scottish renewables

ONSHORE WIND CONFERENCE

12 JUNE 2018 **GLASGOW**

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SCOTTISHPOWER RENEWABLES

The Power of Onshore Wind

Lindsay McQuade

CEO, ScottishPower Renewables

@SPRenewables

Iberdrola: Leader in Renewable Energy

Iberdrola is a leader in renewable energy with installed capacity of +29GW – the largest wind energy producer worldwide…

$100bn investment in wind and hydroelectric energy, along with the networks necessary to integrate renewable energy

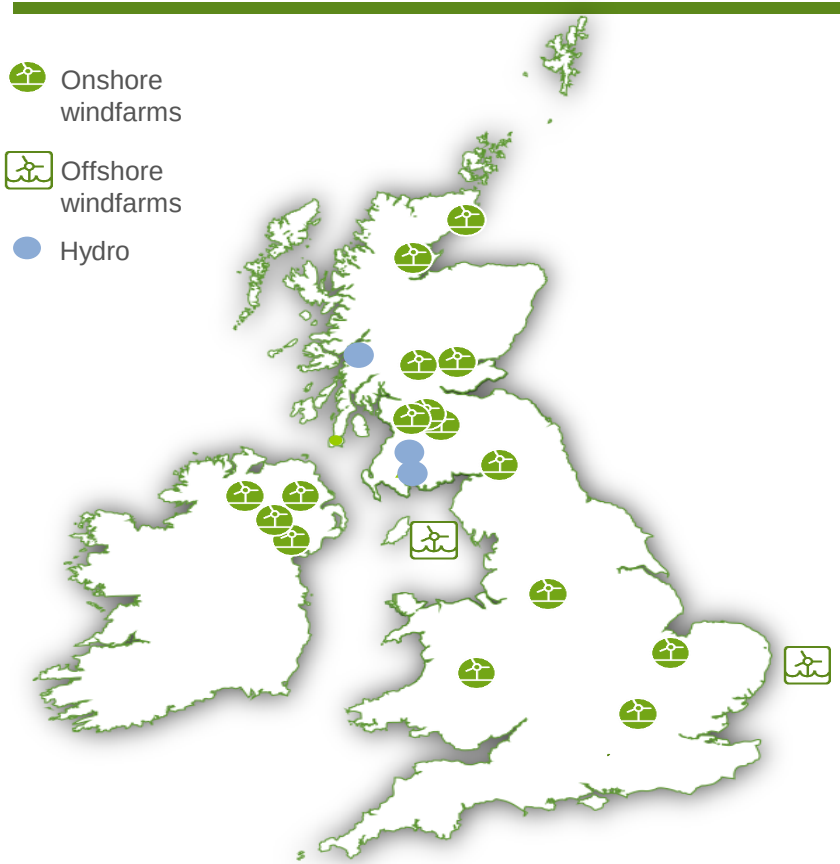
Whitelee Wind Farm, Scotland, 539MW

Wind Energy Ranking

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

… carbon emissions 70% below European peers with plans to close final coal-fired power capacity.

ScottishPower Renewables: UK Leader in wind generation



ScottishPower Renewables: a key part of the Iberdrola Group

Over 2.5GW of wind and hydroelectric installed capacity in UK

£650m 474MW onshore wind programme in 2016/17 delivered **66%** local content

714MW £2.5bn East Anglia ONE in construction, exporting from 2019

Pumped Storage Hydro extension at Cruachan: EU recognition as strategic project

Industry-leading Control Centre supporting wind operations and grid integration

Onshore wind should be promoted through the established Contracts for Difference mechanism

- CfD derisks upfront capital investment, reducing overall cost of onshore wind
- Two-way nature of CfD protects consumers across UK
- Competitive auction ensures only most cost-effective projects successful
- Market certainty critical for investment decisions and supply chain growth

Economic Benefits from Onshore Wind

- BVG Associates undertook analysis of economic impact of onshore wind if supported by UK Government policy through CfD auctions

- Aim was to build a picture of the cost and location of onshore wind projects, and the economic impacts across the UK, gross value added and job creation

The Power of Onshore Wind: Key Results

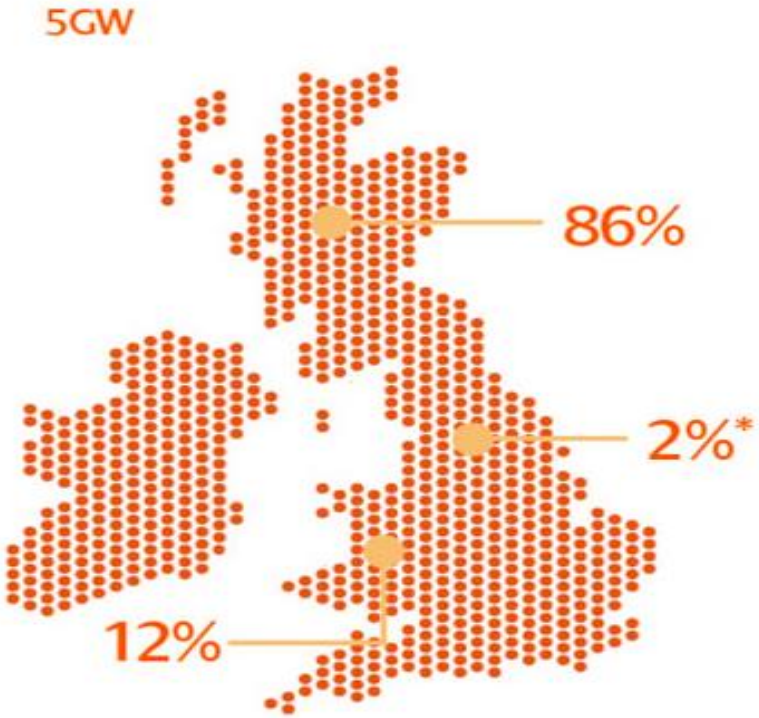
Market Stabilisation CfD derisks upfront capital investment, reducing cost of onshore wind, with 2-way nature of CfD protecting consumers

