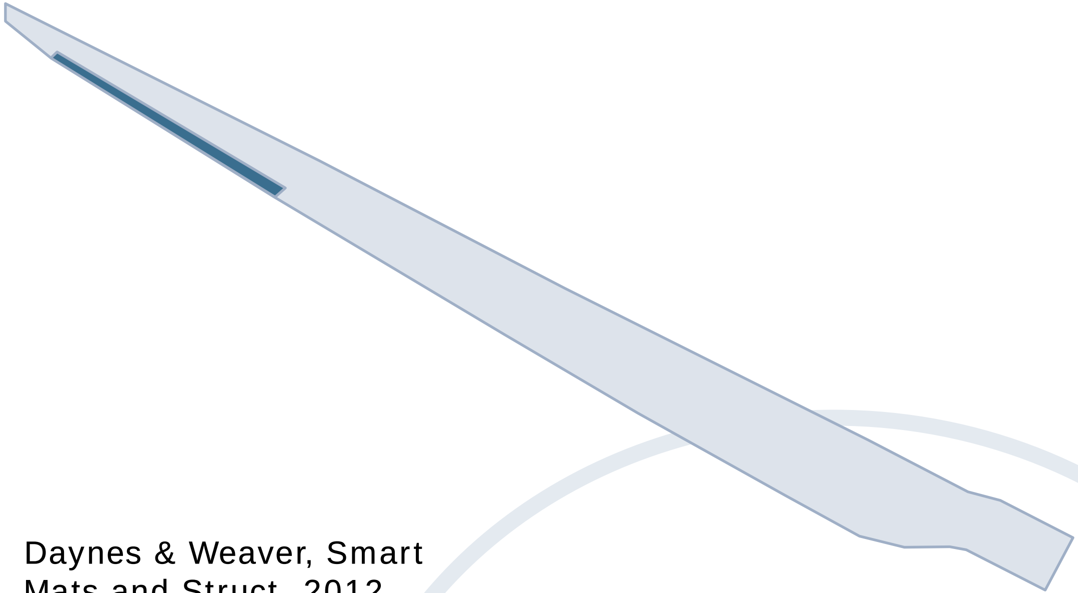


Similarities to Nature



Sycamore seed

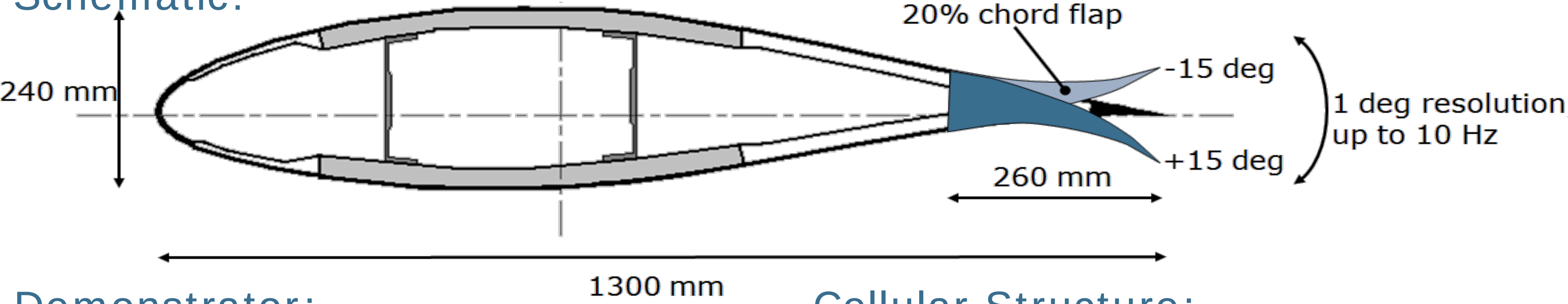
An active shape adaptive airfoil for a wind turbine blade



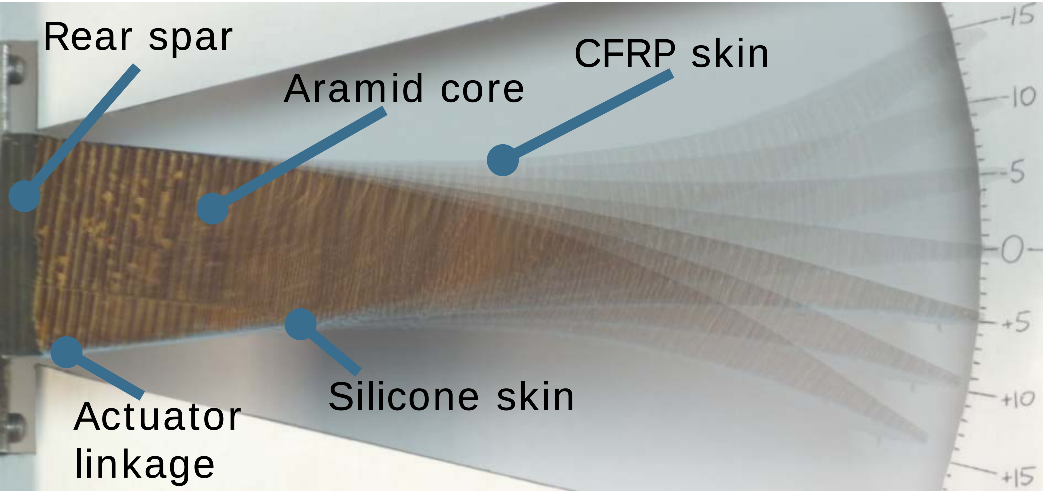
Daynes & Weaver, Smart Mats and Struct, 2012

Morphing Flap Concept

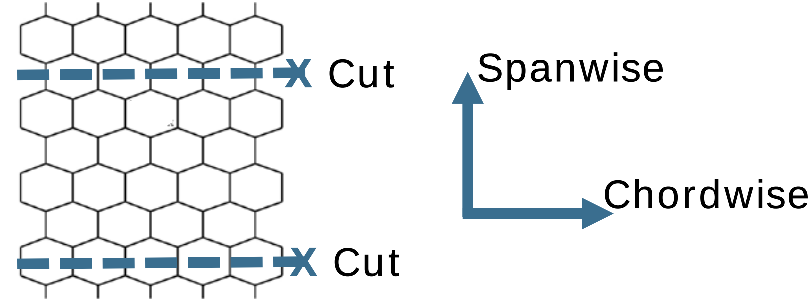
Schematic:



Demonstrator:

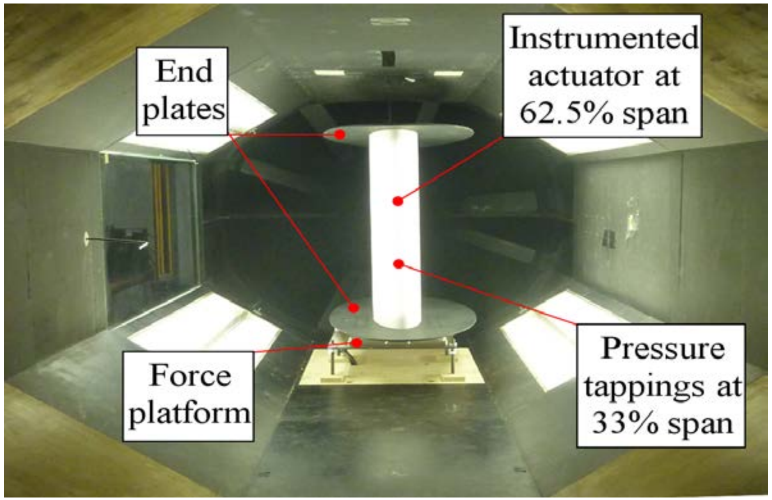


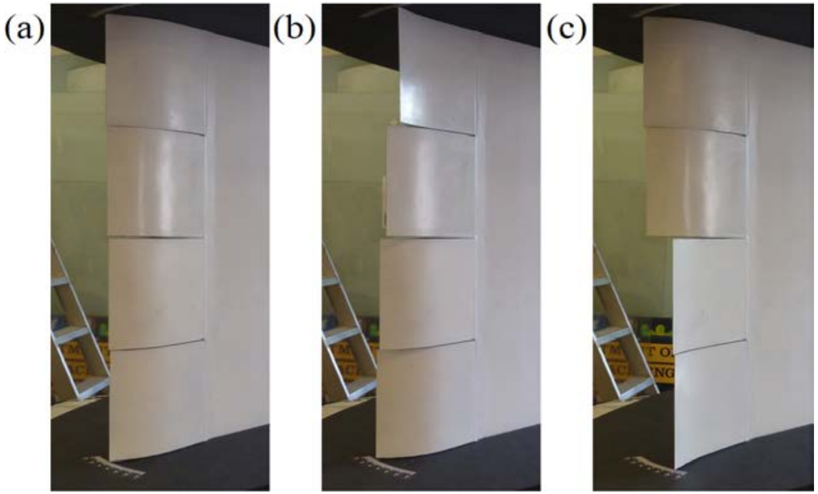
Cellular Structure:



Daynes, S., Weaver, P. M., UK Patent Application for “a wind turbine blade having a flap,” No. XXXXXX, filed XX Feb. 2011.

A shape adaptive airfoil for a wind turbine blade

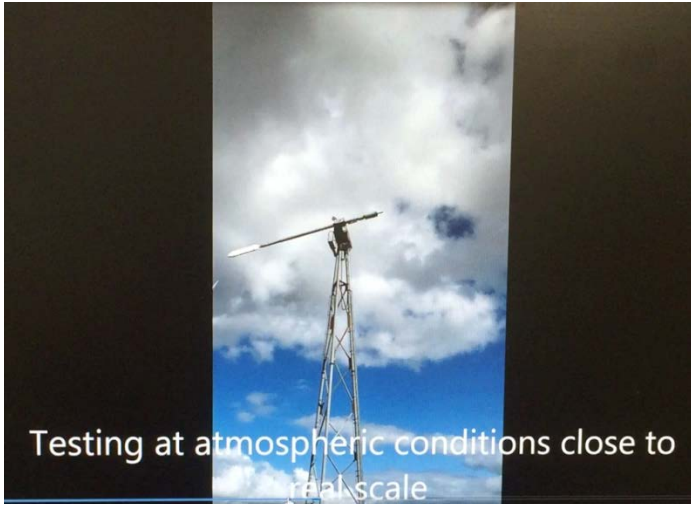




Installed on boom and rig

Thanks to Horizon 2020 (Innwind) and colleagues at DTU Wind for on-site installation and testing- Aug/Sept 2017

Innwind morphing flap demonstrator

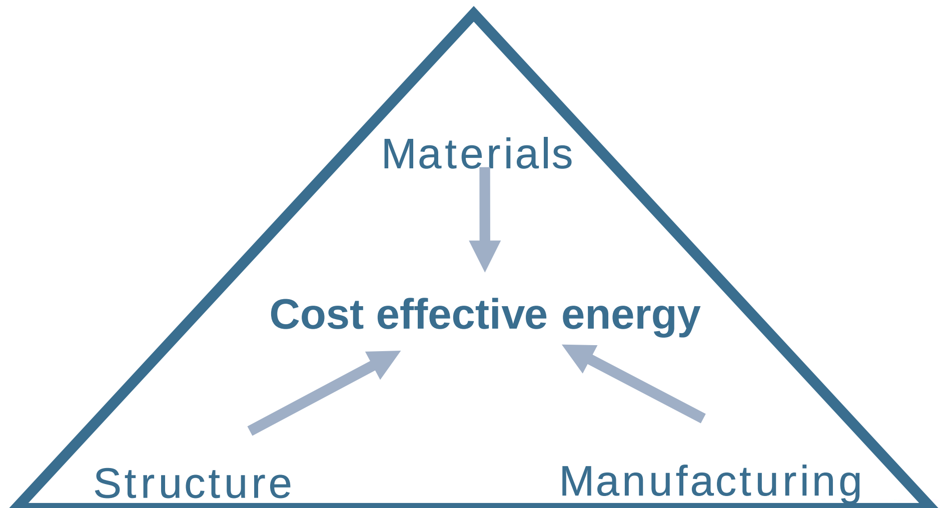


Courtesy of DTU Wind

Conclusion

- To ensure long-term, economically viable wind energy needs cheaper cost of energy.
- Ever longer blades (>100m) are being developed but require:

- An integrated approach for developing **materials**, **structural design** and **manufacturing** method is needed.



Acknowledgements

- *Thanks to my team of PhD, postdoc researchers and colleagues over the last 12 years*
- *S Daynes, A Pirrera, X Lachenal, Neil Buckney, Alex Brinkmeyer, Qing Ai,*
- *Support from EPSRC. Since 2016, thanks to Science Foundation Ireland (SFI) for funding Varicomp under its Research Professor scheme.*
- *For updates see "Varicomp" on Researchgate*

Simon Heyes, CEO, Kite Power Systems

Kite Power Systems Ltd

Simon Heyes, CEO
January 2018

KPS
KITE POWER SYSTEMS

Introduction and Overview

Presentation Contents:

1) Who we are
2) Our funders
3) The concept
4) Benefits of AWE
5) The KPS product
6) KPS Business Objectives
7) Challenges

KPS
KITE POWER
SYSTEMS

KPS Technology Progress

2011-2012

5kW Proof of Principal (Shell Gamechanger)

2012-2016

40kW Technology Development (Shell Gamechanger, Pathfinder, BEIS Energy Entrepreneurs Fund And InnovateUK

2017-2019

500kW System Development

Move to Glasgow

Increase staff numbers

KPS
KITE POWER
SYSTEMS

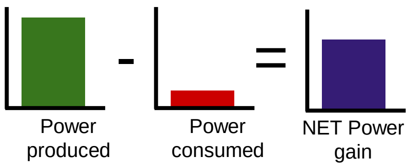
KPS Funding

Equity	Grant
Shell, E.ON, Schlumberger, Scottish Enterprise	Innovate UK Technology Strategy Board; Department for Business, Energy & Industrial Strategy

KPS KITE POWER SYSTEMS

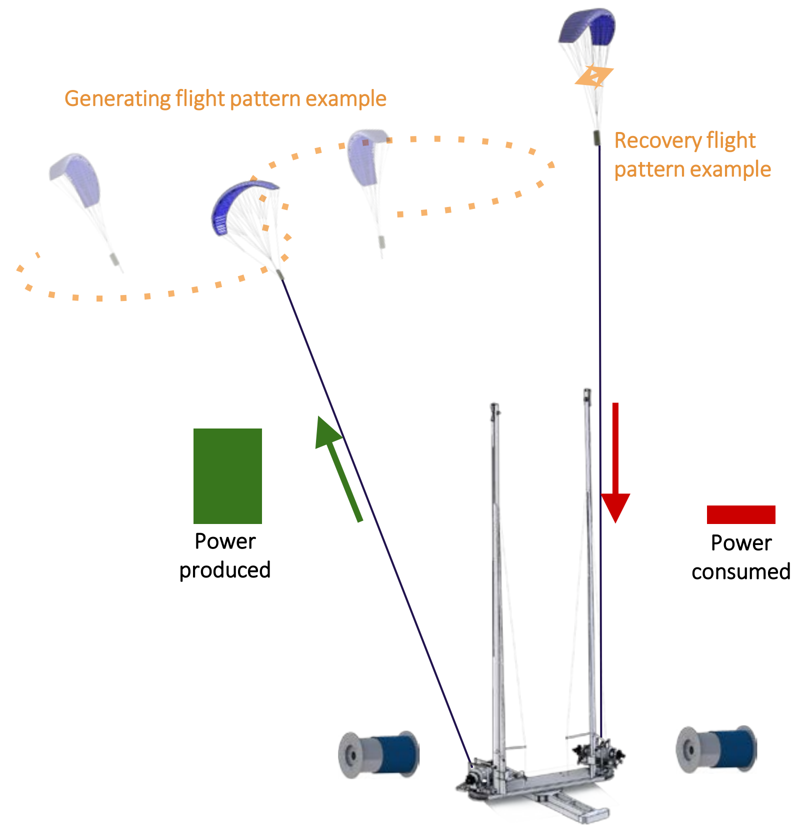
The Concept

A. The ability to control line tension allows a pumping (yo-yo) cycle with a net power gain.



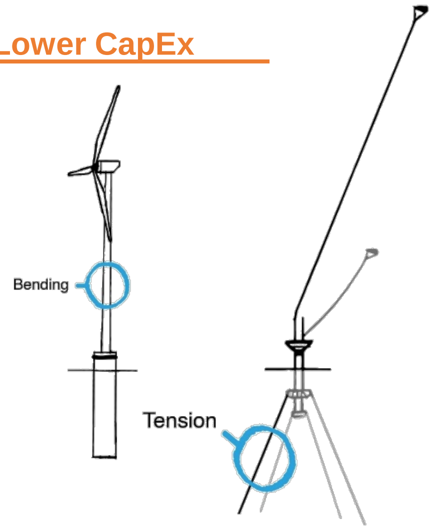
B. Continuous power generation can be achieved by two kites in antiphase.

C. Tether tension can be varied by an order of magnitude through.
- Pitch angle of wing
- Flight speed



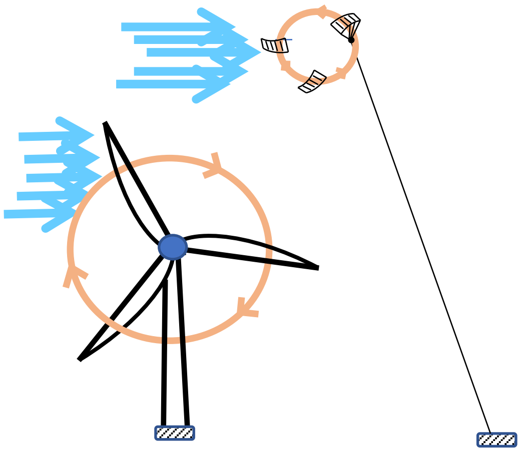
Benefits of Airborne Wind Energy

40-50% Lower CapEx



- Lower system mass, <20% of mass HAWT
- Loads in tension not bending
- 2/3 less torque
- Onshore - CAPEX >40% lower than HAWT
- CAPEX >50% lower than HAWT in 40m water depth