New projects costs forecast to drop below BEIS's forecast wholesale electricity price from 2023

£1.6 billion net payback to consumer over 15 year CfD contract period

The Power of Onshore Wind: key results

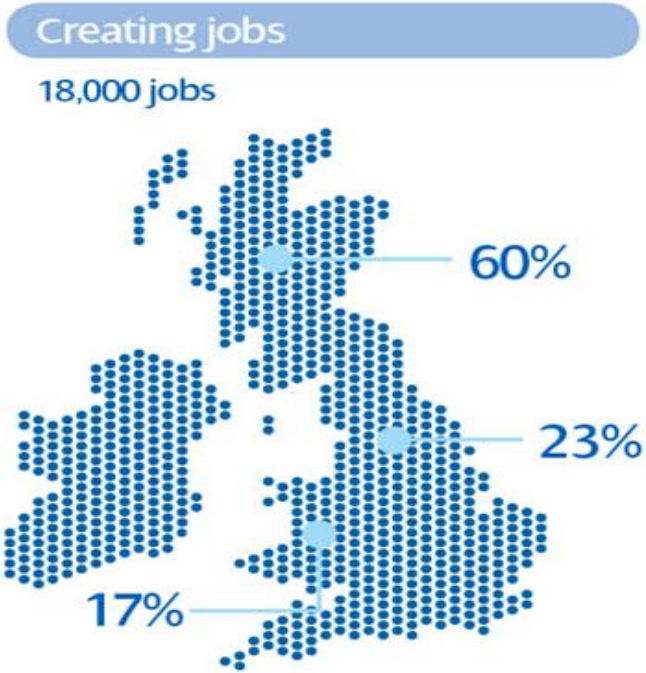
Competitive auctions ensure only cost-effective projects successful

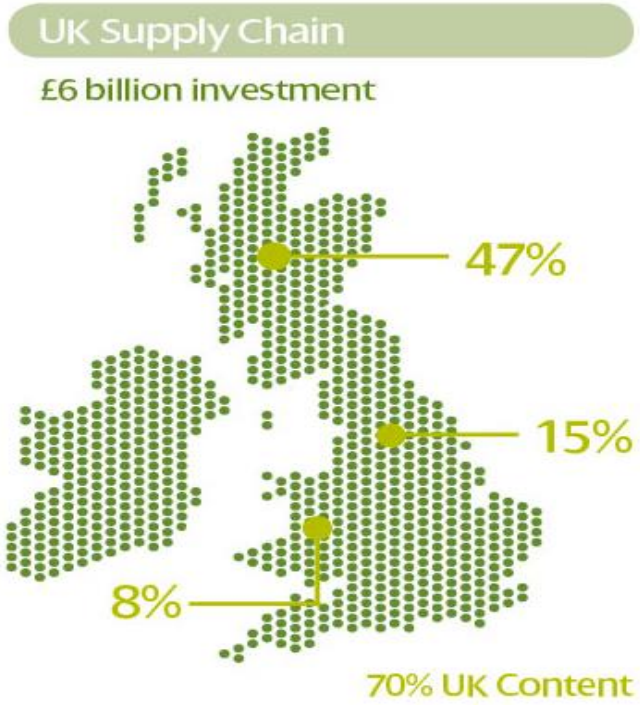


** small scale projects, below 50MW*

The Power of Onshore Wind: key results

Market certainty critical for investment and supply chain growth





THE POWER OF ONSHORE WIND

#onshorewindnow

Lucy Whitford

Development Director

RES

Euan McVicar

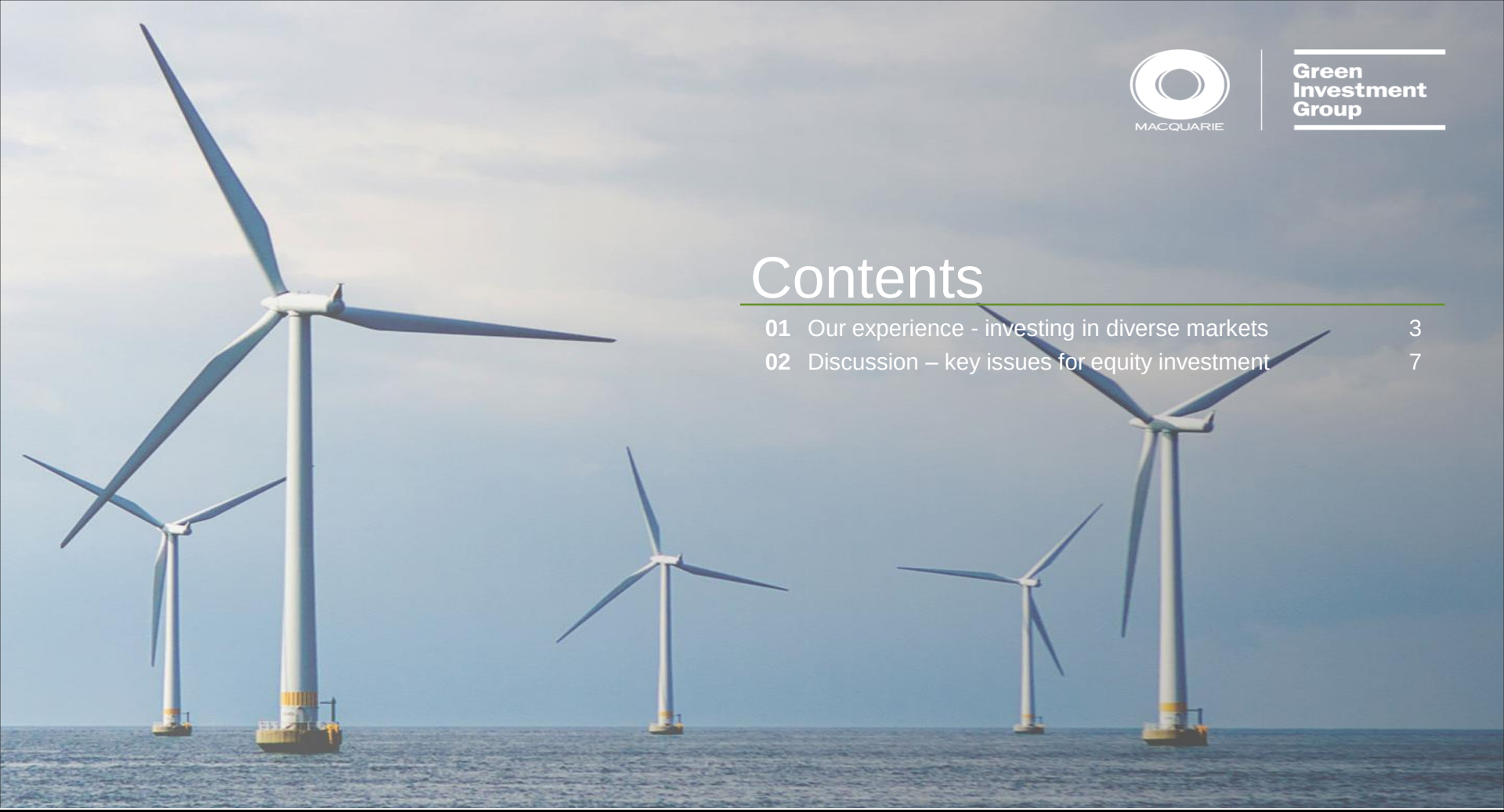
Head of Transaction Structuring

Green Investment Group

Onshore Wind

Some issues relevant to an equity investor

September 2017



Contents

MACQUARIE

Green Investment Group

01

Our experience- investing in diverse markets

MacCap / GIG – What we do

We continue to be a leading principal investor in green infrastructure, targeting investments across:

Established technologies: energy efficiency, district heating, hydro, interconnectors, offshore wind, onshore wind, solar, waste and biomass.

Emerging technologies:
biofuels, low carbon transport, smart grid, storage and tidal.

Investing debt and equity in all stages of the project lifecycle:
development, construction and operations.

Targeting
£3billion
of new investments over the next 3 years

Leveraging the team's investment experience to provide a full range of advisory services:

Project delivery and portfolio services

Providing third parties with technical, project delivery and operations management services for green infrastructure projects. The team are already managing billions of assets on behalf of investors across a broad range of green energy technologies.

Green bank advisory

Drawing on Green Investment Bank's experience in setting up the world's first green bank, the team will offer consultancy services and advice to government and multi-lateral institutions in how to set up effective green finance institutions.

Corporate finance and advisory

Working closely with colleagues in Macquarie's M&A and Corporate Finance business we will offer specialist M&A and capital raising services to businesses operating in the low carbon economy.

Green impact reporting services

Providing third parties with green impact reporting services, including Green Impact Opinion Reporting for a specific project, Green Bond or for a portfolio of assets.

Our onshore wind track record

Macquarie Capital and GIB[1] have supported total investment in over 4GW of onshore wind globally, operating across the capital structure and through the project lifecycle, including development

1 Supporting investment in 4GW of capacity

2 Deep knowledge of markets and technology through investment, arranging & advisory

3 Longstanding development capability and commitment to development capital

4 Scope to provide PPAs to support debt finance

Selected onshore wind transactions

Project	MW	Transaction Type	Transaction Value[2]	Client/Partner
Coopers Gap	453	Debt	~A$850m	AGL, QIC, futurefund
Silverton	200	Debt	~A$500m	AGL, QIC, futurefund
Macarthur	210	Adviser, Debt & Equity arranger (2 transactions)	~A$1,191m	AGL, Mitsubishi, meridian, MALAKOFF
Ararat	240	Advisory & Development	~A$450m	RES, GE, Partners Group, OPTrust
Markbygden ETT	650	Development & Equity	~A$1,625m	GE, SVEVIND, NCC, WT Energiesysteme, HYDRO
Waterloo	111	M&A	~A$500m	PALISADE, Northleaf Capital Partners
Mumbida	52.5	Advisory & Development	~A$159m	verve ENERGY, GE, WATER CORPORATION
Acacia Renewables	200	Development platform	~A$500m	RES
Canadian Breaks	200	Advisory & Development	Undisclosed	FREMANTLE ENERGY

Notes: (1) Prior to acquisition by Macquarie Group (2) Based on assumed $2.5 million/MW for undisclosed transactions.

Key onshore wind transactions

GIG, with Macquarie Capital, is applying extensive experience as an investor to move early in the project lifecycle, taking development risk in valuable project opportunities

Markbygden ETT, Sweden

Merchant exposure in Europe's largest single site onshore wind farm

- Once completed, Markbygden Phase 1 is expected to become the largest single site onshore wind farm in Europe, with 650 MW total capacity
- The project boasts a corporate PPA with Nordic industrial offtaker Norsk Hydro, and provides a model for developments in low-subsidy markets
- Unique lending structure, involving Euler Hermes and EIB

Murra Warra, Australia

Developing Australia's largest turbine site

- Macquarie Capital and RES are joint owners of Murra Warra – one of the highest wind resource, lowest cost sites in Australia
- Favourable permit conditions: Permit to install 116 turbines with tip height up to 220m (largest in Australia)
- First 226MW phase to commence construction early in 2018

Acacia Renewables, Japan

Pipeline & development platform

- Macquarie has acquired from Renewable Energy Systems (RES) Group its Japanese subsidiary, RES Japan (Acacia Renewables)
- Acacia is developing a 200 MW pipeline of onshore wind energy projects across Japan
- Market-leading team with expertise in development, engineering and construction of renewable projects in Japan strengthens Macquarie's capability in renewables development across Asia

Canadian Breaks, USA

Lead developer of a high value opportunity

- 200 MW onshore wind farm in Texas, making use of strong, proven and predictable wind regime and high PTC (subsidy) value
- Up to 45 year operating lease term allows owner to maximum re-powering, re-contracting and terminal value optionality
- 9.21 m/s predicted wind speed at 80m hub height