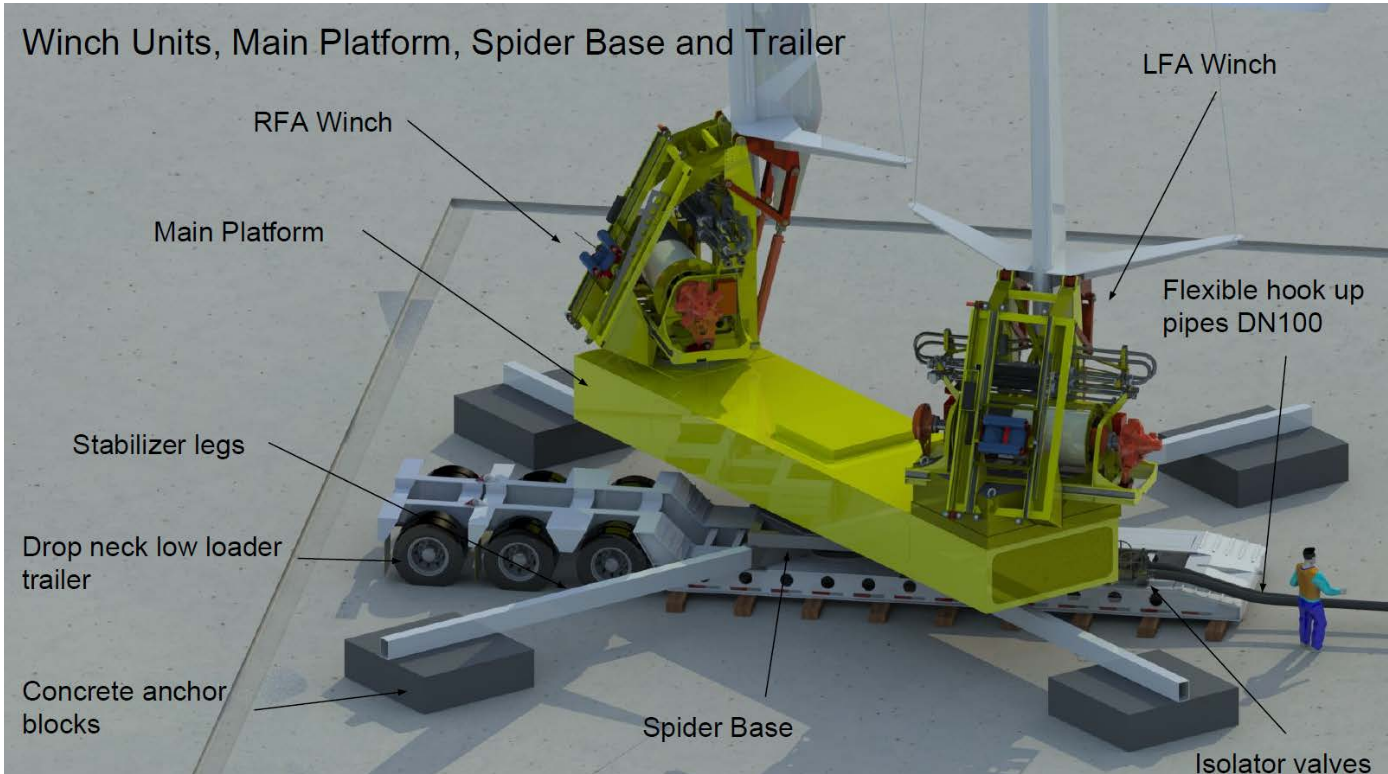
10% Higher Capacity Factor



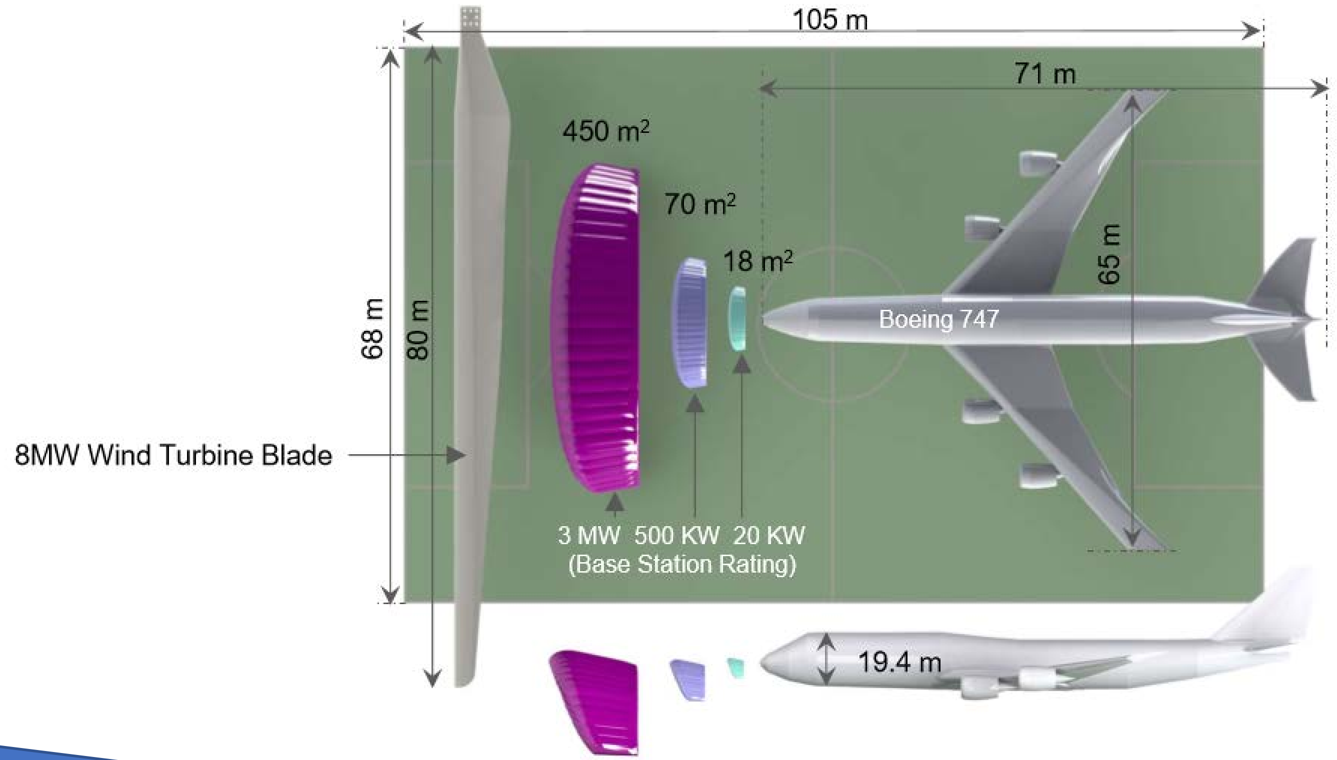
- Stronger wind at higher altitude
- Kite size can be changed to suit site conditions
- Low cut in equivalent wind speeds achievable
- BVGA validation indicates a 55.8% base case net capacity factor

KPS KITE POWER SYSTEMS

The KPS Product



How big are the kite wings?



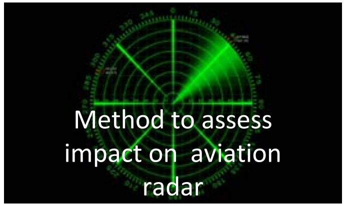
KPS Business Objectives

Objectives:

1) To build and test a 500kW prototype system and achieve autonomous operation by end 2019.
2) Develop from the prototype design to mid-scale “Beta” pre-production units
3) To identify and consent a demonstration array site for 3 x mid-scale “Beta” units, to operate 2020 - 2023.
4) Refine “Beta” design to 500 kW commercial product, shipping first units in 2023.
5) Consider the potential for a large-scale (notionally 3 MW) offshore system, and validate offshore LCOE.
6) Identify test sites for floating 3MW system.

KPS KITE POWER SYSTEMS

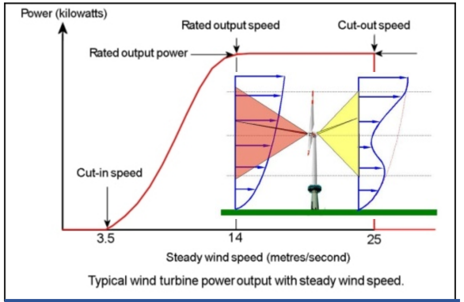
AWE – Common Challenges


Method to assess impact on aviation radar


Aviation safety case / segregated airspace


Bird strike modelling


Array loss assessment



Power curve definition and measurement


Noise measurements

Lloyd's Register
BUREAU VERITAS
DNV
Made in EU
Standard approach to certification

Funding resources and duration

KPS KITE POWER SYSTEMS

Thank You

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Andy MacDonald
Senior Innovation Manager, Offshore Renewable Energy Catapult

Session 3A
Windfarms of the future
Disruptive innovation

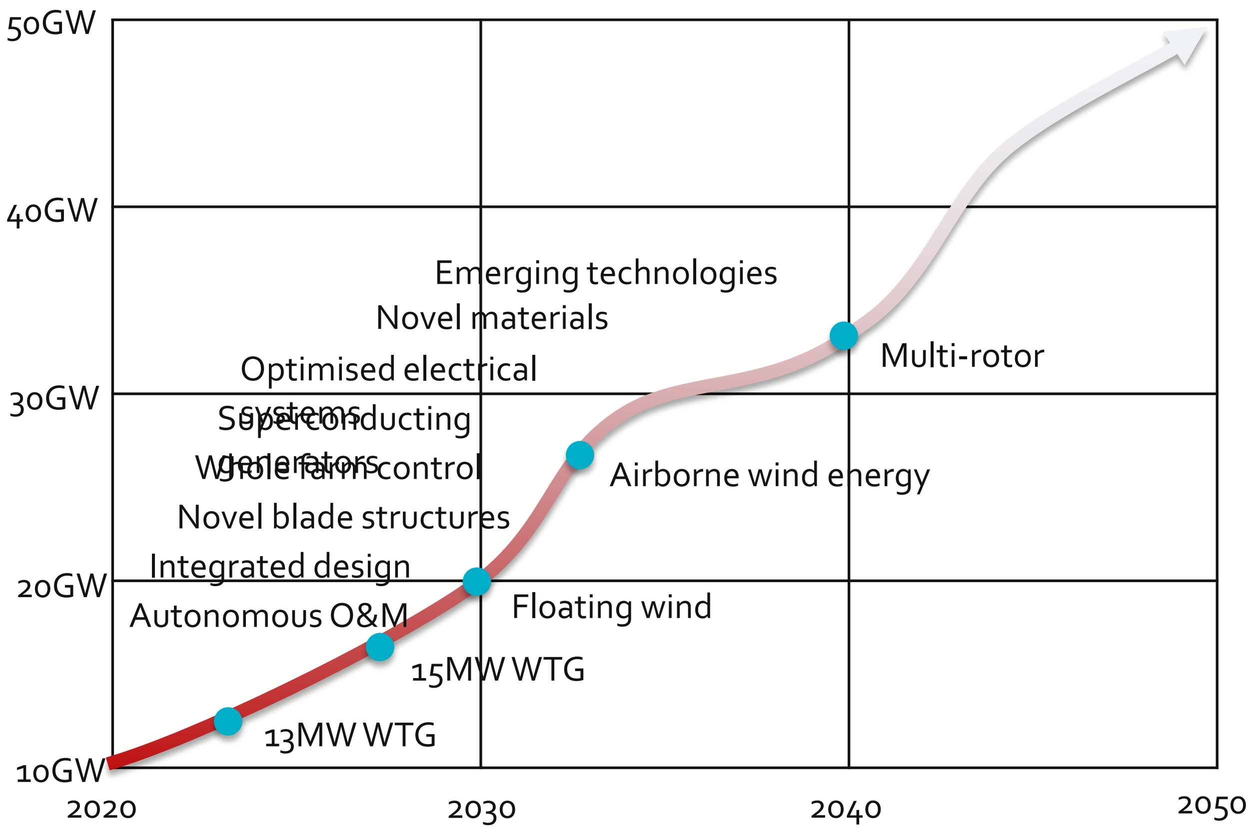
30/1/18

Andy Macdonald

CATAPULT
Offshore Renewable Energy

Disruptive innovation

Disruptive innovation pathways



Disruptive innovation scenarios – short term

Short term 1 – data analytics

Use of powerful data analytics will disrupt the O&M supply chain shifting the balance between OEMs and owner operators.

Opportunities will open up for consultancies to increase third party asset management activity in partnership with data analytics providers.

Short term 2 – autonomous O&M

Use of autonomous systems for inspection will disrupt the market for turbine inspection. New entrants will deliver low cost autonomous drone inspections. Robotics for repair will follow.

Disruptive innovation horizons – medium term

Medium term 1 – ferrite magnet generators

Shortage of rare earth magnets could restrict production of generators. OEMs with access to novel ferrite magnet technology would benefit from significantly lower costs.

Medium term 2 – artificial intelligence

Advanced robotic technology combined with Artificial Intelligence could enable self-service turbines with automated repair as well as inspection.

Disruptive innovation horizons – long term

Long term 1 – floating wind

As deployment of floating wind increases, costs will decrease. Combined with increased demand from global markets this could push floating wind costs below fixed in majority of markets.

Long term 2 – airborne wind energy systems

Breakthroughs in airborne wind systems, multi-rotor or large vertical axis could radically change the market beyond 2030.

Long term 3 – novel business models

New energy system business models could combine demand side response with wind turbine production. e.g. non-time critical demand will automatically purchase wind generation via consolidation services.

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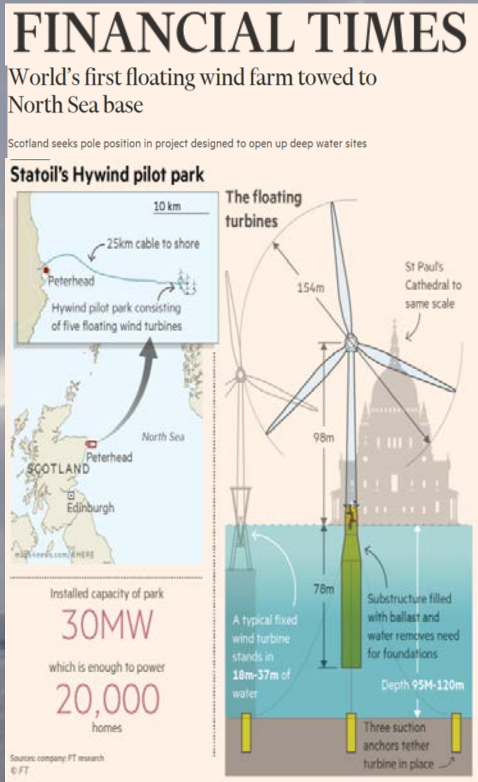
ore.catapult.org.uk

Sebastian Bringsvaerd, Head of Floating Wind Development, Statoil ASA


FINANCIAL TIMES

World's first floating wind farm towed to North Sea base

Scotland seeks pole position in project designed to open up deep water sites

Riding the next wave in renewables

Statoil

Offshore Wind Conference, Glasgow 30 Jan 2018

Sebastian Bringsværd – New Energy Solutions - Statoil

2001
The idea

2009
The demo

2017
The world's first floating wind park

Our strategy

SHORT TERM	MEDIUM TERM	LONG TERM
Faster and deeper cost reductions	**Build the next generation portfolio**	**Provide energy for a low-carbon future**
• Strict financial discipline • Capturing the upturn in oil and gas prices	• Maximizing value and seek opportunities • Build renewables portfolio consistently towards a material scale	• A resilient upstream portfolio • A material renewable energy portfolio

Offshore wind - building on our oil and gas competence

SAFETY IS OUR FIRST PRIORITY

LARGE COMPLEX PROJECTS

MARINE OPERATIONS

LEVERAGE GLOBAL SUPPLY CHAIN

TECHNOLOGY AND INNOVATION

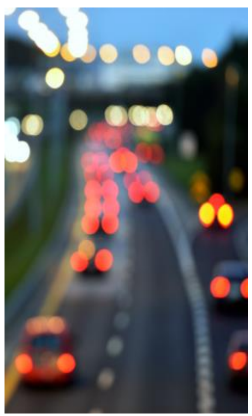
Statoil

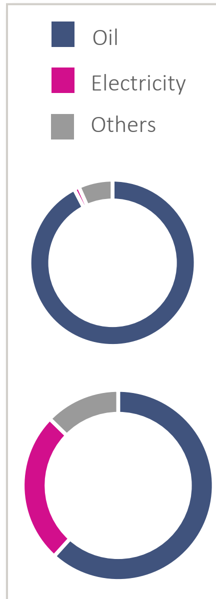
Energy Transition - where does it take place?

2017

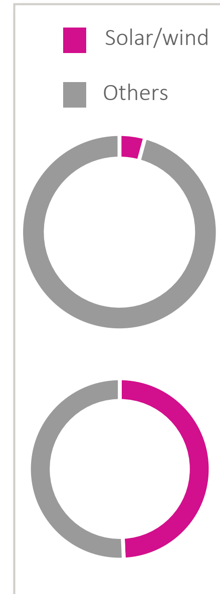
2050

Transport





Power



Heat

Source: Statoil's EP18, Renewal scenario

Reducing cost by 30% in large-scale project*

Targets in 2016

Dudgeon offshore wind park

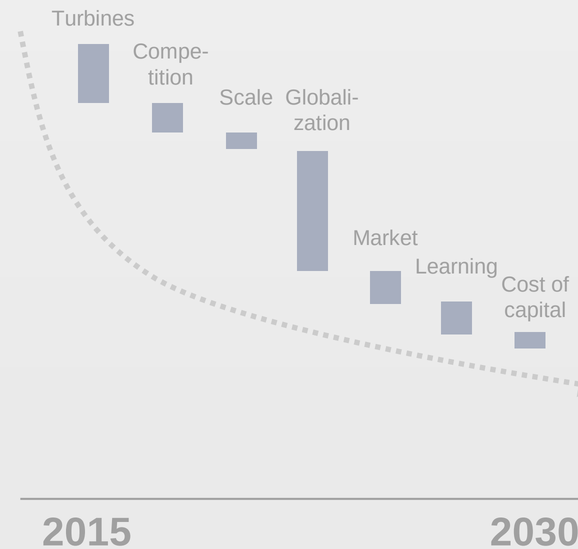
- 402 MW production capacity
- 67 turbines w/6 MW capacity: «State of the art» technology
- GBP 1.5 billion total investment sanctioned in 2014
- Offshore installation in 2016
- First electricity in 2017

Statkraft | Masdar A MUBADALA COMPANY | Statoil

Illustration photo from Sheringham Shoal

Roadmap to reduce costs further by 40% towards 2030

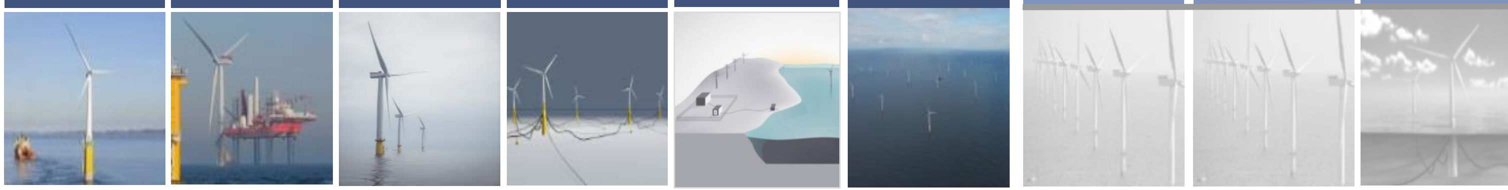
Cost of energy drivers – illustrative future projects



** Compared to similar previous large-scale offshore wind project*

Rapid expansion within offshore wind

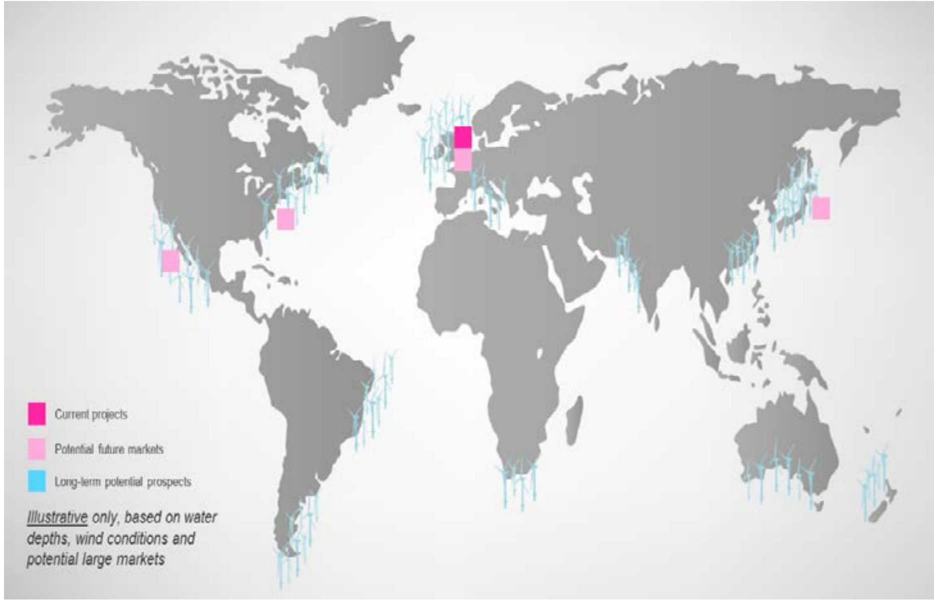
						North West Europe	United States East Coast	Japan / US West Coast
Hywind demo	Sheringham Shoal	Dudgeon	Hywind Scotland	Batwind	Arkona	Dogger Bank	New York	Hywind large scale
In operation	In operation	In operation	In operation	In development	In development	Consented	Auction won	
2.3 MW	316 MW	402 MW	30 MW	1 MW	385 MW	3 x 1.2 GW	1-2 GW	
2009	2012	2017	2017	2018	2019	2020 +	2024 +	



** All capacity figures on 100% basis*

Statoil

Vast potential for floating offshore wind



Size of the prize

12 GW in 2030

Expected LCOE

40 – 60 €/MWH by 2030

The big four

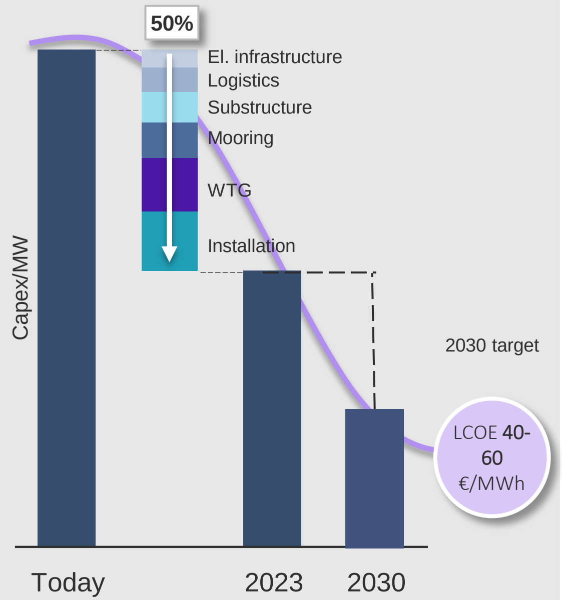
US West Coast
Japan
France
Scotland/Ireland