MACQUARIE

Green Investment Group

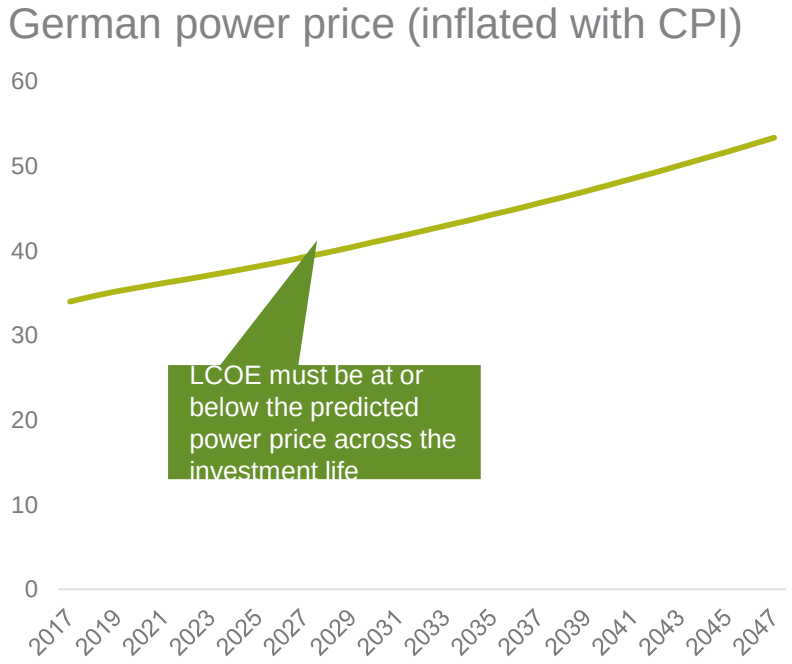
02

Some issues relevant to an equity investor

Assessing an Investment in Onshore Wind

The case for investment in an onshore wind project depends on the relationship between the cost of generation and the investor's view on future power prices

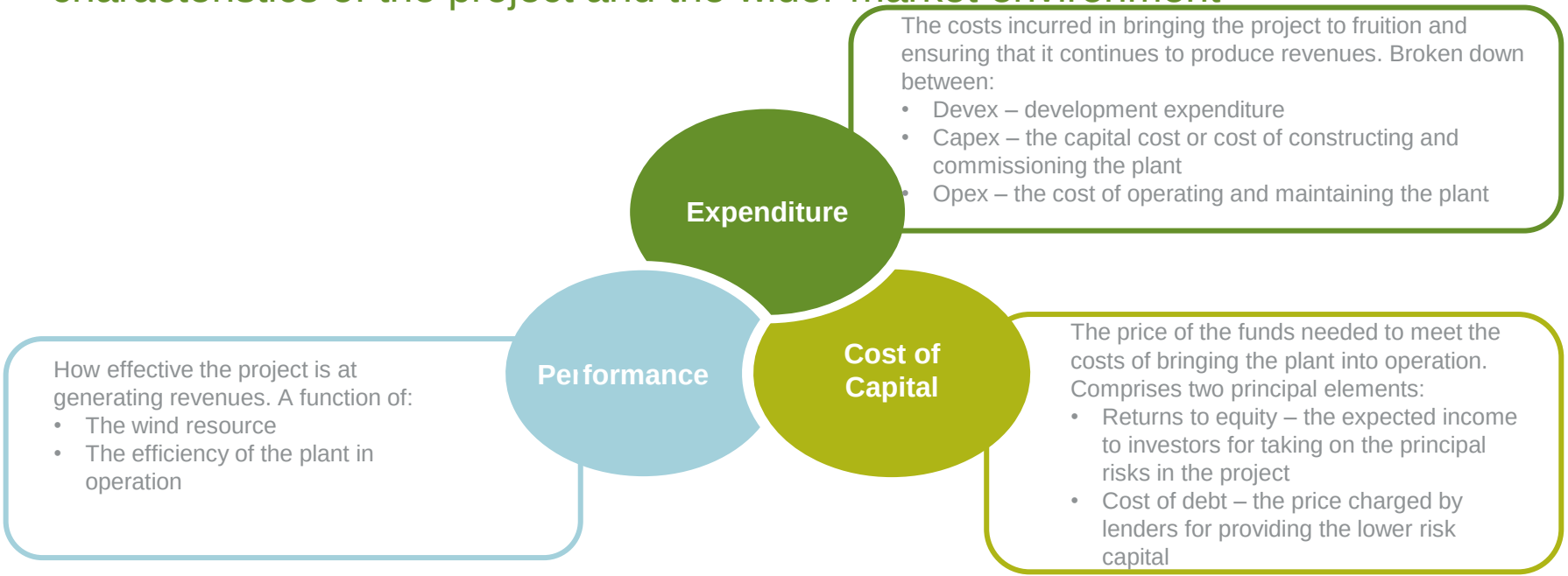
- The 'all-in' cost of generation from a power station is commonly termed the Levelised Cost of Energy (LCOE)
- An investor will expect to see the LCOE remain at or below the price that it can secure in the market for the electricity that it produces – across a defined operating life for that asset
- The Final Investment Decision (FID) will be made under the conditions applying at the time – at this point the majority of the costs of the project are effectively locked in



Sources: Spot price from Bloomberg, German CPI forecast from IHS

The Levelised Cost of Electricity (LCOE)

The LCOE is the product of a combination of factors that reflect the characteristics of the project and the wider market environment



The costs incurred in bringing the project to fruition and ensuring that it continues to produce revenues. Broken down between:

- Devex – development expenditure
- Capex – the capital cost or cost of constructing and commissioning the plant
- Opex – the cost of operating and maintaining the plant

How effective the project is at generating revenues. A function of:

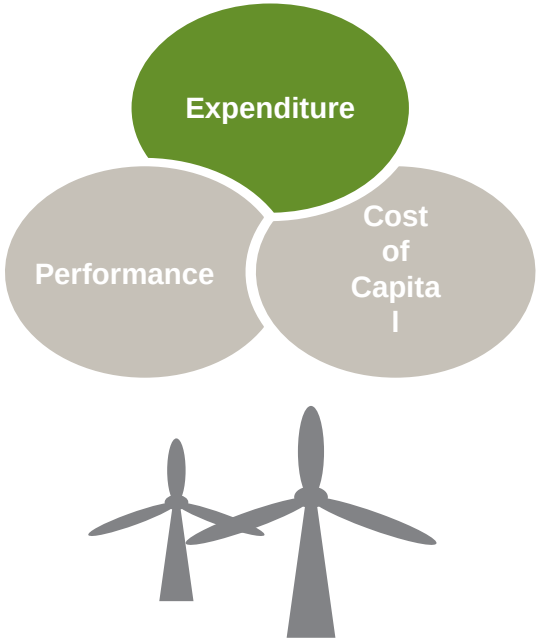
- The wind resource
- The efficiency of the plant in operation

The price of the funds needed to meet the costs of bringing the plant into operation. Comprises two principal elements:

- Returns to equity – the expected income to investors for taking on the principal risks in the project
- Cost of debt – the price charged by lenders for providing the lower risk capital

Expenditure impacts on LCOE

Capex is the single biggest factor affecting LCOE, but Devex is increasingly significant for projects with marginal viability



Downward pressure on expenditure through:

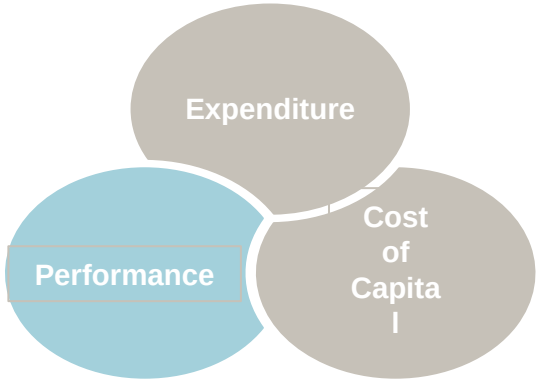
- Global reduction in capex costs of turbines through increasing supply and greater competition
- Growing experience and efficiency in construction and operation
- Consolidation of project pipelines and coordination of construction programmes

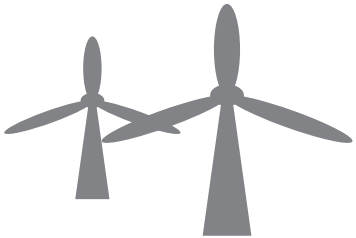
Cost reduction constrained through:

- Ability to realise economies of scale – only the largest windfarms can access scale efficiencies and most favourable terms from suppliers
- Scattered patterns of development across multiple sites
- Grid connection costs
- ‘Friction’ in planning processes
- Poor site access

Performance impacts on LCOE

Performance is a function of the wind quality of a site and the turbines' ability to capture that resource - high performance delivers higher revenues





Performance is enhanced through:

- Ability to deploy the largest possible turbines employing the latest technology
- Siting of turbines to access maximum wind resource
- Operation & maintenance regime

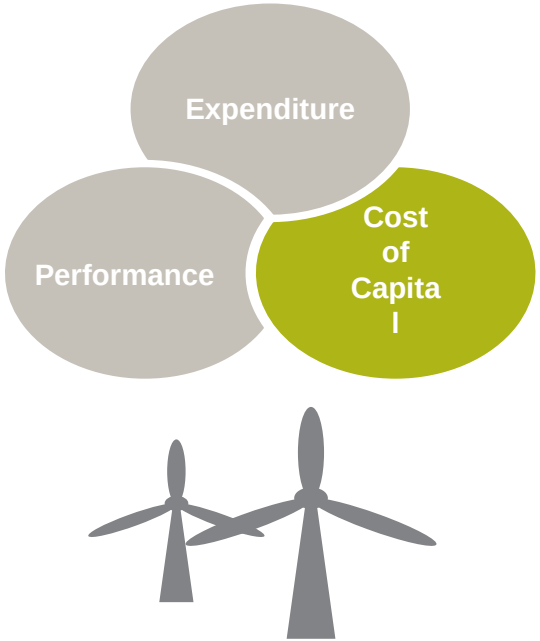
And constrained by:

- Access to high-yielding sites: increasingly the optimum sites have already been developed

Performance of a site is defined by its 'Net Capacity Factor' the proportion of its theoretical maximum output that it achieves in practice

Cost of capital impacts on LCOE

As wind technology becomes increasingly mature, uncertainty over power prices and related revenues becomes the biggest factor affecting cost of capital



Cost of capital reduced through:

- Securing access to firm power prices through a Contract for Difference (CfD) or private Power Purchase Agreement (PPA)
- Confidence in the performance of wind turbines in operation and contractors during construction

Cost of capital increased through:

- Lower levels of 'gearing' – the proportion of lower cost debt finance in relation to higher cost equity investment in a project
- Without security over future power prices gearing levels are reduced

LCOE effects in practice: comparison of German and Nordic situations

A combination of factors results in major variations in LCOE between different locations and markets

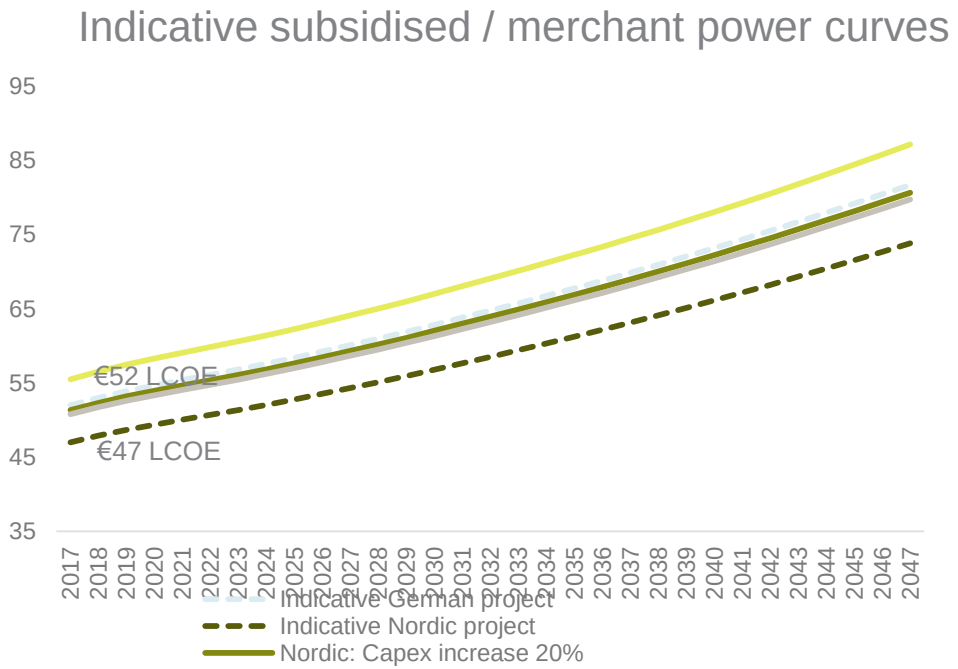
Germany benefits from:
- low CAPEX costs, with a competitive supply chain
- a subsidy regime that affords a low cost of capital