Statoil

Next step for Hywind - lead floating wind to industrial scale

Cost

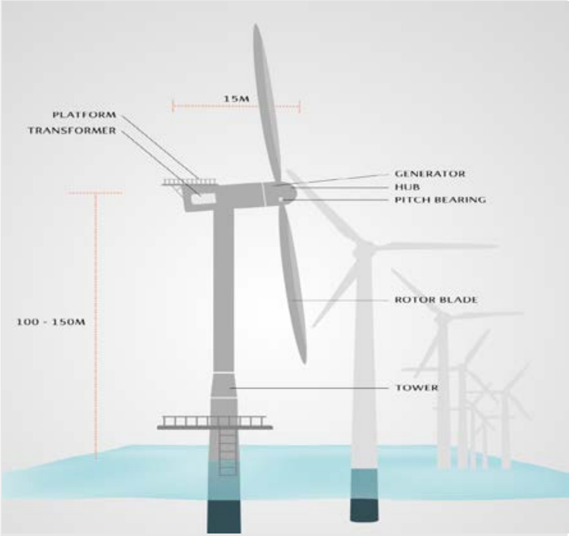
Hywind cost roadmap



Deployment

Scalability critical for market success

Concept development



Technology development focused on:

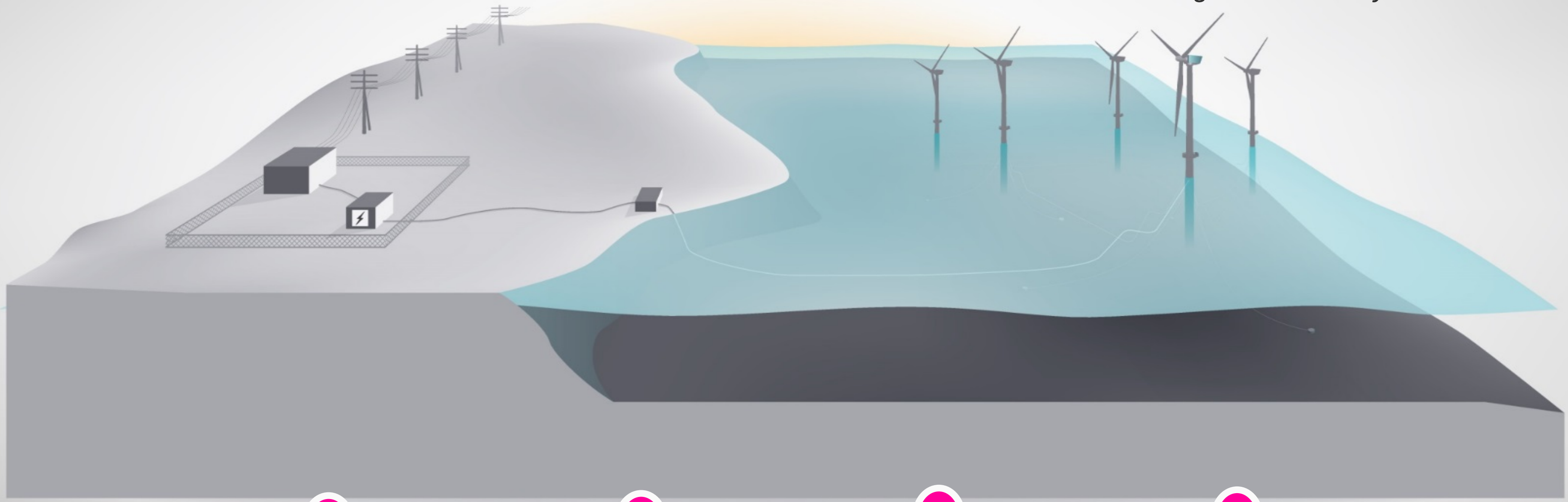
- Site selection and park layout
- Design for scale and weight
- Proprietary motion controller
- Installation and maintenance

Piloting the Batwind concept @Hywind Scotland

Floating Wind + Storage + Grid

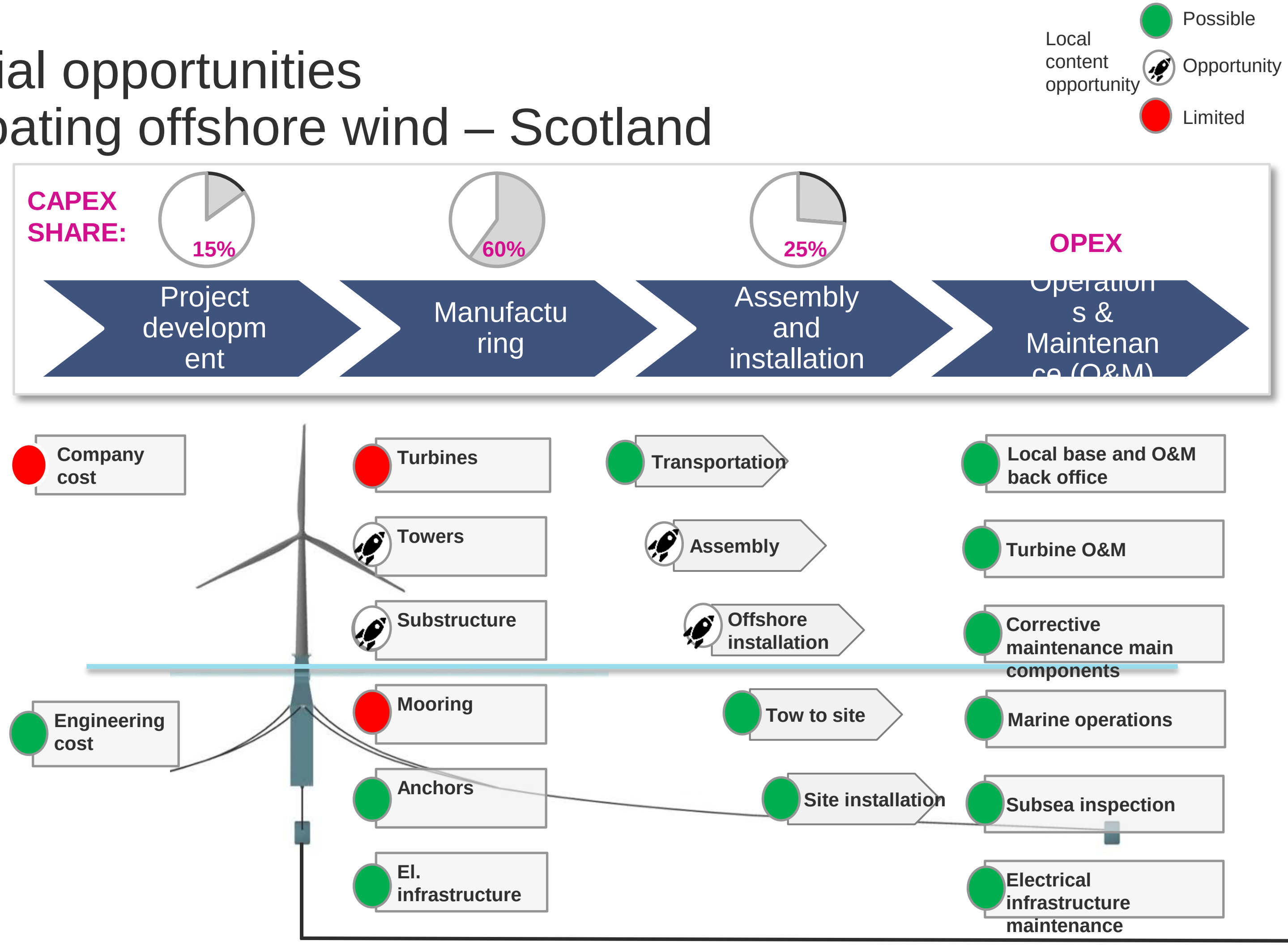
1 MWh / 1 MW Li ion battery storage system

- *Mitigate variablity and enhance the value of of wind energy*
- *Responds to the need for integrated storage in future power systems*
- *Test business models to make storage commercially viable*



1. Capture excess wind power
2. Reduce balancing cost
3. Increase revenue through price arbitrage
4. Deliver grid and system services

Industrial opportunities from floating offshore wind – Scotland



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Statoil. The Power of Possible

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Dr Steve Wyatt, Research and Innovation Director, Offshore Renewable Energy Catapult

Professor Paul Weaver, Professor in Lightweight Structures, University of Bristol

Simon Heyes, CEO, Kite Power Systems

Andy MacDonald, Senior Innovation Manager, Offshore Renewable Energy Catapult

Sebastian Bringsvaerd, Head of Floating Wind Development, Statoil ASA

IN ASSOCIATION WITH

CATAPULT
Offshore Renewable Energy

scottish renewables

OFFSHORE WIND CONFERENCE, EXHIBITION & DINNER

29 & 30 JANUARY 2018 **GLASGOW**

areg Aberdeen Renewable Energy Group

Crown Estate Scotland
Oighreachd a' Chrùin Alba

ECOSSE Subsea Systems ...because we think differently

HIE
Highlands and Islands Enterprise
Iomairt na Gàidhealtachd 's nan Eilean

INVEST IN FIFE

James Fisher Marine Services

NewWaves Solutions
Marine & Environmental Services

A Competitive, Sustainable Scottish Supply Chain: Performance, Risk and Efficiency

Isla Robb, Offshore Wind Lead Specialist, Scottish Enterprise

Jim McSporran, Regional Director, Peterson UK Ltd

Iain Sinclair, Chief Business Development Officer, Liberty Steel UK

Mike Wilson, Chairman, Ecosse Subsea Systems

John Best, Special Projects, James Fisher Marine Services

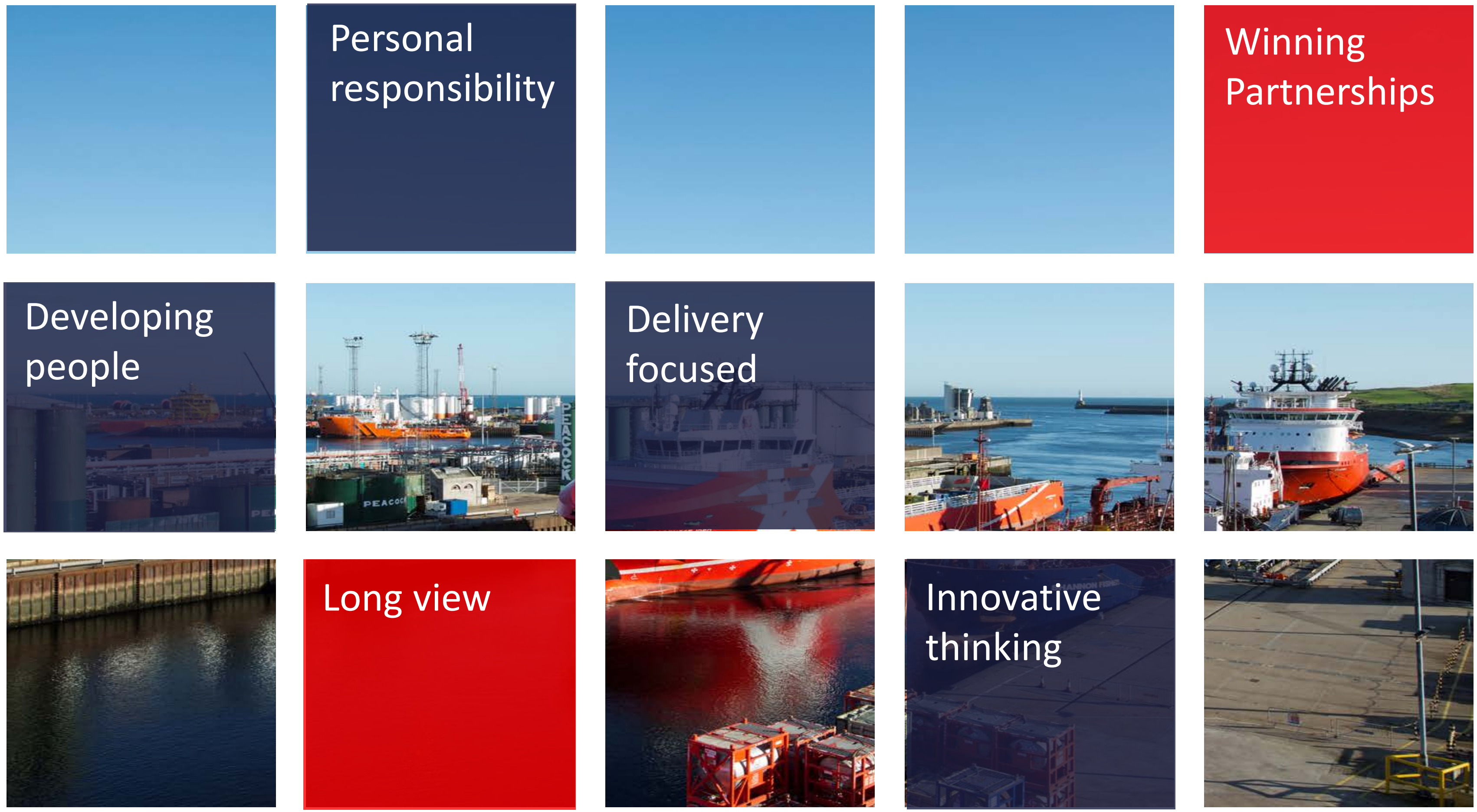
Jim McSporran

Regional Director, Peterson UK Ltd

PETERSON

A new model for energy logistics

January 2018


Personal responsibility
Winning Partnerships
Developing people
Delivery focused
Long view
Innovative thinking

PETERSON CONTROLUNION

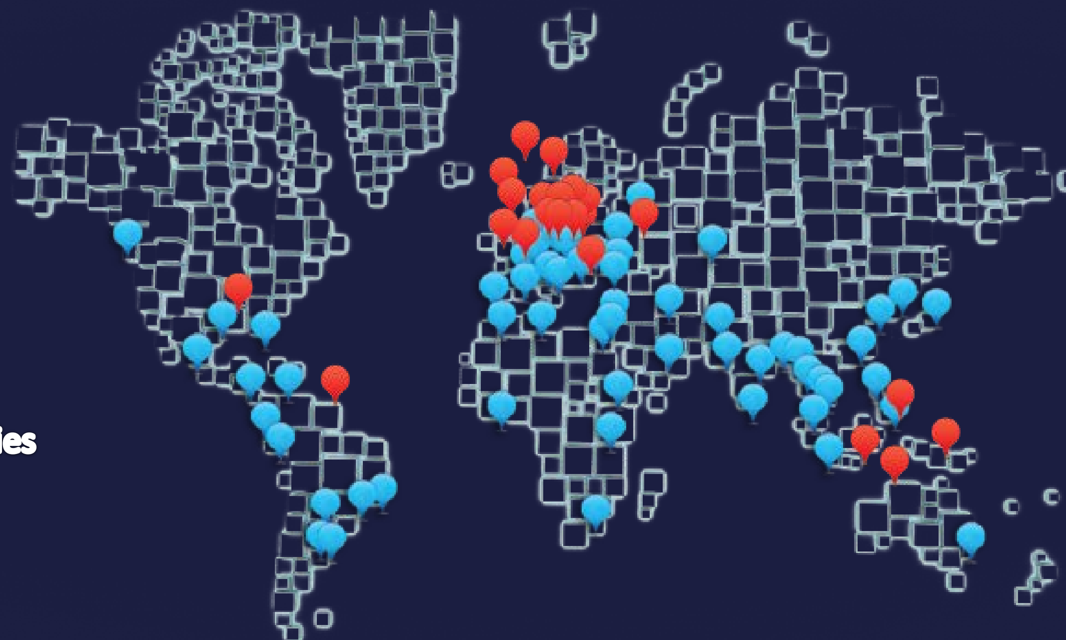
1920

4500+ People

€1bn

Turnover

70 Countries



Family owned
non listed company.
Long term vision -
Thinking in generations.

Inspections | Certifications | Collateral Services | Logistics | Recruitment | Procurement

About us

Active since

1968

1,000+ People

Market leading position and a growing international presence

Part of a wider group delivering an extensive range of services in logistics, quality, certification and risk management

International network of offices and operations

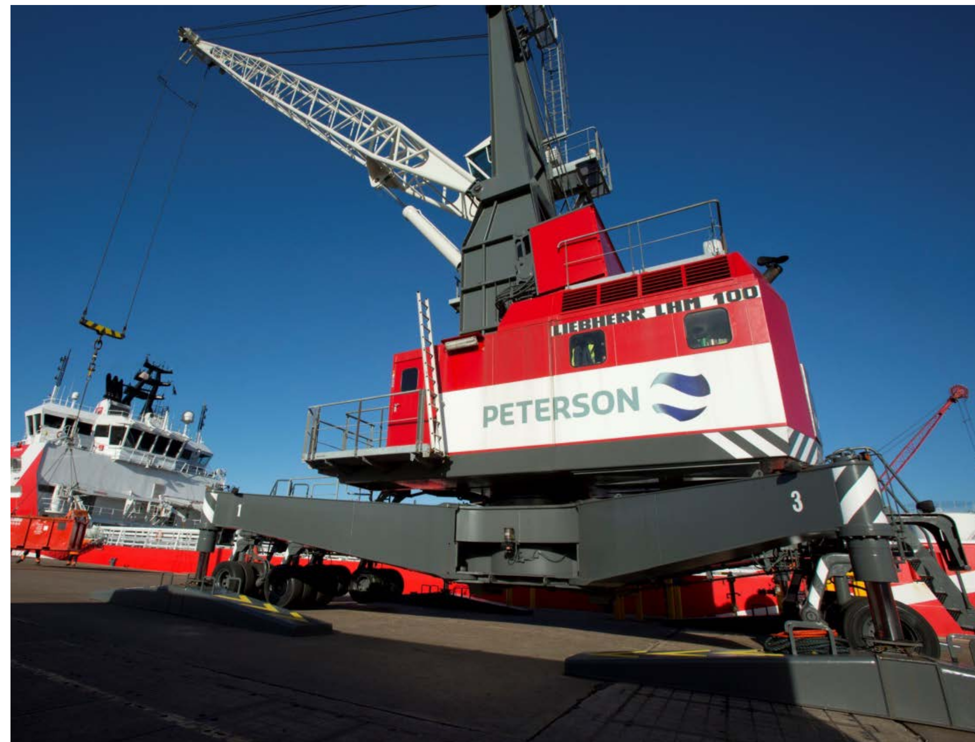
ISO	9001
ISO	14001
ISO	18001
ISO	50001

accredited

Energy logistics

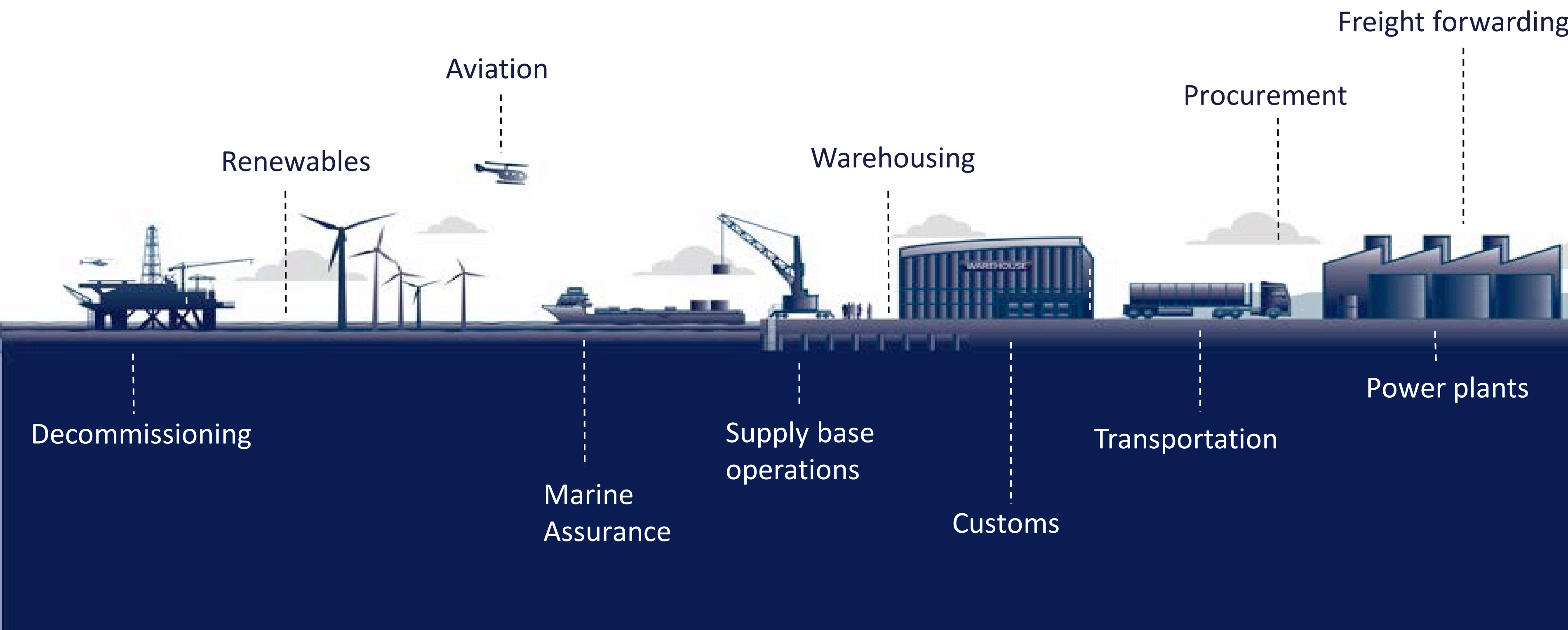
PETERSON

- Market leader in energy logistics and supply chain optimisation
- Broad range of services and capabilities
- Supported by leading edge technology
- Focused on delivering improved customer asset utilisation and lowering cost through shared resource model
- Long-term relationships with customers in key regions



Our vision

Successfully transferring logistics experience and safety standards from highly regulated oil & gas industry to other areas of the energy sector.
This incudes providing complete supply chain management services for the renewables and power plant industries.