But:
- has poor sites with relatively low capacity factors

Nordics benefit from:
- moderate CAPEX costs, supported by excellent economies of scale
- excellent performance, with high wind yields supporting high net capacity factors

But:
- offers little certainty over future power prices
- has a subsidy regime offers no secure revenues

	Germany	Nordics
Capex (€m/MW)	1.1	1.2
Net Capacity Factor	30%	37%
Fixed O&M (€/MW/yr)	23,400	17,900
Levered cost of equity	6%	10%
Cost of debt (above LIBOR)	120bps	260bps
LCOE estimate (€/MWh)	**52**	**47**



Sources: Bloomberg New Energy Finance (1H17 Data); GIG estimates; power curves inflated using German CPI forecast from IHS

Conclusions

Some Key Issues

- **Scotland can benefit from global cost reductions in onshore wind:** LCOE is falling globally and coming into line with projected wholesale power prices
- **DEVEX and OPEX are also important**
- **Access to a CfD is a material consideration for financing wind in Scotland:** This mechanism enhances the security of revenues and has a major impact on cost of capital
- **The impact may be partly mitigated through a PPA:** The scale of impact will depend on the life of these contracts, but there is an open question as to the size of this market for PPAs and the number of windfarms that can be supported. Market liquidity may also be an issue.
- **Public Sector Demand :** may help provide a route to market for some participants
- **Can Project Life / Terminal values be improved?**
- **Allowing higher performance sites will improve LCOE:** In the most favourable sites this may be sufficient to secure investment, depending upon other cost factors

Hugo Batten

Head of GB Renewables

Aurora Energy Research

Economics of onshore wind

Onshore wind conference, 12 June 2018

The focus of this materials will be on subsidy-free onshore wind

Example challenges for renewables in GB

- Declines in subsidies
- Rising price cannibalisation at higher levels of renewables deployment
- Opaque and non-liquid PPA markets
- Rising interest rates and a potential end to the era of very cheap capital
- Managing intermittency on high renewable penetration systems
- System stability and inertia challenges

Levers to help facilitate additional renewables in GB

Technology
- Hybrid pairings (e.g., solar + batteries, wind + pumped hydro/ green gas)
- Provision of synthetic inertia
- Facilitation of higher levels of EV penetration

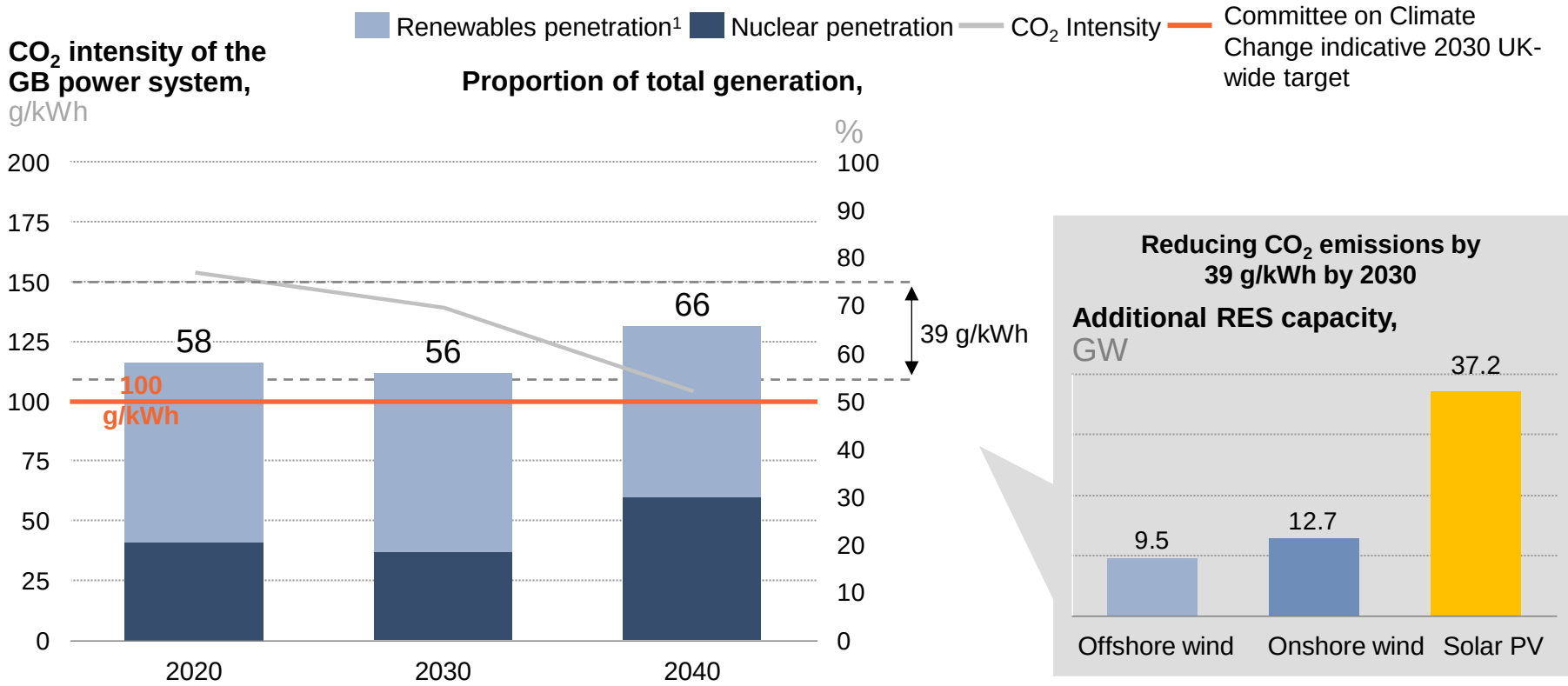
Policy
- Creation of 'revenue-stabilisation' or 'zero-subsidy' CfDs
- Opening balancing and ancillary markets to renewables to diversify and increase revenue streams
- Inclusion of new build renewable generation (and hybrid technologies) in the GB Capacity Market

Finance/ business model
- Facilitation of deeper and more transparent PPA markets
- Identification of 'worst case' scenarios for capture prices to assess maximum leverage on a given asset (thus reducing cost of capital)
- Development of portfolio approach to suite of generation assets

System set-up
- Incentivising additional flexible technologies (e.g., compressed air, pumped hydro, batteries)
- Increasing interconnection with Europe and Ireland

Source: Aurora Energy Research

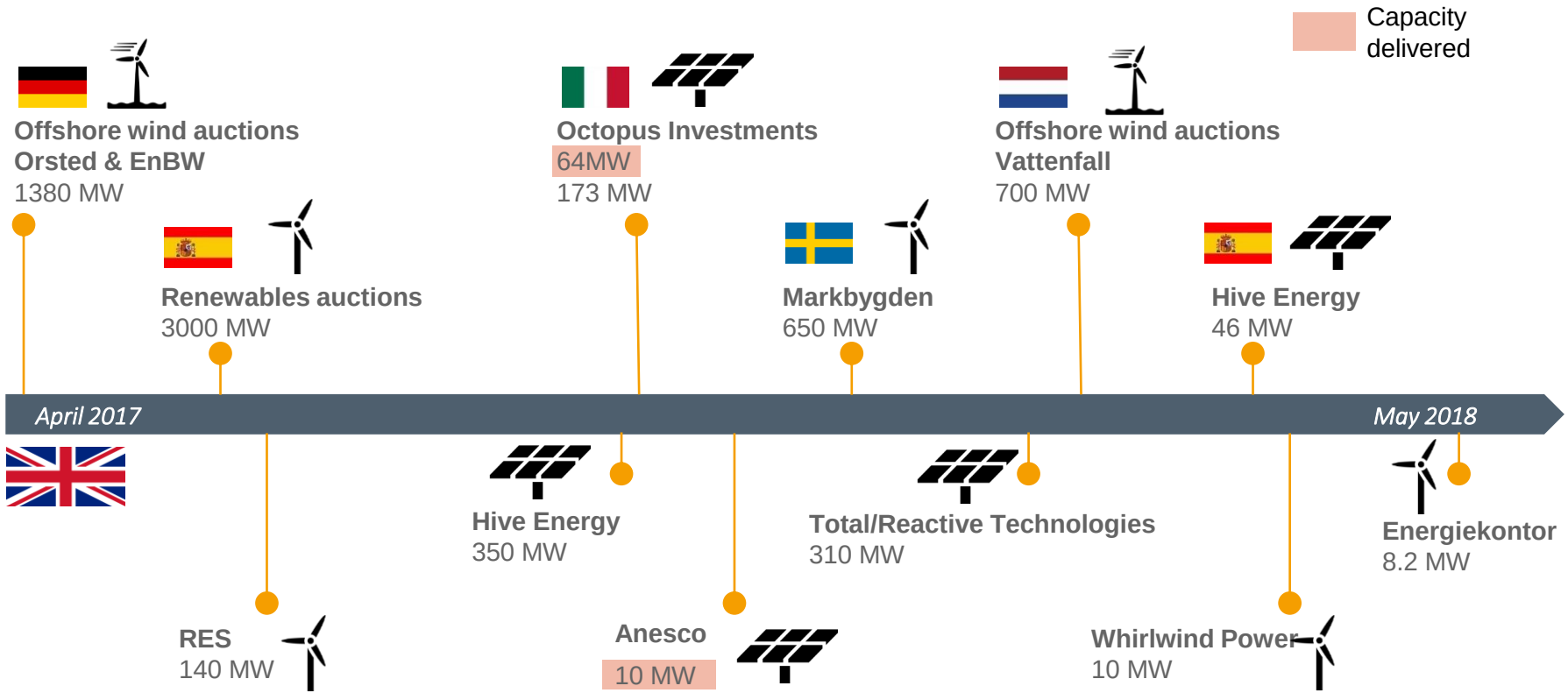
Plan for nuclear to hit carbon targets alone is increasingly unlikely, leaving need for additional RES deployment



1) Penetration presented as a fraction of total generation excluding interconnectors; renewables include offshore wind, onshore wind, solar, biomass, and hydro. This analysis only includes currently committed renewable deployment and is thus different from Aurora Central.