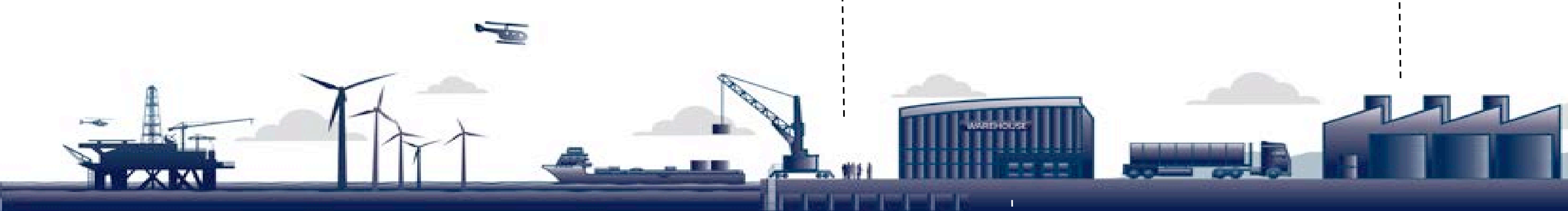


PETERSON

60,000 te of offshore decommissioning

1 million tonnes of cargo movements

600 million litres fuel throughput



Largest vessel charterer in the North Sea*

1 million ft^2 warehousing

*non operator

North & Baltic Sea presence

PETERSON

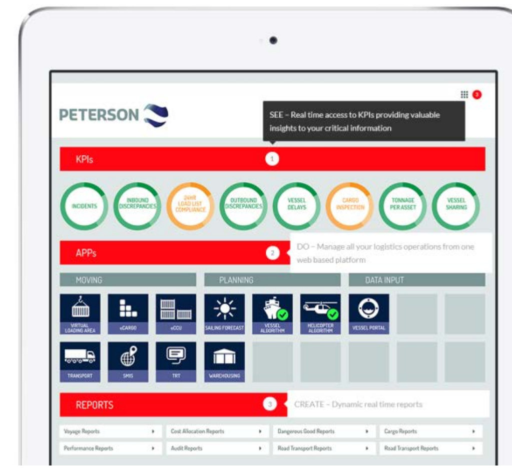
Offshore wind support

- ASSET MANAGEMENT CONTROL
- CCU RENTAL
- CUSTOMS FORMALITIES
- DRONE SERVICES
- FUEL SERVICES
- AVIATION SERVICES
- CHEMICAL SUPPLY
- WAREHOUSING & STORAGE
- DECOMMISSIONING
- FREIGHT FORWARDING
- MARINE TECHNICAL SERVICES
- SUPPLY BASE OPERATIONS
- SELF-PROPELLED MODULAR TRANSPORTERS
- ROPE ACCES
- OSV CHARTERING
- PROCUREMENT
- SHIPS AGENCY
- NON DESTRUCTIVE TESTING
- VESSEL SHARING
- ROAD TRANSPORTATION
- PRE-SHIPMENT INSPECTIONS

Game changing technology…

… to us it's the new normal

- We use advanced analytics and **machine learning** to build a supply chain that is faster, more robust and more responsive to change.
- Our decisions are **smarter**, because they are based on **real time** data that identifies even small savings to drive costs out of our customers operations and take efficiency to another level.



Real time logistics | **Track and trace** | **Data driven decisions** | **Real time KPIs** | **Collaborative supply chain**

Track record – renewables

United Kingdom

- Dudgeon
- Race Bank
- Burbobank
- Burradale
- Aberdeen
- Walney 1-2

Netherlands

- Gemini

Germany

- Baltic 1 & Baltic 2
- Veja Mate
- Wikinger

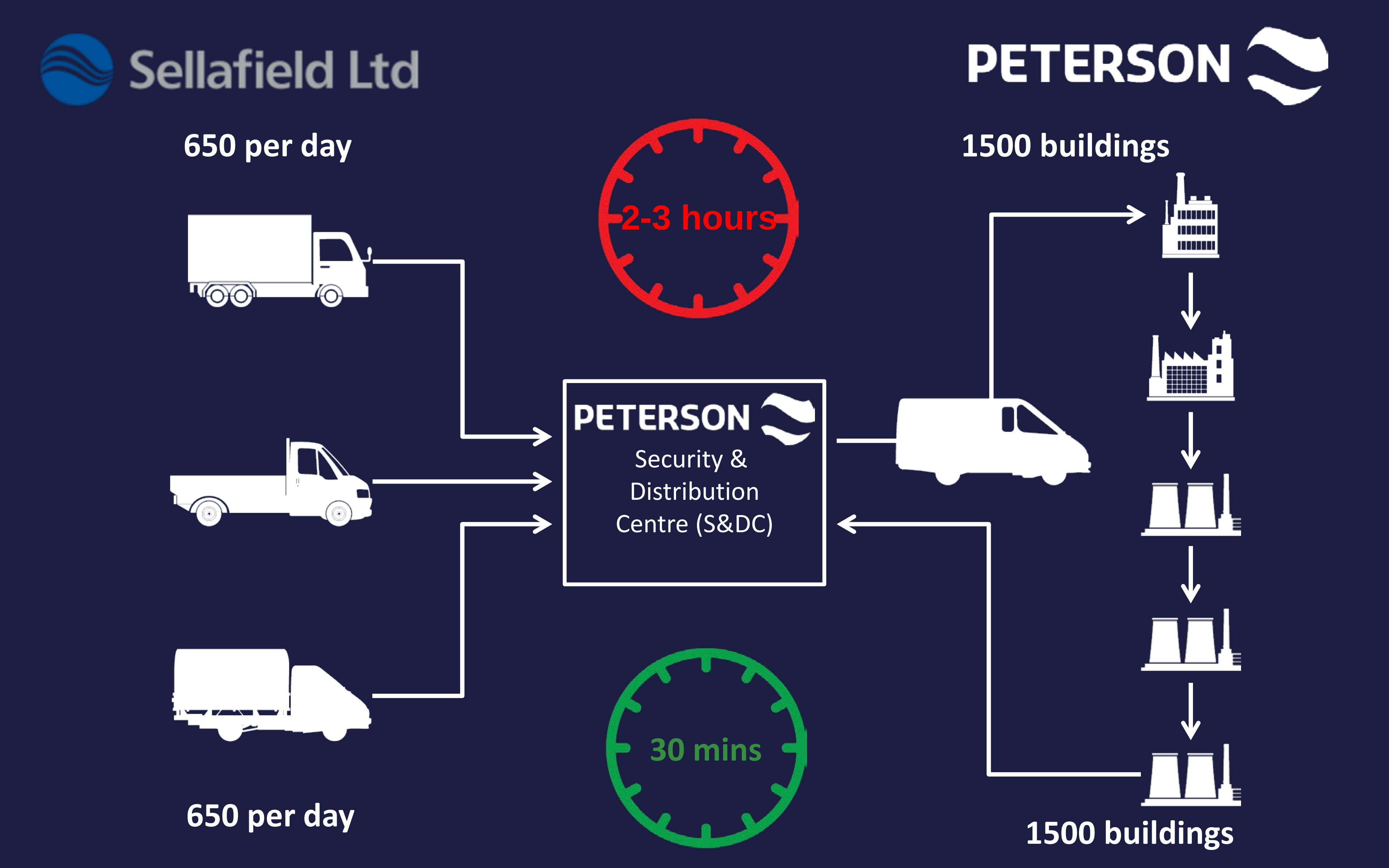
Case study – Sellafield

PETERSON

The problem – crush at the gate
Typical morning at Sellafield main gate

A Nuclear Management Partners company operated under contract to the NDA

Sellafield Ltd


Sellafield Ltd
PETERSON
650 per day
2-3 hours
1500 buildings
PETERSON
Security & Distribution Centre (S&DC)
30 mins
650 per day
1500 buildings

The solution – a collaborative approach

Working in collaboration with Sellafield Ltd, Peterson are partners in the management of the new inbound logistics service through the introduction of a web-based **Delivery Management System** and the **Lillyhall Distribution Centre.**

"While working with Peterson as part of the new inbound logistics service for Sellafield I have found them to be a collaborative partner who are keen to work with us to provide the most effective solution to meet the customers' demands. The approach taken by the team has been professional throughout and they have used their previous experience in this field to aid success."

Liz Spedding, Head of Facilities Services

Case study - offshore wind SNS

PETERSON

- A leading provider of logistics support to windfarm assets in the Southern North Sea.
- Provision of comprehensive logistics services including stevedoring, ship agency services, provisions delivery and transportation of personnel for walk to work security. Also responsible for the supply of fuelling services from its facility in Great Yarmouth.

Case study - SPMTs

- Supported the barge load-out of the 1,800Te Dudgeon offshore windfarm substation provided 12 Self-Propelled Modular Transporters (SPMTs) axles required for this operation.

Case study – Walk to Work

- Supported the Walk to Work vessel with logistics services, fuel provision and Walk to Work support.

Local Content

- Track record in recruiting, training and developing employees local to our areas of operation where possible
- Committed to creating opportunity for local supply chain and supporting local suppliers in the provision of goods and services for the execution of the work
- Active in the communities we works in through our Dare to Care programme donations in excess of £60,000 to local causes in Scotland since 2015, including Friends of Anchor, RNLI, Grampian Autistic Society & Alzheimer's Scotland.

A new model for energy logistics

Iain Sinclair

Chief Business Development Officer, Liberty Steel UK

LIBERTY STEEL

Daring to be different....

Presented by

Iain Sinclair, Chief Business Development Officer

Tuesday 30th January 2018

Challenge own value chain

Green to Greener

A new vision for the steel industry

- GFG's vision to transform the future of industry by delivering innovative solutions to our customers that enable them to grow and thrive.
- The strategy for achieving this is called **GREENSTEEL**:
    - Using steel manufactured in the local market using local materials
    - Produced using green, renewable long-term sources of power
    - Re-invigorating the subsequent engineering supply chain and delivering innovative solutions that provide a competitive advantage to customers

Value chain to OW supply chain

LIBERTY
STEEL

Only
steel manufacturer
in **Scotland**

LIBERTY currently supports over **5000** jobs in the UK

Targeting and positioning

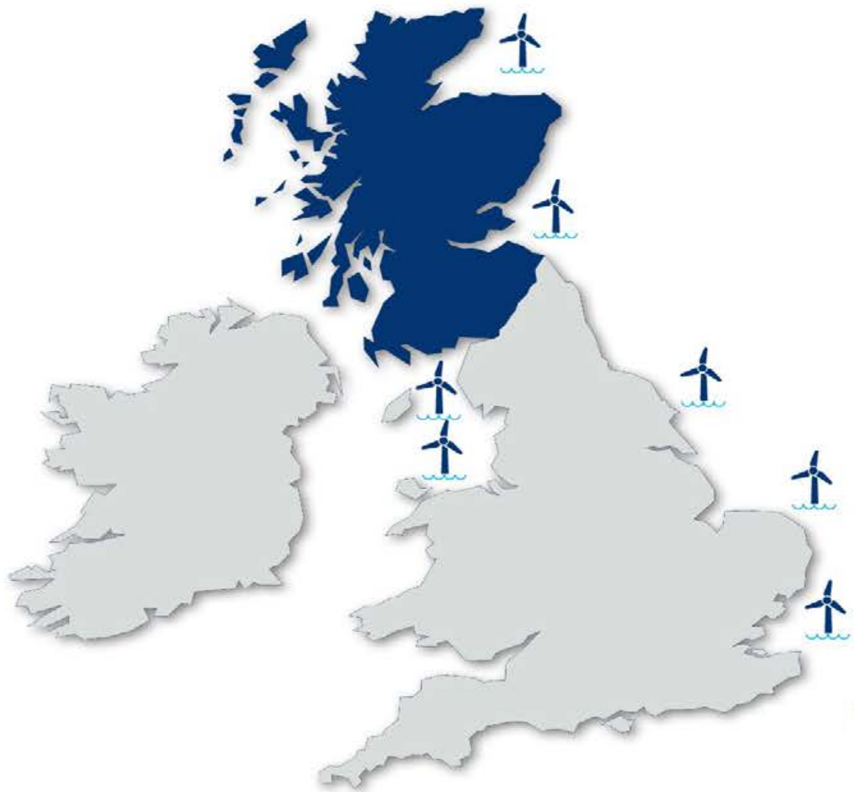
LIBERTY STEEL

Scotland has over **25%** of **Europe's** total offshore wind resource

Scottish Government has a **target** of generating the equivalent of **100%** of electricity consumption from **renewable sources** by **2020**

4 GW of consented **offshore wind generation** to be installed

Over **£500 million** **capex spend** on **NnG project** in Scotland



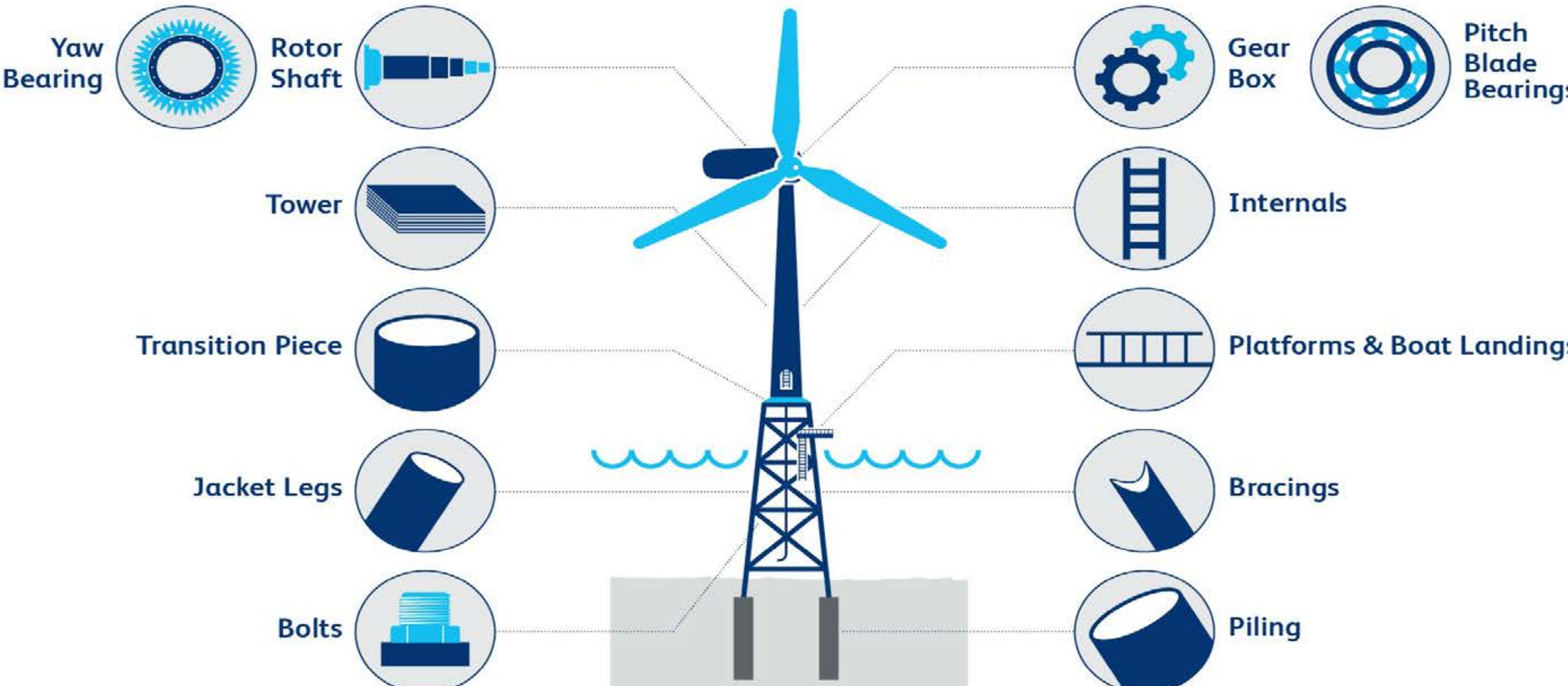
84% of a wind turbine is **steel weight**

UK to have a **total capacity** of **30 GW** of **offshore wind** by **2030**

The cost of **new offshore wind** has fallen by nearly since **50%** since 2015

In the **next four years**, the industry **will invest** over **£17.5bn** in projects

Have a clear value proposition



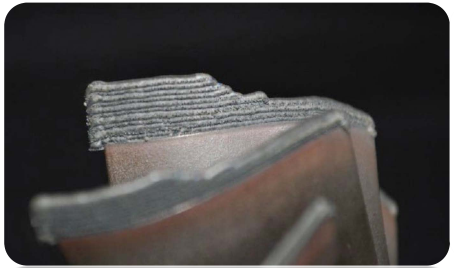
Collaboration and risk mitigation..

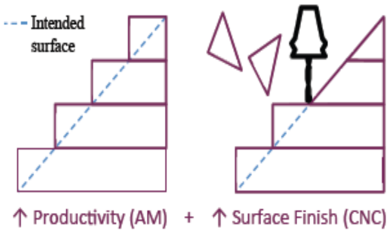
LIBERTY STEEL

= enhanced value creation and shared success

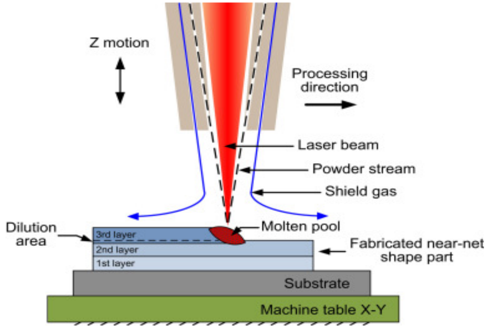
Future Technologies - Today

- **Hybrid processing** – Additive manufacturing and CNC Machining Combined - Has the potential to revolutionise supply chains
- This allows the repair of damaged components – such as bearings and gears in turbines - which would traditionally be replaced.
- The below image shows an impellor which has had 10 layers of Inconel 718 deposited – essentially, 3D printed - prior to finishing





- **Hot Isostatic Press, HIP** is the process designed to reduce porosity of a material and improves mechanical properties and workability.
- This process can be used to directly manufacture components either from a mould or that has been printed
- **Laser Engineered Net Shaping, LENS** is the system used for the component repairs



Investment in future talent

- **The GFG Foundation** is a charitable organisation which focuses on the retention and creation of engineering skills.
- Its vision is to identify and develop the potential in people to give them a pathway into employment.
- The Foundation delivers programmes that identify and close the skills gaps that support the development of the engineering, metals and renewable energy sectors.
- The initial focus of the foundation will be in the United Kingdom, with programmes in other countries planned for the future.

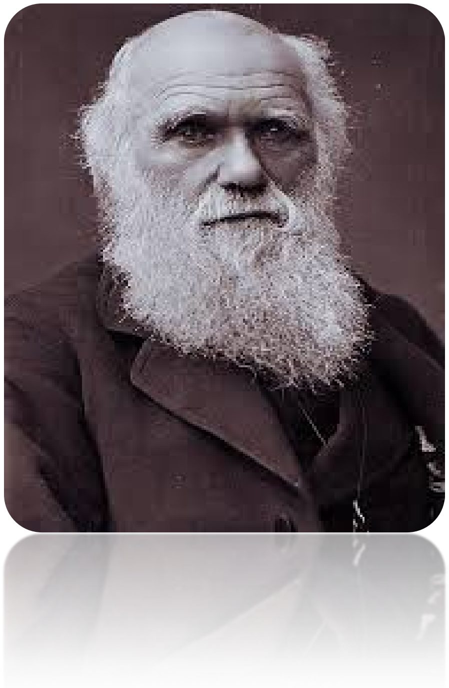
A Steel Sector Deal

A vision for the future of the UK steel sector

Our future vision for the UK steel sector is for it to become a leader in steel productivity and innovation, working in partnership with our customers and the full value chain to develop advanced steel products and services for our customers to the benefit of both society and the wider economy. Steel products of the future must not only be made in as environmentally friendly manner as possible, but they themselves must be a part of the wider solution to our transition to a low carbon, circular, economy; our sector will be at the forefront of meeting this challenge. UK steel will invest in the long term, in our facilities, our R&D, and the training and skills of our people. In doing so, UK steel producers will become the hall-mark of quality and innovation, positioning the sector to capture more of growing markets both at home and overseas.

September 2017

eef The manufacturers' organisation | UK Steel



"It is not the strongest of the species that survives, not the most intelligent, but the one most responsive to change."

Charles Darwin, 1809

Mike Wilson

Chairman, Ecosse Subsea Systems

The ESS Success Story

Ecosse Subsea Systems - Mike Wilson – Chairman

Parallel 3B: A Competitive, Sustainable Scottish Supply Chain: Performance, Risk and Efficiency

www.ecosse-subsea.com

...because we think **differently**

Contents

ESS: Company Overview

Personnel

Engineering Consultancy

Pipe-lay Technologies

Route Preparation

Ambient Lifting

Trenching

Founded in
1996

ESS Today
2018

ESS Management

ECOSSE Subsea Systems
...because we think differently

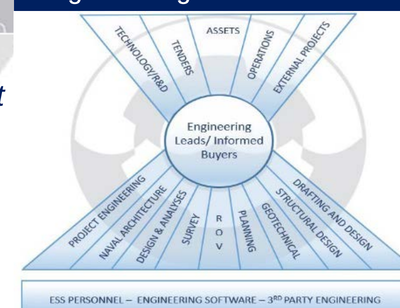
Safe, Simple, Robust

£26 million

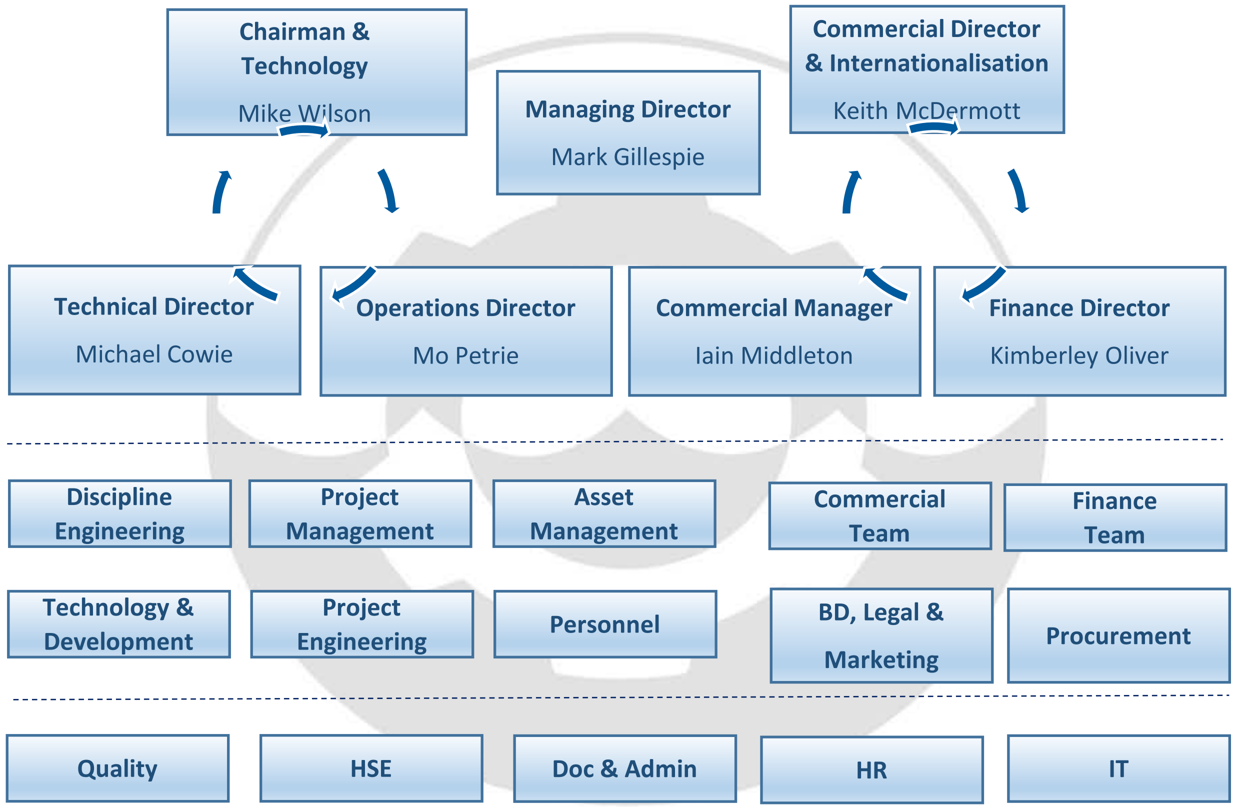
CERTIFIED ISO 9001:2008 COMPANY

90+
Personnel

Engineering & PM



ESS: Company Structure



ECOSSE Subsea Systems

ESS: Customers / Clients

Prysmian Group
NKT
Ørsted
Tideway Offshore Solutions
JD-Contractor A/S Subsea Cables & Pipelines Denmark Since 1972
FairfieldEnergy
Black Rock Tidal Power
Balfour Beatty
SIEM Offshore Contractors
e·on
Nautricity
TechnipFMC
CNR International
Allswater
EnQuest
wave energy SCOTLAND
TOTAL
Apache
CRC-EVANS
ITHACA ENERGY
Bibby Offshore because we love this business
Perenco
TAQA
Swire Seabed
GE Oil & Gas
Clough
DOF Subsea
subsea 7

ESS: SCAR Tools

SCAR Seabed System

SCAR 1
- Pre-cut trenching (multi-pass)
- Route preparation / boulder clearance

SCAR 2 / SCAR 3 / SCAR 4
- Pre-cut trenching (multi-pass)
- Route preparation / boulder clearance
- Backfill

SCAR 5 / SCAR 6
- Pre-cut trenching (multi-pass)
- Route preparation / boulder clearance
- Backfill

SCARJet
- Post-lay / simultaneous trenching
- Trench remedial works

ESS: SCAR Seabed System

One system – 3 processes - takes trenching / back fill off the critical path

Clears many boulders quickly and effectively

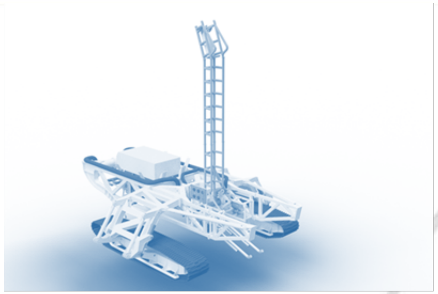
Trencher makes multiple passes within the existing trench

No part of trencher near the cable provides low risk solution for the cable

Robust through vast range of soils; reliable; fast trench production; versatile – Shore ends, shallow water, deep water

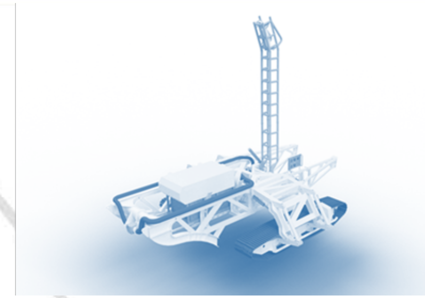
ECOSSE Subsea Systems

ESS: SCARJet



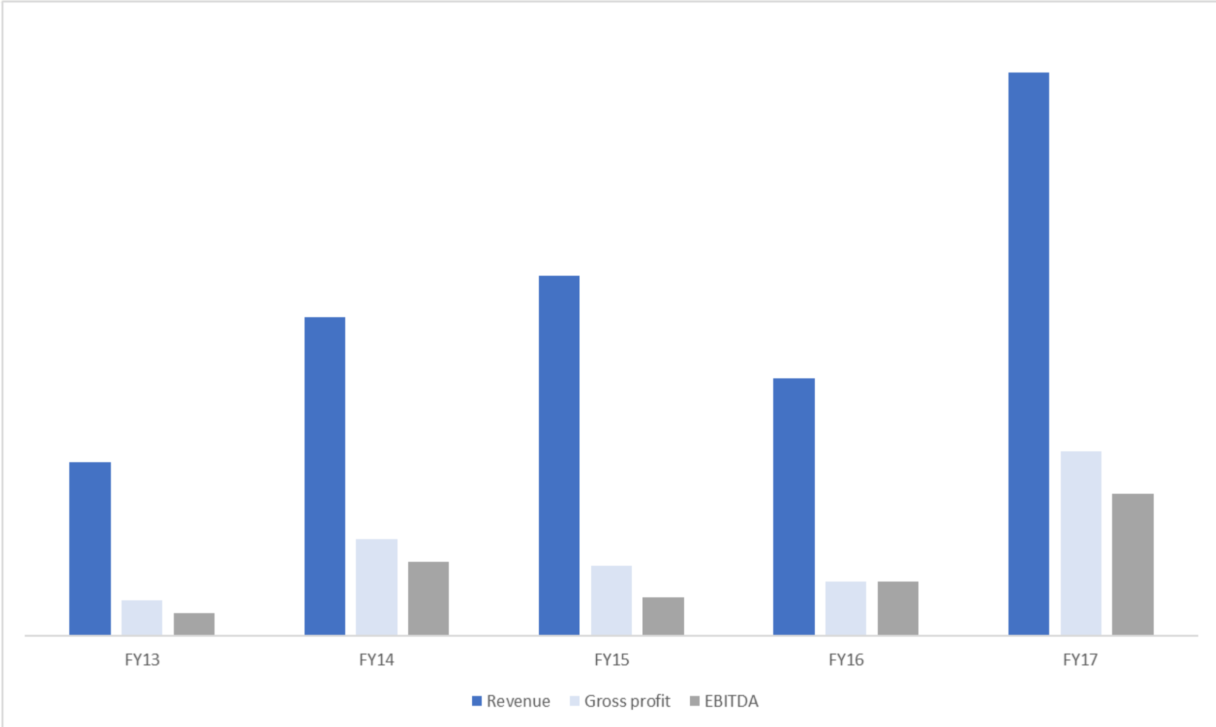
ECOSSE Subsea Systems

SCARJet



- From concept - to prototype – to reality… in 8 months….

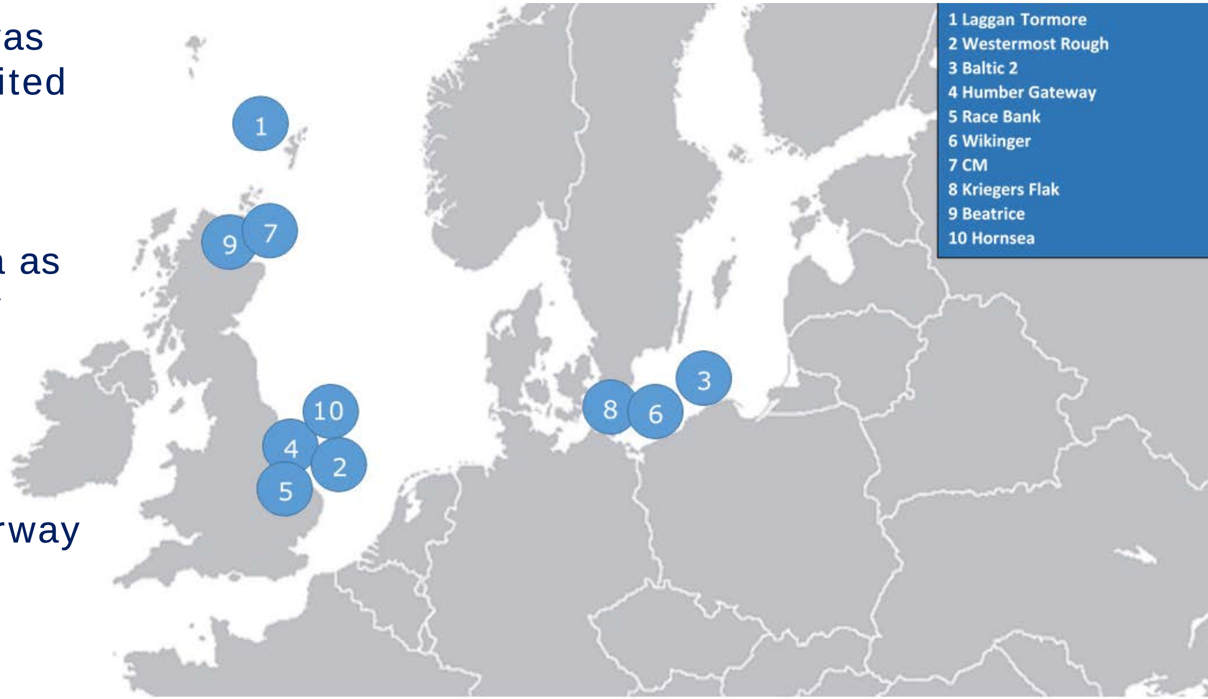
ESS: Financial Growth Story



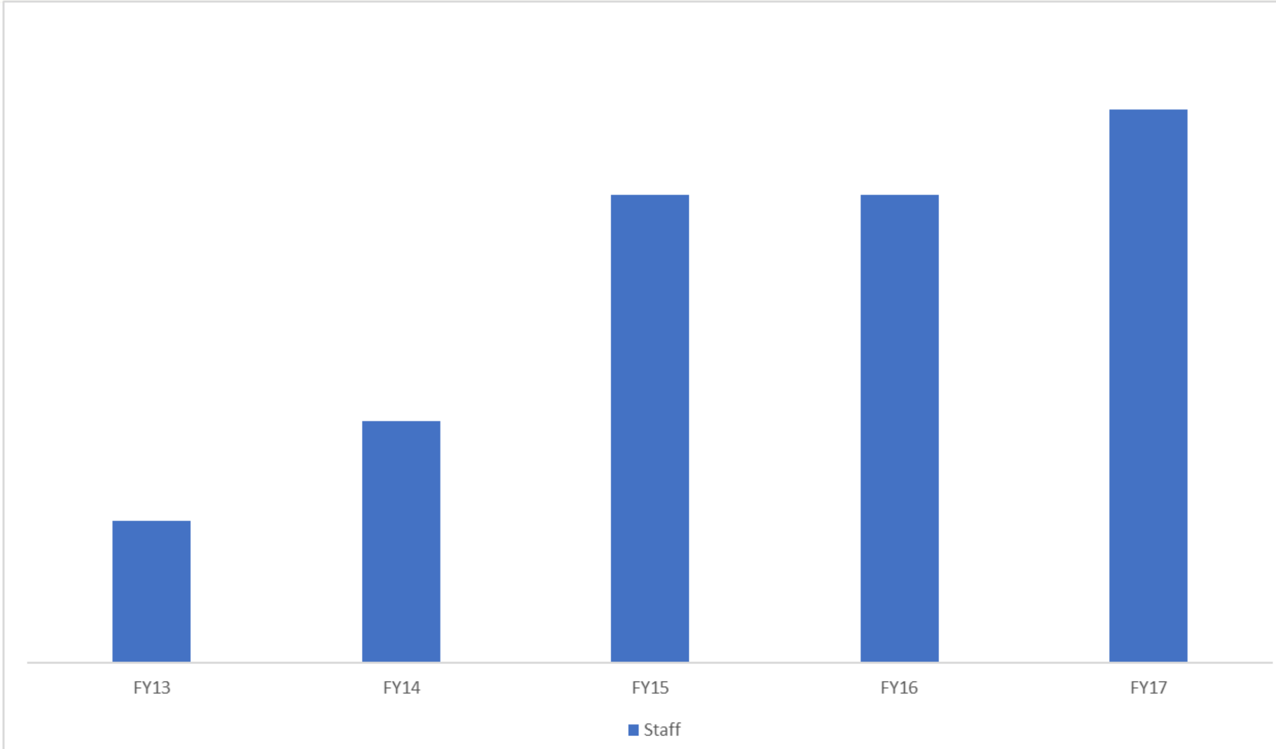
- FY17 revenue of £27.7m, more than double FY16
- FY18 is forecast to continue on an upward trajectory

ESS: A Company With International Reach

- In FY17 over a third of revenue was generated from outside of the United Kingdom.
- ESS have performed work in the Northern and Southern North Sea as well as the Baltic Sea in Germany with the SCAR Seabed System.
- ESS Personnel & Engineering Consultancy team have provided personnel to Azerbijan, Baku, Norway and Cape Town.
- ESS are currently exploring opportunities in the USA, China, Taiwan and the Pacific Ocean.
- The introduction of SCARJet will generate an increase in global trenching opportunities.



ESS: A Sustainable Employer



- Headcount has more than doubled in the last 3 years with in excess of 40 people employed. The workforce extends to more than 90 at times of peak deployment.

ECOSSE
Subsea Systems

Thank you for listening
www.ecosse-subsea.com

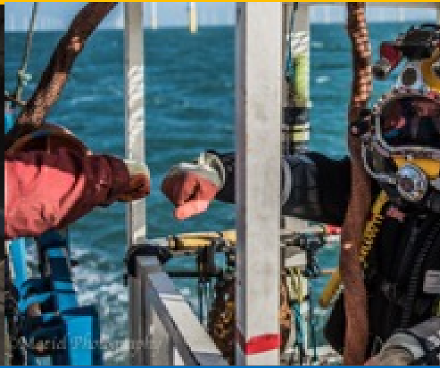
John Best

Special Projects, James Fisher Marine Services

James Fisher
Marine Services

James Fisher Marine Services

Offshore Services Contractor - Supply Chain Integrator



www.jfmarine-services.com

James Fisher and Sons plc: an overview

2,500+ people

45
offices

40+
countries

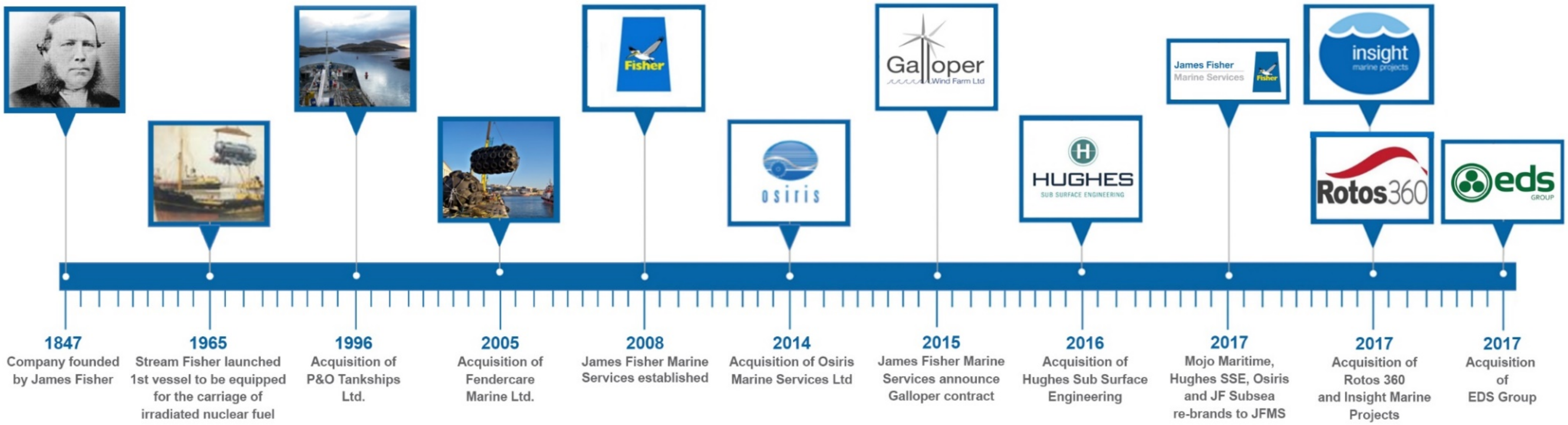
Established
1847

FTSE 250
UK PLC

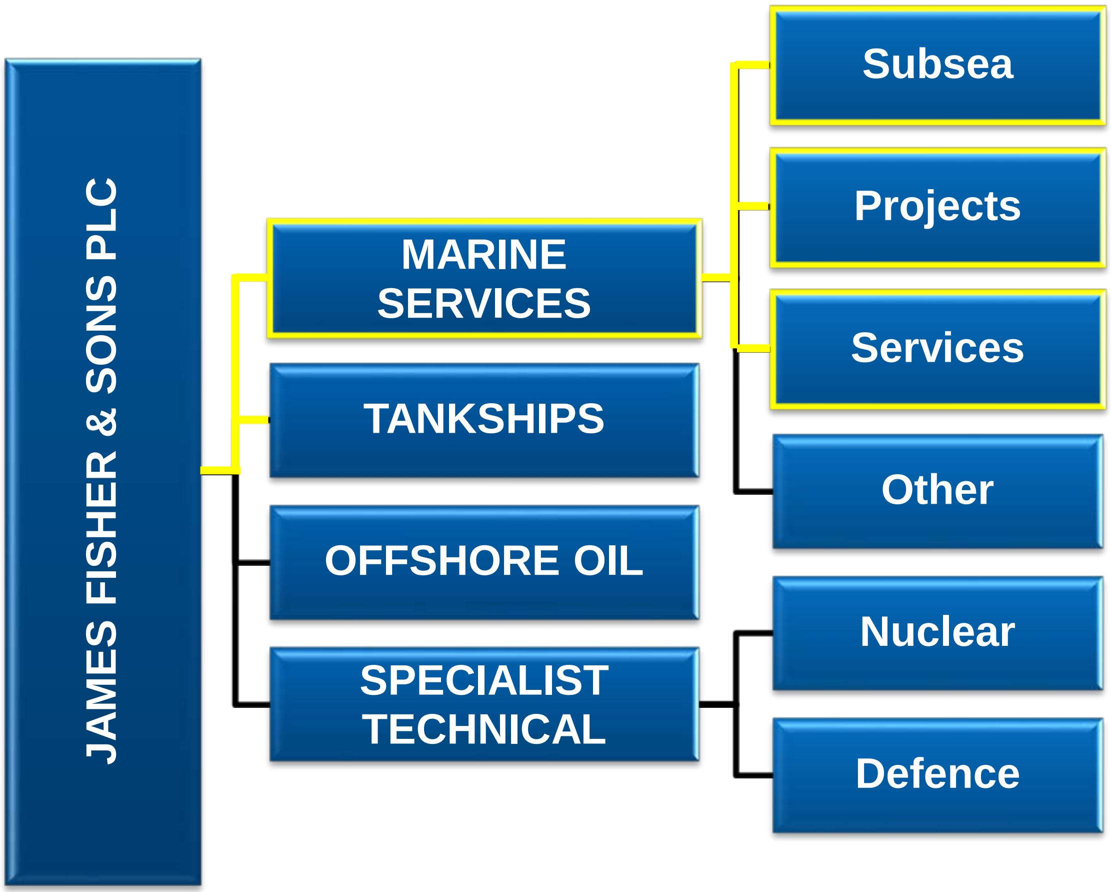
Turnover 2015-2016:
£600m

Charity:
25% all Dividends

Our history


1847
Company founded by James Fisher
1965
Stream Fisher launched 1st vessel to be equipped for the carriage of irradiated nuclear fuel
1996
Acquisition of P&O Tankships Ltd.
2005
Acquisition of Fendercare Marine Ltd.
2008
James Fisher Marine Services established
2014
Acquisition of Osiris Marine Services Ltd
2015
James Fisher Marine Services announce Galloper contract
2016
Acquisition of Hughes Sub Surface Engineering
2017
Mojo Maritime, Hughes SSE, Osiris and JF Subsea re-brands to JFMS
2017
Acquisition of Rotos 360 and Insight Marine Projects
2017
Acquisition of EDS Group

Group organigram



FINANCIAL STABILITY

With an annual turnover of ~£466m in 2016, James Fisher and Sons is listed on the London Stock Exchange in the FTSE 250 Index. All group companies contribute to the group stability.

James Fisher Marine Services

James Fisher Marine Services (JFMS), a wholly-owned subsidiary of James Fisher and Sons plc, is a provider of a wide range of marine, topside and subsea services to the **renewables**, **oil and gas** and **nuclear** industries. Operating under a single entity with a sole accredited quality management system that delivers solutions to its clients through three integrated operating divisions:

core capabilities

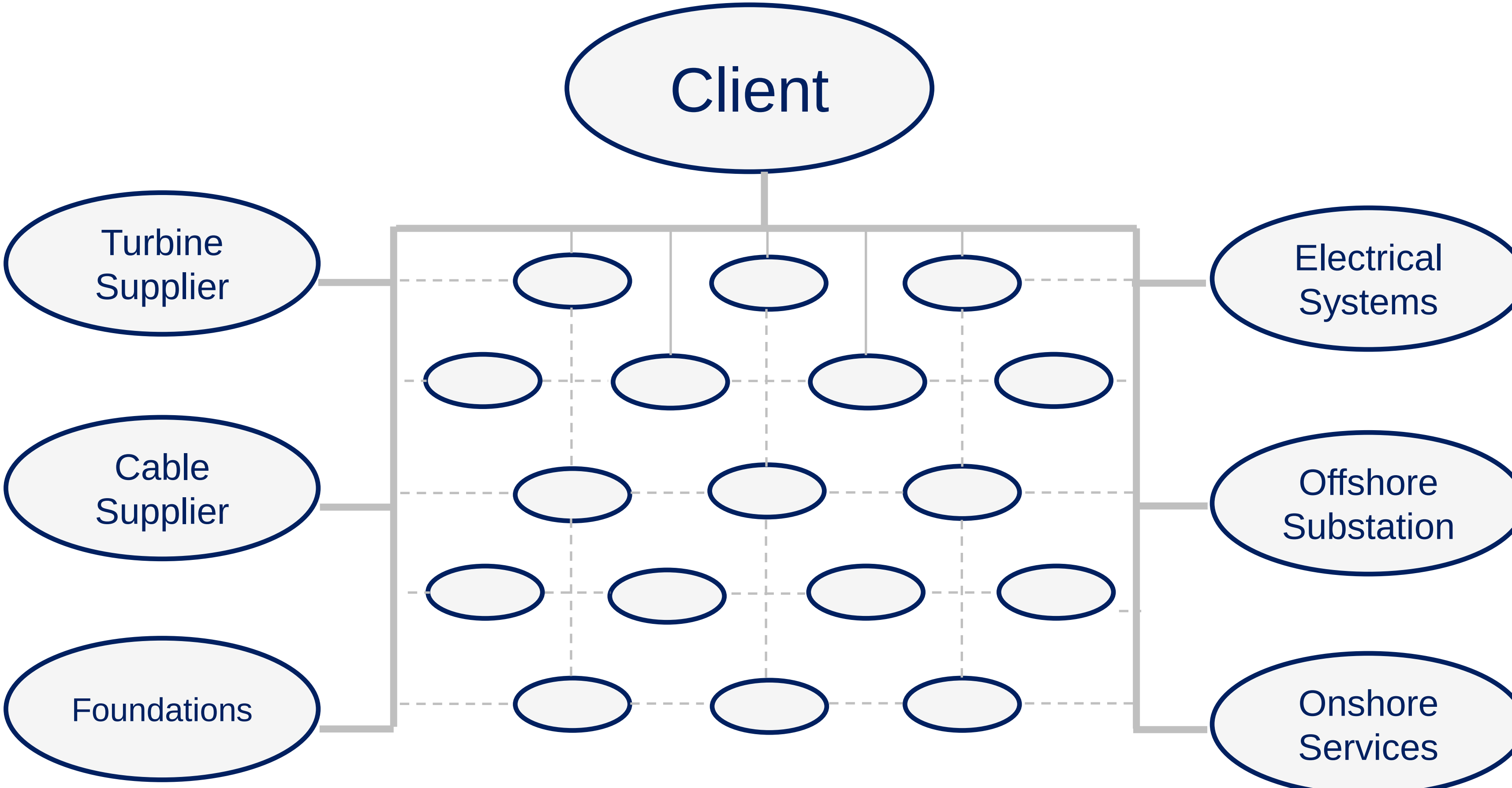
James Fisher
Marine Services

Projects

Subsea

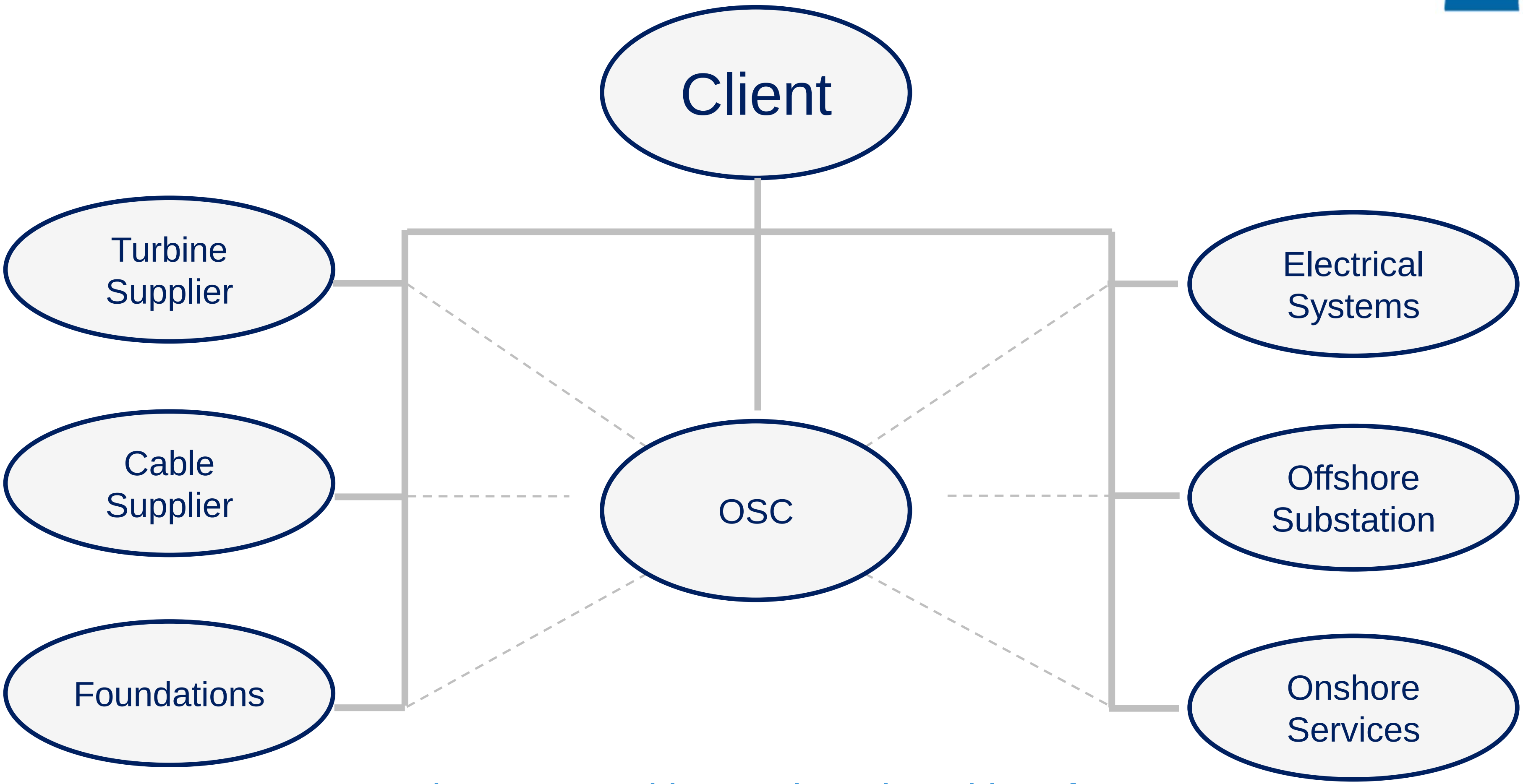
Services

Wind farm construction: a traditional approach



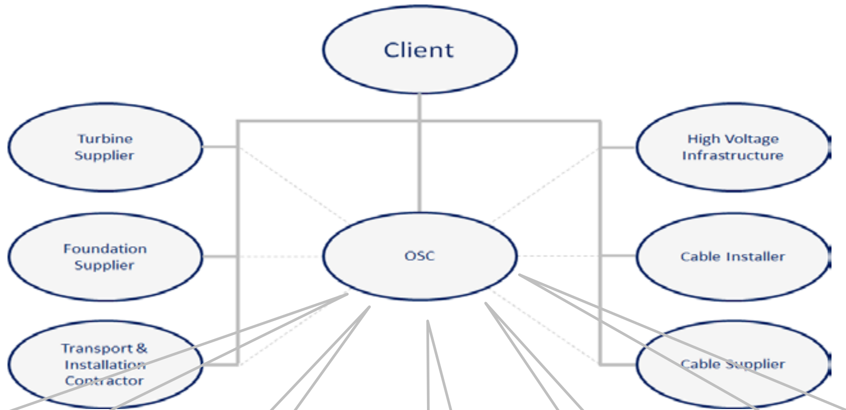
30 – 50 sub-contracts with hundreds of interfaces

Wind farm construction: an OSC approach



1 sub-contract with greatly reduced interfaces

Wind farm construction: why an OSC Approach?



Reduced Operational Lines of Communication & Operational Interfaces:

Better Focus on Day to Day Heath & Safety

Reduced Geographical Footprint;

Reduced Travel Leading To A Lower Carbon Footprint

Less Transactional Value Leakage:

A Reduction in the Project's Levellised Cost Of Energy

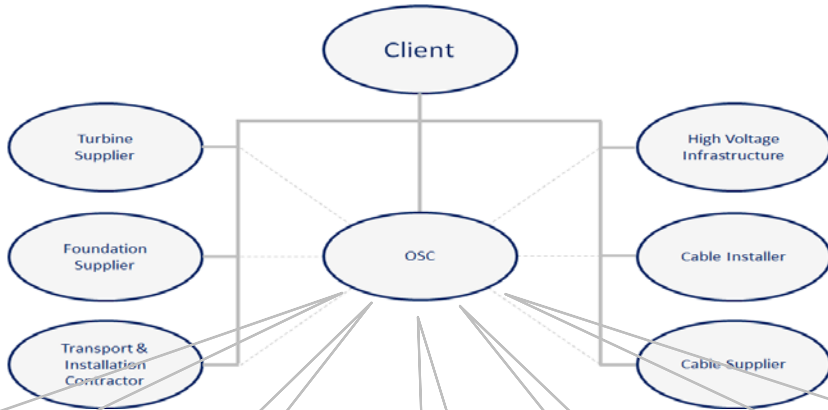
Reduced Margin on Margin from Flattened Supply Chain;

Increased Day to Day Commercial Transparency

Reduced Number of Contractual Interfaces :

Increased Day to Day Operational Transparency

Wind farm construction: key OSC benefits



OSC Part of an Integrated Team with Customer

Increased Knowledge Sharing & Smaller Management Team

OSC Contractor Provides Performance Securities

Greater Risk Assurance for Project Funding Partners

OSC Leads on Local Content

Closer Relationship with Local Supply Chain

OSC Buys into Risk & Reward Contracting Structure

Closer Alignment Across the Tier 1s

OSC Buys into Fixed Price Delivery of Scope

Greater Cost Certainty for Customer

An integrated approach

James Fisher Marine Services adds value to its clients' projects by integrating the Group's capabilities to deliver cost-effective solutions.

- James Fisher is the UK's leading marine service company with expertise applied overseas
- Focussed on marine energy markets, including oil and gas, renewables, nuclear and power
- It encourages increased in-house co-operation and integrated delivery through its group of companies
- It draws on group wide solutions to deliver larger more complex projects and term contracts through the integration of our services
- An extensive proven track record of success

Service | Integration | Delivery

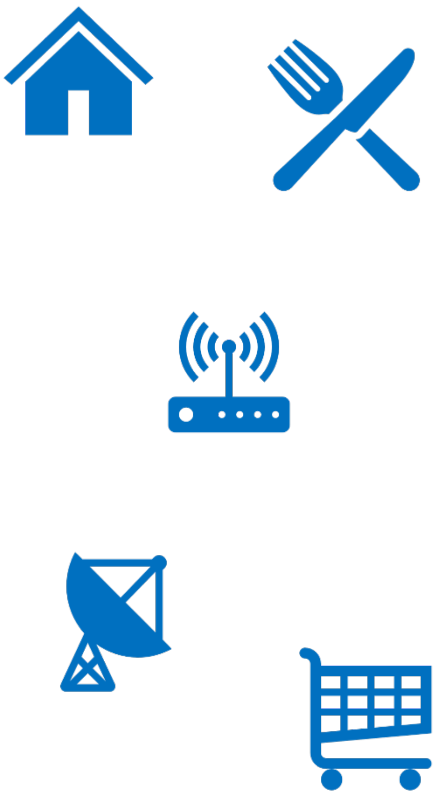
Integrating Marine Solutions

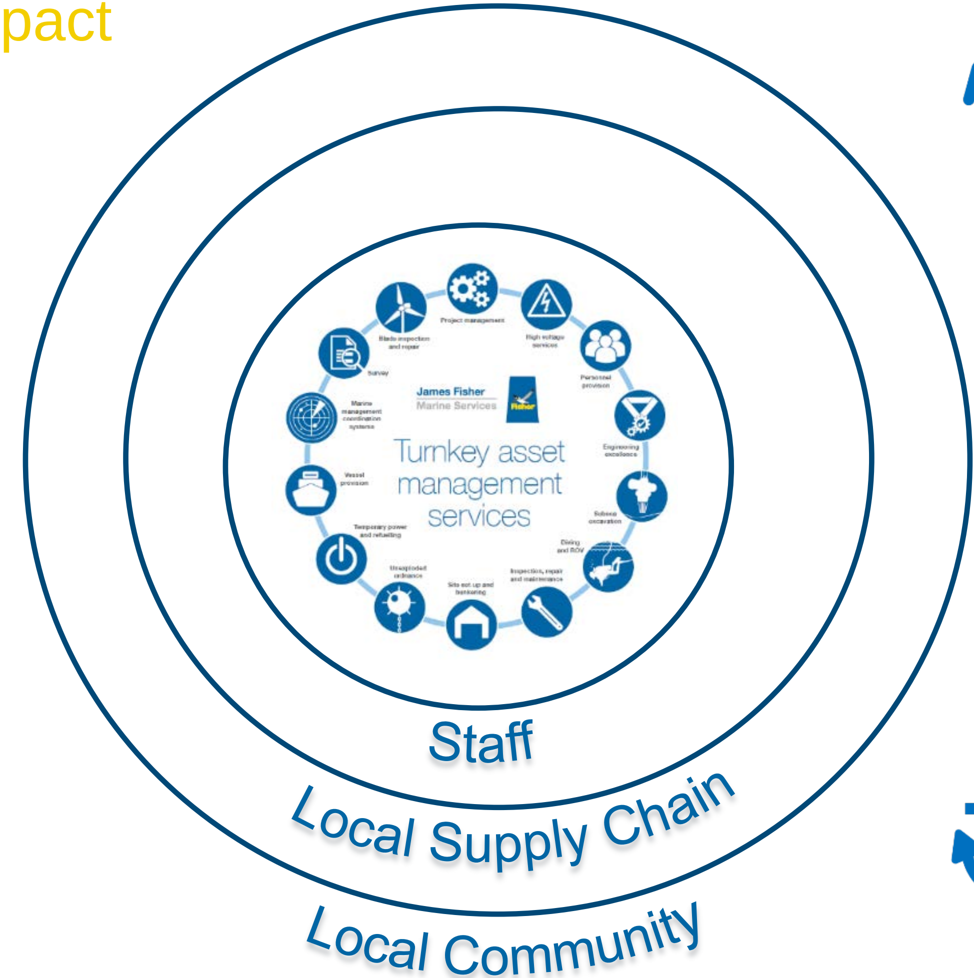
Delivering value by integrating the Group's capabilities to deliver cost-effective solutions

Service → **Innovation** → **Integration** → **Delivery**

Integrating Marine Solutions

Supply chain impact





Quality, health, safety & environment (QHSE)

The James Fisher group of companies is fully committed to delivering the highest standards of safety to its employees, contractors and on-site visitors.

- **Zero** spills to water of crude oil ship-to-ship (STS) transfers
- James Fisher Subsea operated from 2011 to 2017 with **zero** medical treatment cases
- In 2015 James Fisher Subsea Excavation operated **80,975** man hours with **zero** LTIs or fatalities
- James Fisher Subsea has delivered over **2,539,504** operational man hours from 2011-2017
- James Fisher Subsea has operated with **zero** reported environmental incidents

James Fisher Marine Services' HSE KPIs

Over **1,105,382** man hours worked in the last 3 years

0 environmental incidents in the last 3 years

0 prosecutions or enforcements in the last **3** years

0 occupational diseases in the last **3** years

Accreditations and memberships

JFMS operates to the highest, most stringent of industry standards

James Fisher prides itself on its quality systems and the delivery of its services in the safest and most environmentally efficient manner possible.

This is reflected throughout the Group and within its subsidiary companies ensuring the continued delivery of high standards and performance levels as the UK's leading marine services provider.

Local content:

Group company bases - Scotland

ScanTech Offshore
The Well Test Support Service

- Specialist oil rig cooling equipment
- 35 employees
- Turnover of £22M

RMS pumptools

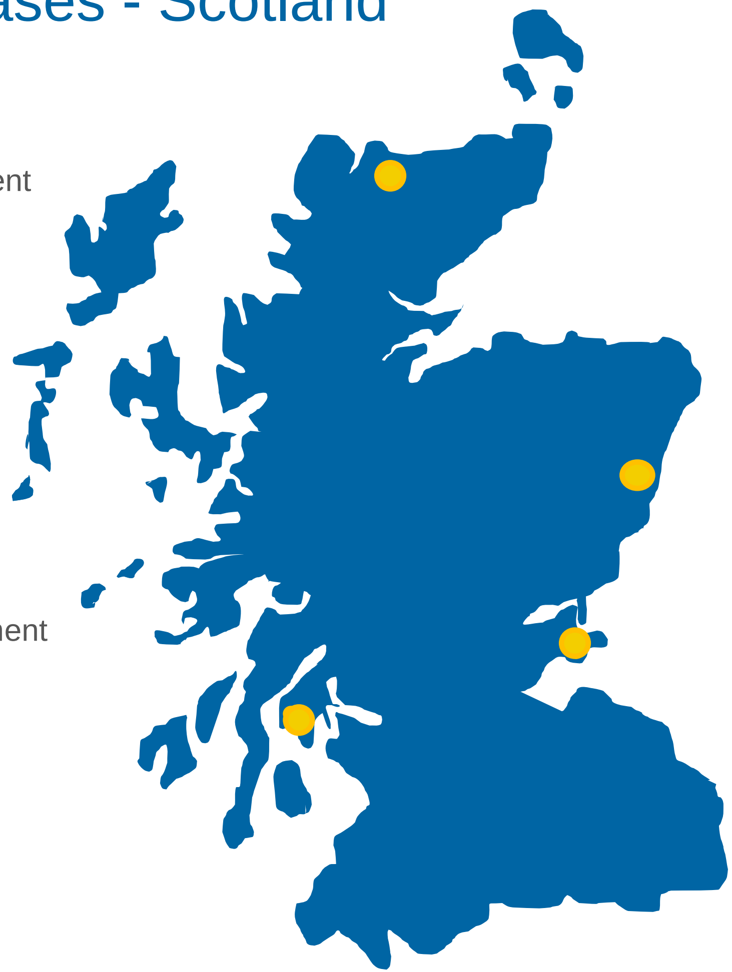
- ESP artificial lift specialists
- 25 employees
- Turnover of £7M

Fisher Offshore

- Extensive fleet of subsea equipment
- 50 employees
- Turnover of £12M

JFD

- Submarine rescue solutions
- 210 employees
- Turnover of £20M



Fisher

- Nuclear decommissioning
- 40 employees
- Turnover of £15M

national hyperbaric centre

- TUP and SAT diving services
- 25 employees
- Turnover of £8M

James Fisher Subsea Excavation

- World's largest fleet MFE tools
- 50 employees
- Turnover of £13M

Scotload
Load Measurement Specialists

- Load cell and data specialists
- 15 employees
- Turnover of £2M

R2S
RETURN TO SCENE

- Offshore digital asset management
- 23 employees
- Turnover of £2M

Core expertise

Marine projects

An enviable reputation for the effect delivery of large and highly complex marine project

Marine services

We’re able to fulfil >70% of offshore operations with integrated marine services

Subsea services

Range of specialist subsea engineering, including diving & ROVs, surveys and equipment

Core expertise

Marine projects

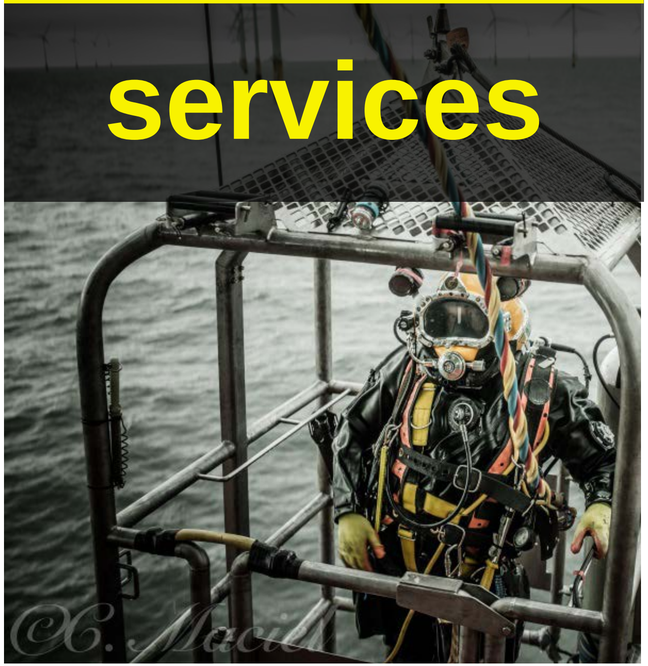
- Wave and tidal installation, O&M and decommissioning
- Inter array & export cable repair, replacement, recovery and disposal
- Seabed survey and rectification
- Pontoon design, construction and installation
- FEED engineering, detailed design and consultancy
- Shore end and inter array cable pull
- Mooring installation design and analysis
- Vessel charter
- Marine economic risk management aid (Mermaid)
- Naval architecture and sea-fastening design
- Project management and supervision
- Installation and maintenance of offshore demarcation buoys

Core expertise

- Offshore services contractor services
- Construction site set up and support management
- Principal contractor services
- Asset monitoring and management services
- Topside balance of plant services
- Temporary power, oil exchange, refuelling & bunkering
- OFTO management services
- Offshore communications
- Marine coordination services
- Offshore Wind Management System (OWMS)
- Vessel Motion Monitoring Systems (VMMS)
- Intelligent fender systems
- Vessels (Guard, CTV, accommodation a multi-cats)
- Offshore blade inspection and repair
- Confined space, NDT , IRATA O&M and IRM technicians
- Statutory inspections
- Offshore spill response

Core expertise

Subsea services



- Diving & ROV services including UWILD services
- UXO identification and disposal
- Controlled flow excavation and remediation
- Installation & decommissioning of scour protection
- Pre lay grapnel runs, and boulder relocation
- Riser, caisson, clamp and anode installation
- Seabed manifolds, templates and protection
- BOP structures and pipeline – subsea services (IRM)
- HP jetting, cleaning, grit blasting and debris removal
- Wire, hydraulic shears, explosive and cold cutting
- Subsea bolt-tensioning, torqueing and tooling
- Bubble curtains and cathodic protection
- Mooring installation, replacement and tensioning
- NDT fixed and floating structures
- Salvage of stricken and sunken vessels

OWIG - Scottish Offshore Wind Supply Chain Forum

Workshop - Glasgow – 29th January 2018

Giving the Supply Chain a Voice…

Building a Sustainable Future…

Next steps:

1/ Confirm an appetite exists
2/ Set out timeline of delivery to 31-Mar-18
3/ Circulate slides and timeline to all delegates
4/ Develop and agree questionnaire and set context (4 volunteers)
5/ Distribute through various channels (membership groups, NNG Coalition, Agencies)
6/ Analyse feedback and develop 'the ask' to OWIG for 31-Mar-18
7/ Ready to 'Go live' after OWIG sanction (website, common voice messages, steering group and initial contributors)
8/ Any personal feedback or comments unable to raise in public forum

Isla Robb, Offshore Wind Lead Specialist, Scottish Enterprise

Jim McSporran, Regional Director, Peterson UK Ltd

Iain Sinclair, Chief Business Development Officer, Liberty Steel UK

Mike Wilson, Chairman, Ecosse Subsea Systems

John Best, Special Projects, James Fisher Marine Services

IN ASSOCIATION WITH

CATAPULT
Offshore Renewable Energy

scottish renewables

OFFSHORE WIND CONFERENCE, EXHIBITION & DINNER

29 & 30 JANUARY 2018 **GLASGOW**

areg Aberdeen Renewable Energy Group

Crown Estate Scotland
Oighreachd a' Chrùin Alba

ECOSSE Subsea Systems ...because we think differently

HIE
Highlands and Islands Enterprise
Iomairt na Gàidhealtachd 's nan Eilean

INVEST IN FIFE

James Fisher Marine Services

NewWaves Solutions
Marine & Environmental Services

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Marine Services

NewWaves Solutions
Marine & Environmental Services

Getting Steel in the Water: Project Updates

John Robertson, Senior Manager E&I, Crown Estate Scotland

Mark Timmons, Senior Manager - Supply Chain Strategy, ScottishPower Renewables - East Anglia One

Steven Wilson, Project Manager, SSE - Beatrice Offshore Windfarm

Oscar Diaz, Project Director, EDP Renewables - Moray Offshore Windfarm

Adam Ezzamel, Project Director, Vattenfall - European Offshore Wind Deployment Centre (EOWDC)

Allan MacAskill, Director, MacAskill Associates - Kincardine Offshore Windfarm

Andrew Donaldson, General Manager, Red Rock Power Ltd - Inch Cape Offshore Windfarm

Mark Timmons, Senior Manager - Supply Chain Strategy, ScottishPower Renewables

East Anglia One

Scottish Renewables Offshore Conference 2018

East Anglia ONE Project Update

Mark Timmons

Senior Manager, Supply Chain Strategy

Iberdrola, **leader in renewable energies** with an installed capacity of **28,800 MW[2] and 1st wind energy producer worldwide…**

1st investor worldwide in renewable energies: £27 billion renewable investment till 2016 and close to additional £8.1 billion planned to 2020[1]

Wind energy Ranking

- **… # 1 Worldwide**
- **… # 1 Europe**
- **… # 1 United Kingdom**
- **… # 1 Spain**
- **… # 3 US**

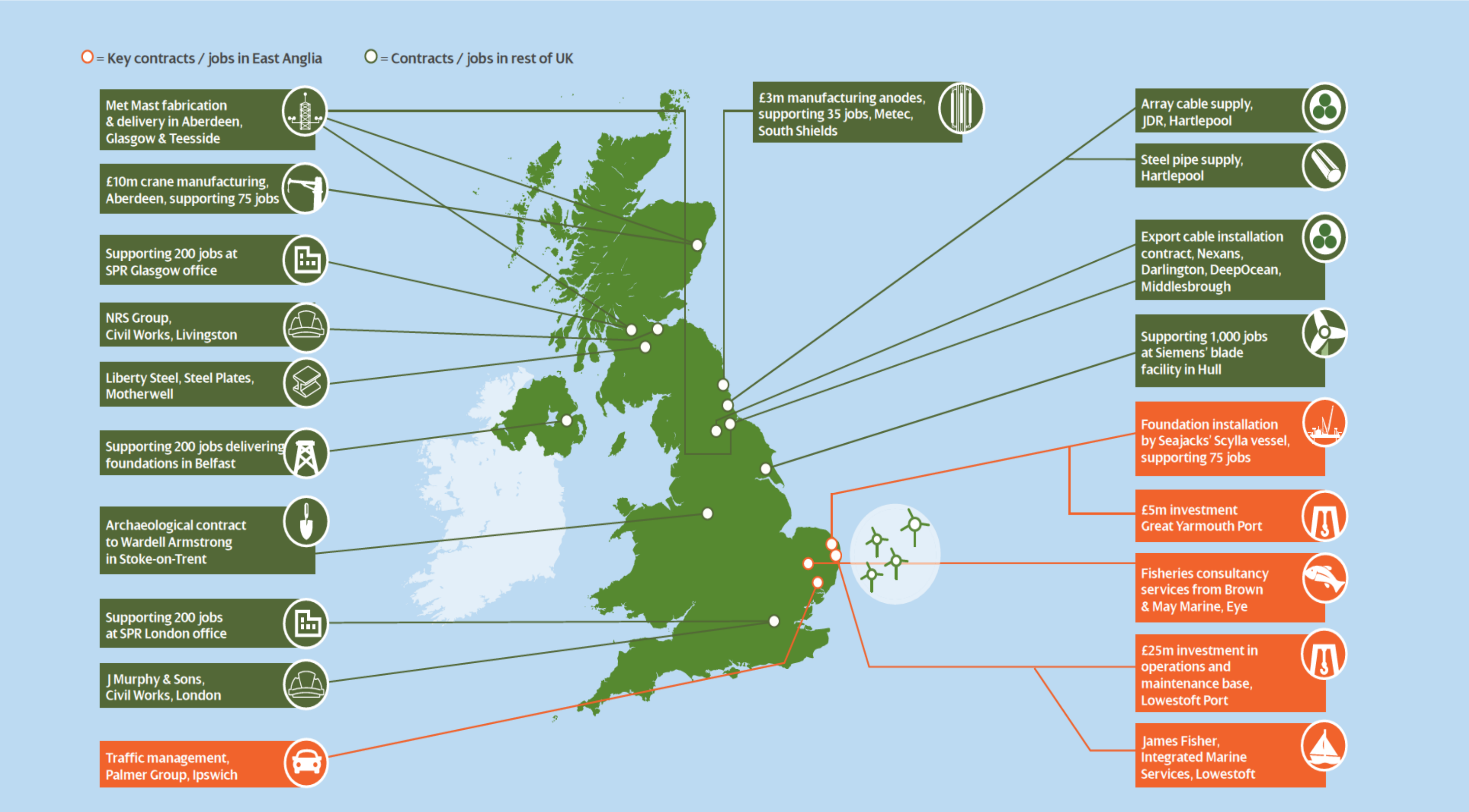
1.2017-2020 investment   *2. Includes hydro capacity*

…and leveraging **solar solutions for** our **domestic** and **industrial clients**

Iberdrola World Wide Offshore Projects

East Anglia Zone

East Anglia ONE – UK & International Supply Chain Collaboration



EA1 Developments

2017

2018

Contact us

@SPRenewables

SPREastAnglia.co.uk

EastAngliaSuppliers@ScottishPower.com

ScottishPower.jobs

Steven Wilson, Project Manager, SSE

Beatrice Offshore Windfarm

Beatrice
Offshore Windfarm Ltd

- Scotlands largest private infrastructure project
- £2.6Bn investment
- Industry leading innovation

sse | CIP Copenhagen Infrastructure Partners | SDIC Red Rock Power Limited

Onshore

- Substation commissioning ongoing
- Grid connection works complete for first circuit
- Back energisation in March 2018

Beatrice
Offshore Windfarm Ltd

Offshore

- Foundation piles complete
- Jacket installation ongoing
- I-A cable installation ongoing
- First export cable installed

Beatrice
Offshore Windfarm Ltd

O&M Base, Wick

- £15m investment
- Refurbishment of Thomas Telford Buildings
- Harbour works ongoing
- Up to 90 jobs during operations phase

Beatrice
Offshore Windfarm Ltd

Looking ahead

- Turbine installation starts in Q3
- First generation in Q3 2018
- Full generation in Q2 2019
- Recruitment of O&M teams

Beatrice
Offshore Windfarm Ltd

Oscar Diaz, Project Director, EDP Renewables

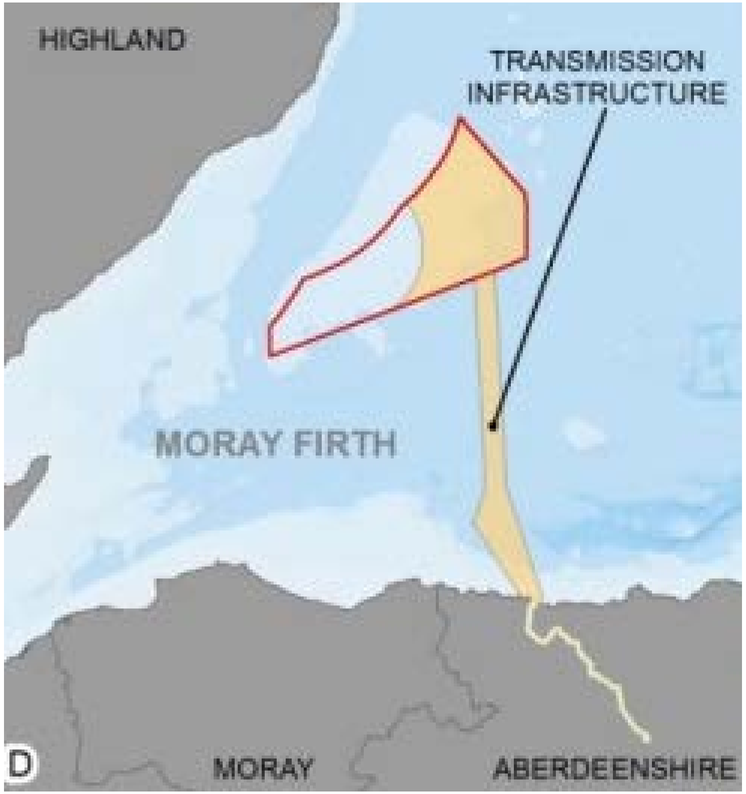
Moray Offshore Windfarm

MORAY EAST
OFFSHORE WINDFARM

PROJECT INTRODUCTION

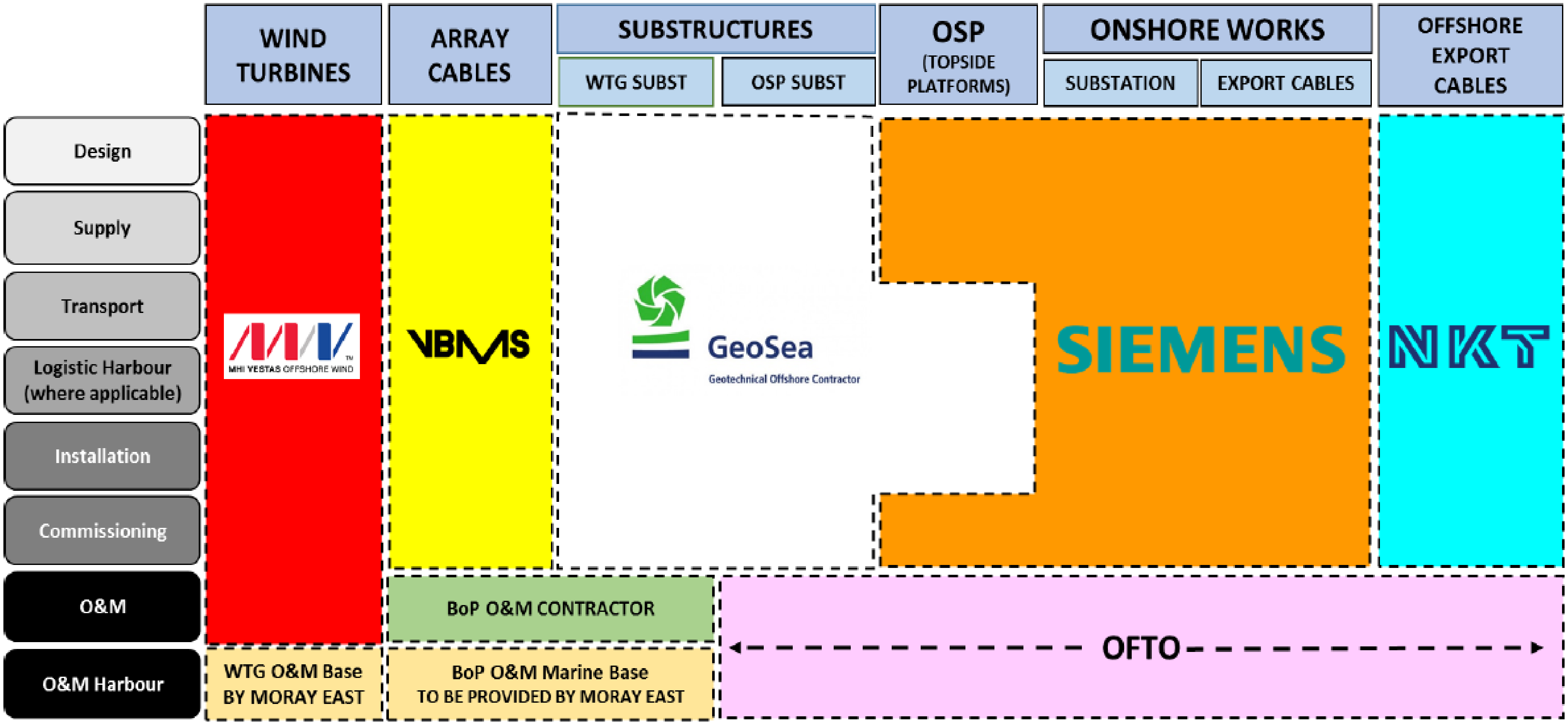
Offshore Wind Conference – January 2018

Project characteristics

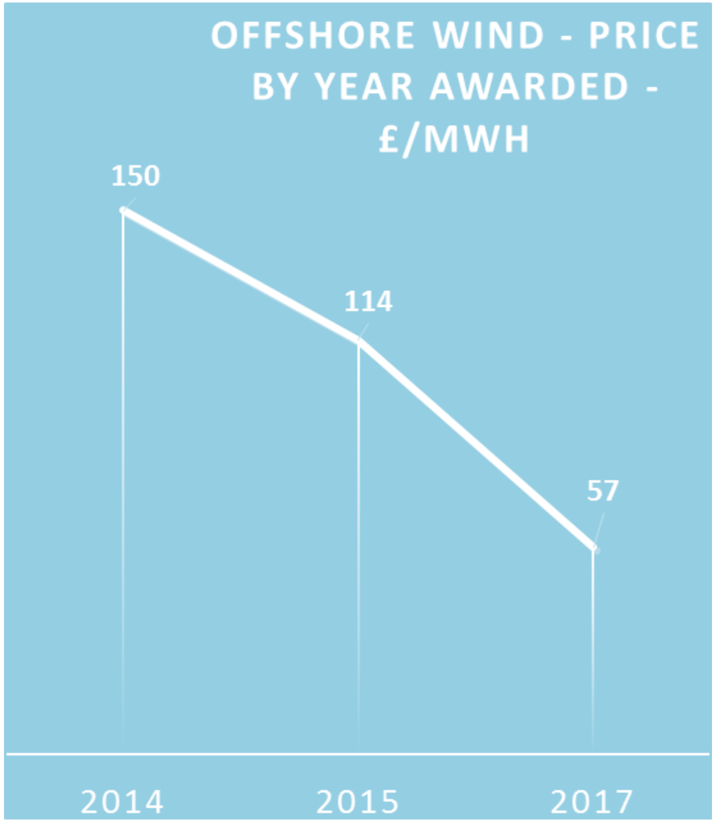


- Consent for 1116 MW granted 2014
- CfD for 950 MW awarded 2017
- Area c.295 km^2
- Water depths up to 57m
- Export cable route c.60km offshore and c.35km onshore
- The project will provide sufficient power for the needs of ca. 950 000 average UK households

Contracting Structure and opportunities



Offshore Wind competitiveness in Scotland



- Power Cost Reduction of 60+% from FIDER
- Average wholesale power cost in 2017: £42/MWh
- Cost of Hinkley C: £92.50/MWh

- Highly Competitive Project
- Excellent Wind resource
- Improved technology with more power from less infrastructure
- Supply Chain alignment and experience developer

- Scottish projects face different Governments setting CfD auction and development processes.
- Transmission charging regime unfavourable to Northern development.

Adam Ezzamel, Project Director, Vattenfall

European Offshore Wind Deployment Centre (EOWDC)

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

Adam Ezzamel, Project Director

Scottish Renewables Offshore Wind Conference, Glasgow, 30th January 2018

VATTENFALL

VATTENFALL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CONVOI EXCEPTIONNEL

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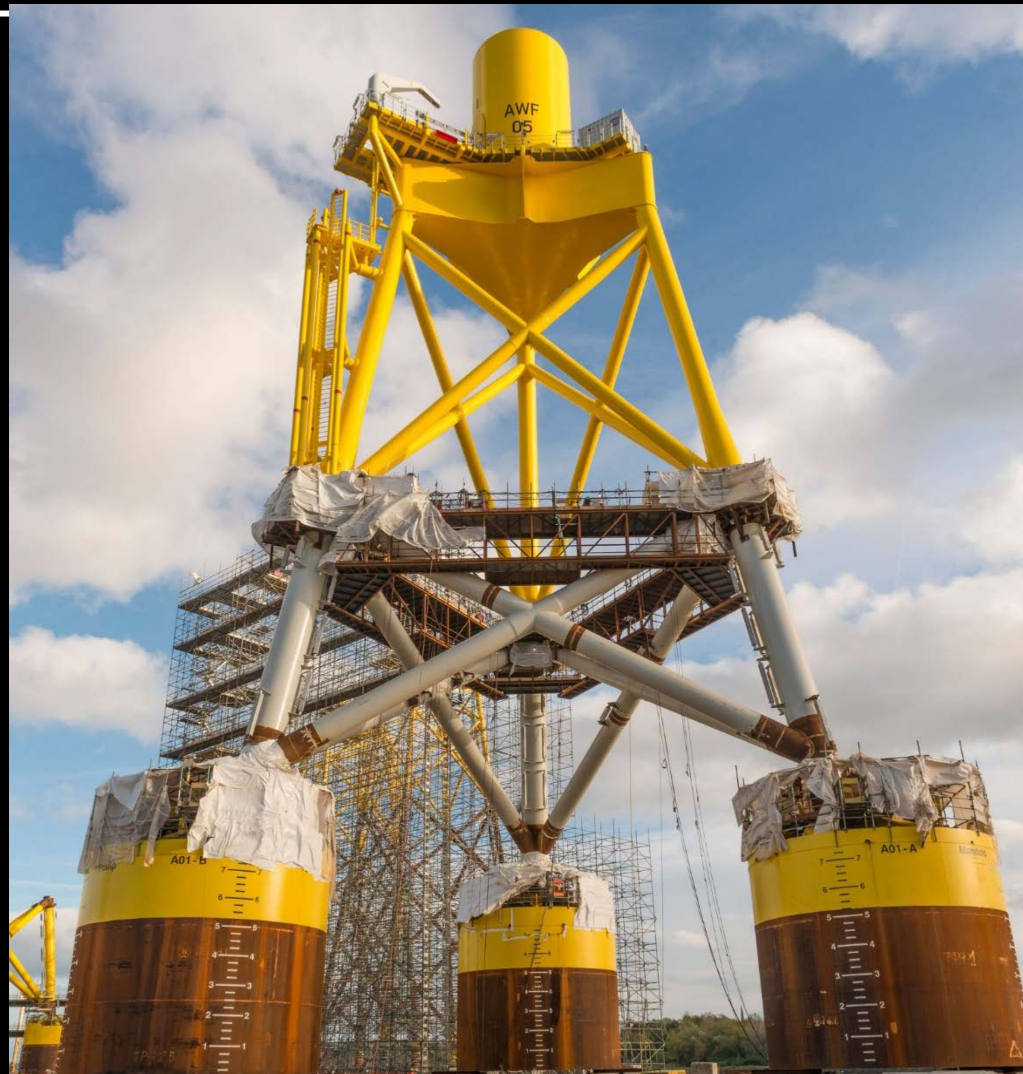


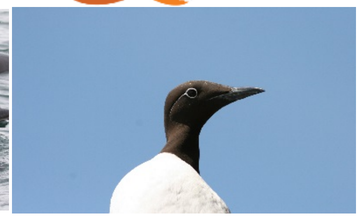
VATTENFALL

VATTENFALL

SCIENTIFIC RESEARCH & MONITORING

€3M ENVIRONMENTAL RESEARCH & MONITORING
LARGEST FUND OF ITS KIND

SMRU Consulting and the University of St Andrews, both St Andrews
Improving understanding of bottlenose dolphin movements along the east coast of Scotland.



MacArthur Green, Glasgow
Measuring connectivity between auk special protection areas populations and offshore wind farms.

The River Dee Trust, Aberdeenshire, and Marine Scotland Science
Assessing the interactions between salmon and sea trout with offshore wind technology.

Oxford Brookes University, Oxford
Researching the socio-economic impact of offshore wind on the human environment.

- **Aug 16** — **Programme Launched**
- **Sep 16** — **Calls for EoI (88)**
- **Nov 16** — **Shortlisted projects submitted detailed proposals**
- **Nov 16-Feb 17** — **Proposals under review**
- **Jun 17** — **Successful projects announced**
- **Jun 17-present** — **Research ongoing**

SCIENTIFIC PANEL

marine scotland science · The Scottish Government · SEPA Scottish Environment Protection Agency · WDC Whale and Dolphin Conservation · VATTENFALL · rspb giving nature a home · Scottish Natural Heritage · JNCC · The Crown Estate · areg

VATTENFALL

Allan MacAskill, Director, MacAskill Associates

Kincardine Offshore Windfarm

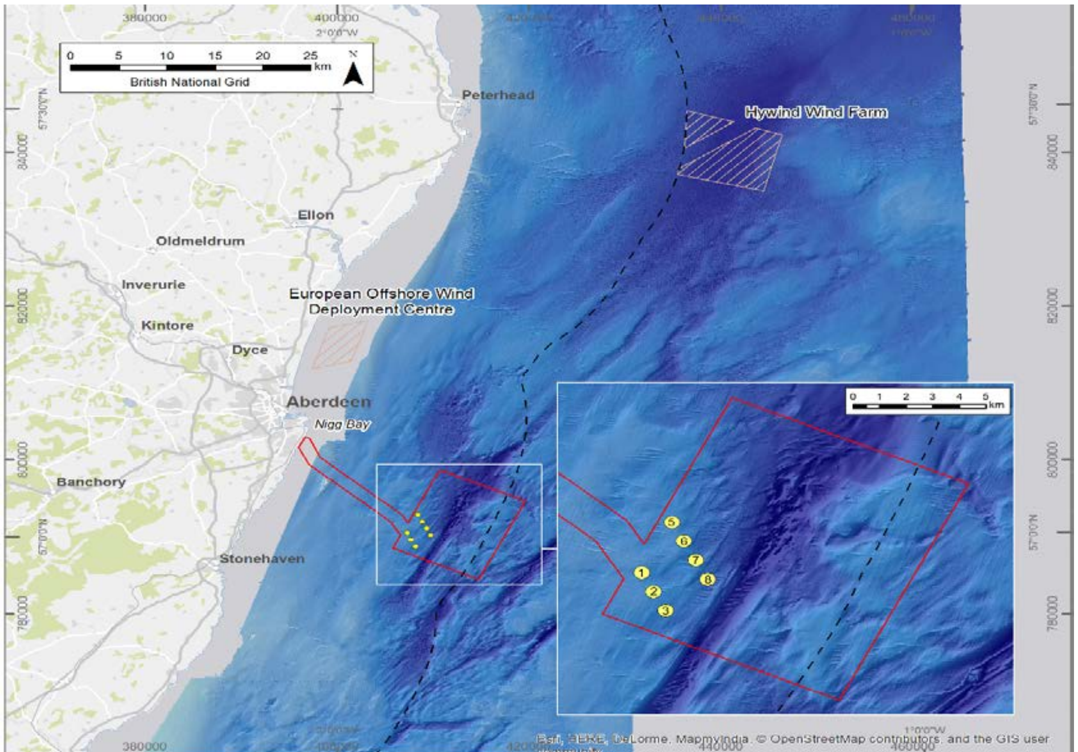
KOWL

Kincardine Offshore Windfarm Limited

Project Summary

Location of Turbines

KOWL



- 2 MW turbine
  - Initially on location 1
  - Move to location 8 at end of programme
- 8 MW turbines
  - Machines 1 to 3 on locations 5 to 7
  - Machines 4 to 6 on locations 1 to 3
- Turbine 1 moved
  - from location 1 to location 8

Key facts

KOWL

- Maximum Output 50 MW
- Project cost circa
  - CAPEX £350 mm
  - OPEX £150 mm over life
- Location 15 km east of Aberdeen/shire coast
- Maximum turbines
  - 6 large turbines
  - 1 x 2 MW prototype
- Grid Connection
  - Landing at Aberdeen adjacent to Altens industrial estate
  - Grid connection at Redmoss
- Operational life
  - Up to 25 years

Project Programme

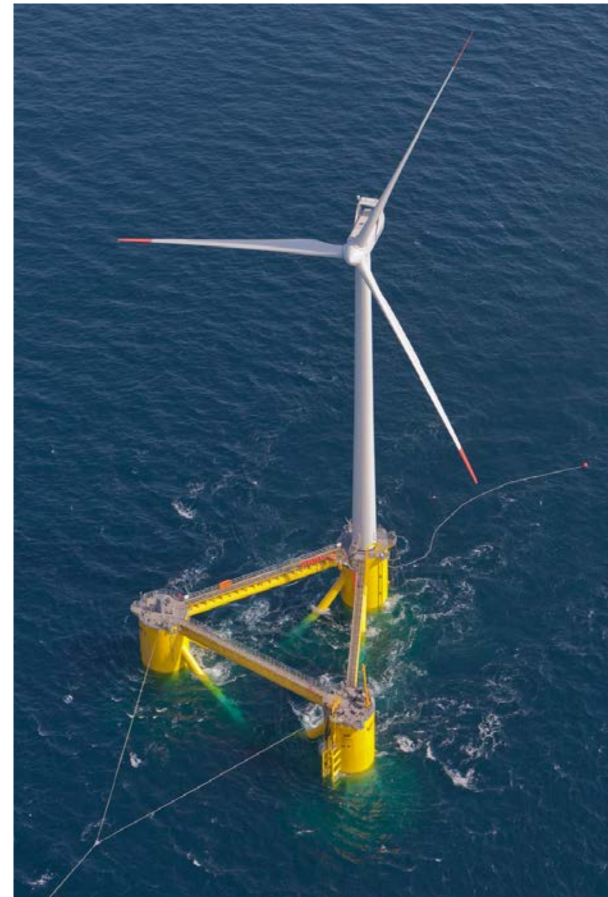
KOWL

- Season 1
  - Onshore facilities and first export cable
  - 2 MW prototype steel semi-submersible installation
  - Manufacture of equipment turbine and substructure
  - First generation / operation / Technical and environmental monitoring
- Season 2
  - Installation of second offshore cable
  - Delivery of 6 x 8 MW turbines
  - Fabrication and assembly of substructures and system
  - Installation of full scale steel semi-submersibles
- Season 3
  - Installation of remaining structures

Semi-submersible Substructure

KOWL

- Fabricated in Steel
- Triangular semi submersible structure
- Tower over one buoyancy chamber
- 3 / 4 mooring lines
- Installation of turbine at yard
- Tow and operation in semi-submersible mode
- Maximum dimensions :
  - Tip height up to 191 m
  - Rotor diameter 164 m
  - Minimum blade height 23 m



KOWL

KINCARDINE OFFSHORE WINDFARM LIMITED

Allan MacAskill

Director

Allan@macaskill-associates.com

07712 864013

Andrew Donaldson
General Manager, Red Rock Power Ltd

Inch Cape Offshore Windfarm

Inch Cape Offshore Limited

Supply Chain Opportunities

Andrew Donaldson, General Manager, Red Rock Power Limited

Scottish Renewables Offshore Wind Conference

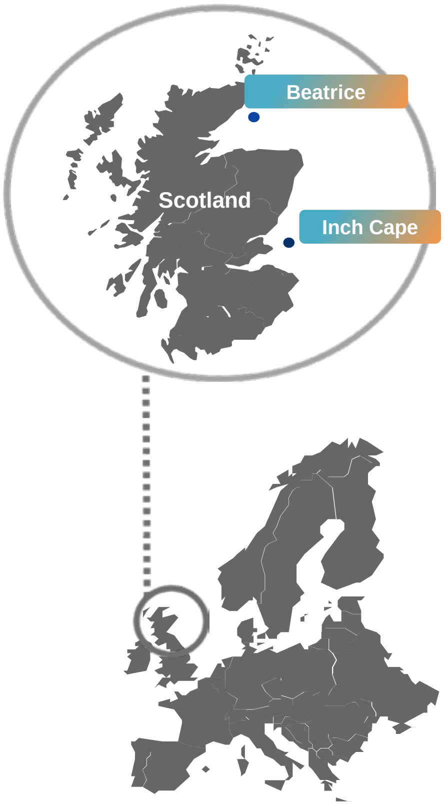
Date: 30th January 2018

SDIC

Red Rock Power Limited

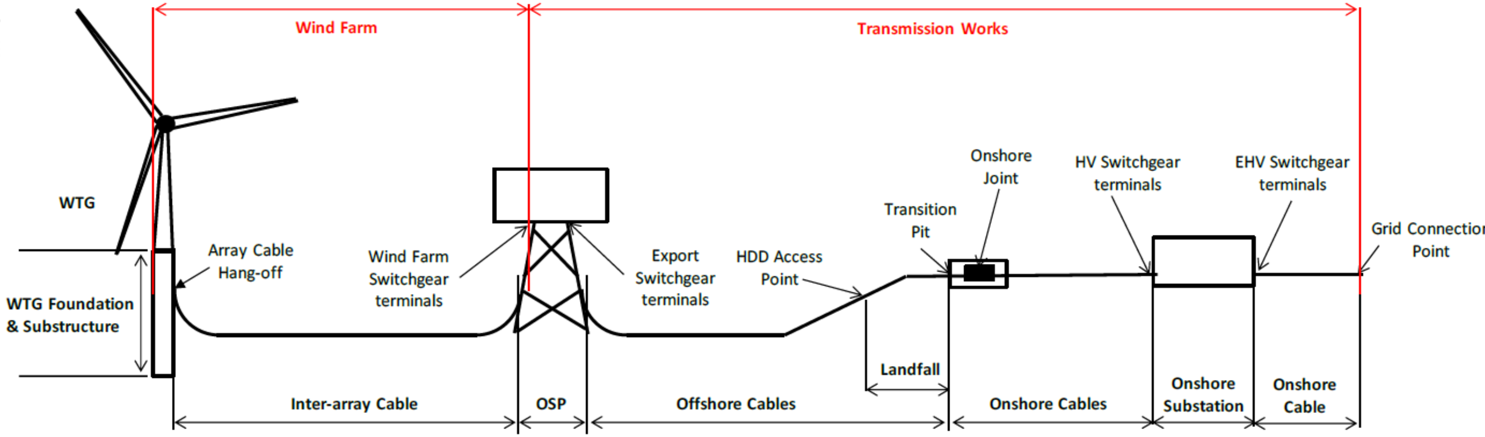
SDIC & Red Rock Power Limited

- SDIC Power Holdings Co. of China is listed on the Shanghai Stock Exchange and owns a total of 27GW of installed power capacity in China, of which >60% is renewable (hydro, onshore wind & solar).
- Red Rock Power Limited is a renewable energy business based in Edinburgh established to develop, own and operate clean energy projects and is a wholly owned subsidiary of SDIC Power.
- Red Rock Power Limited currently has an interest in two offshore wind projects in Scotland: 100% share of Inch Cape Offshore Wind Farm and 25% share of the Beatrice Offshore Wind Farm, led by SSE.

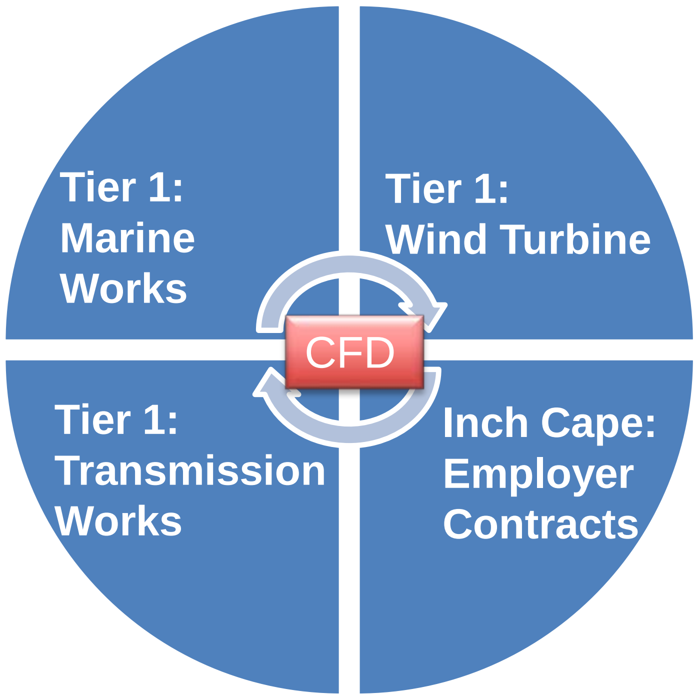


Inch Cape Contract Strategy

- 3 Tier 1 Contractors (WTG, Marine Works & Transmission Works)



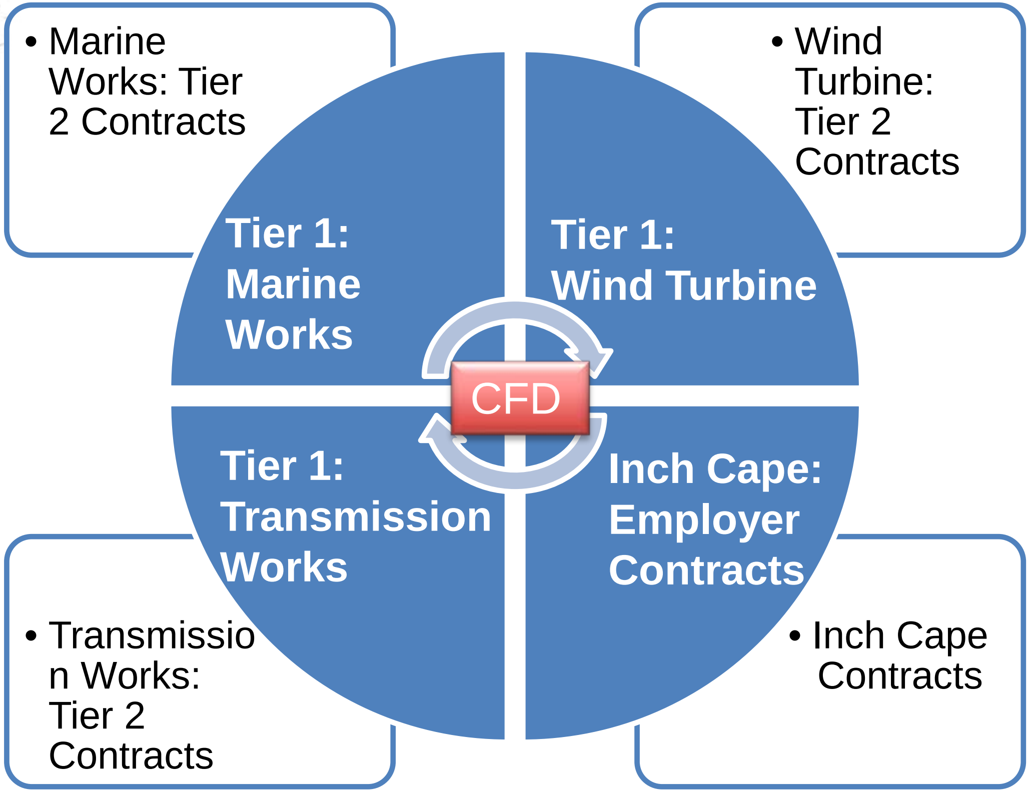
Inch Cape 2 Stage Contract Strategy



Stage 1:

- Early selection of Tier 1 Contractors
- Collaborate to refine concepts and define Tier 2 scopes

Inch Cape 2 Stage Contract Strategy



Stage 2:

- Open book review of Tier 2 proposals.
- Collaborate to agree CFD bid price.
- Finalise EPC contracts and meet CFD milestones

Thank you

Inch Cape Offshore Limited

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