Sources: Aurora Energy Research, CCC

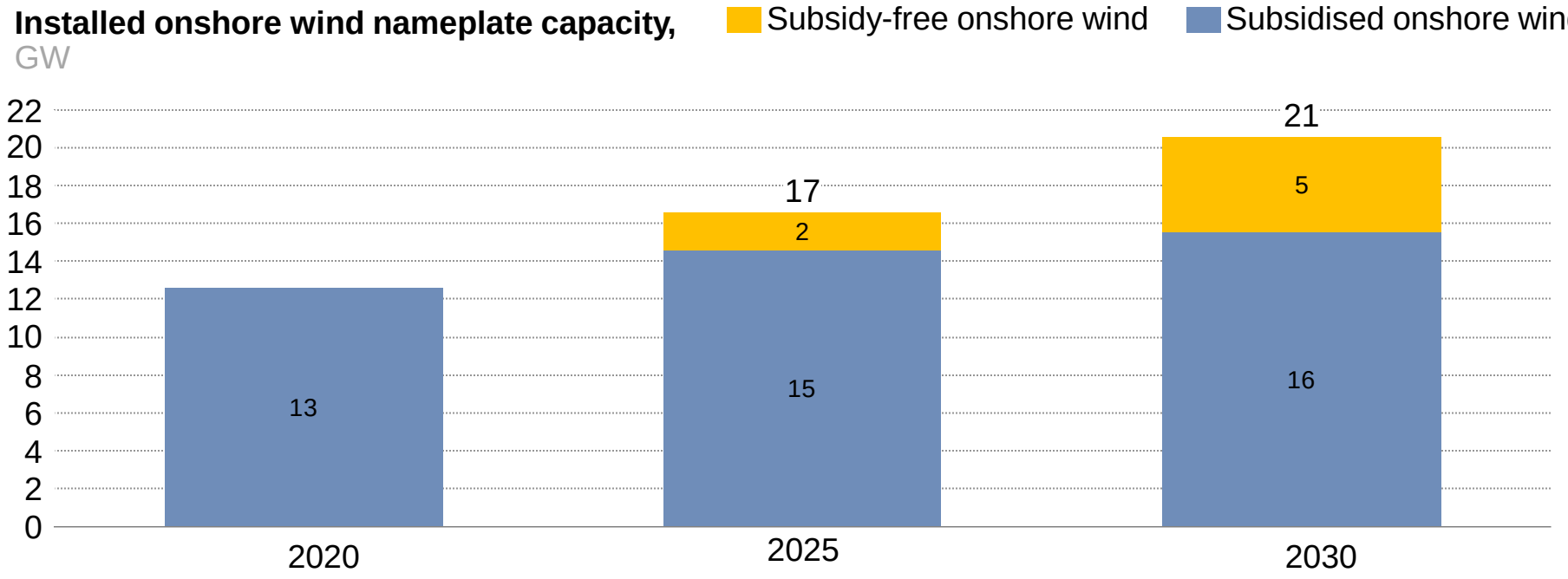
Last 12 months have seen landmark developments in subsidy-free renewables across Europe, with first projects emerging in GB



Source: Aurora Energy Research

GB could see as much as 5GW of subsidy-free onshore wind on the system by 2030 on top of already forecasted capacities

Installed onshore wind nameplate capacity, GW



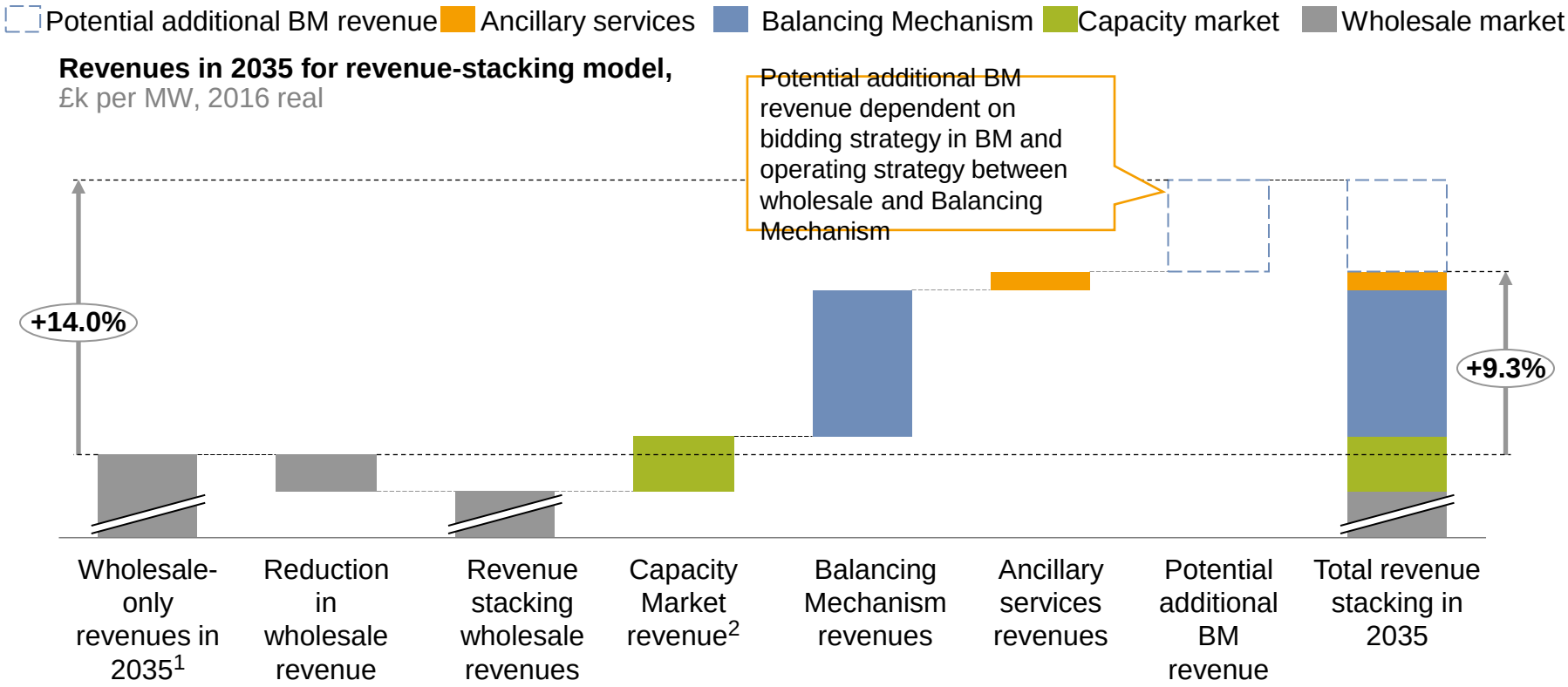
Total subsidy-free capex spending, Cumulative £bn, real 2016

2.4

5.5

Source: Aurora Energy Research

Wind has the capabilities to provide ancillary services and there is significant upside to protect from low wholesale prices



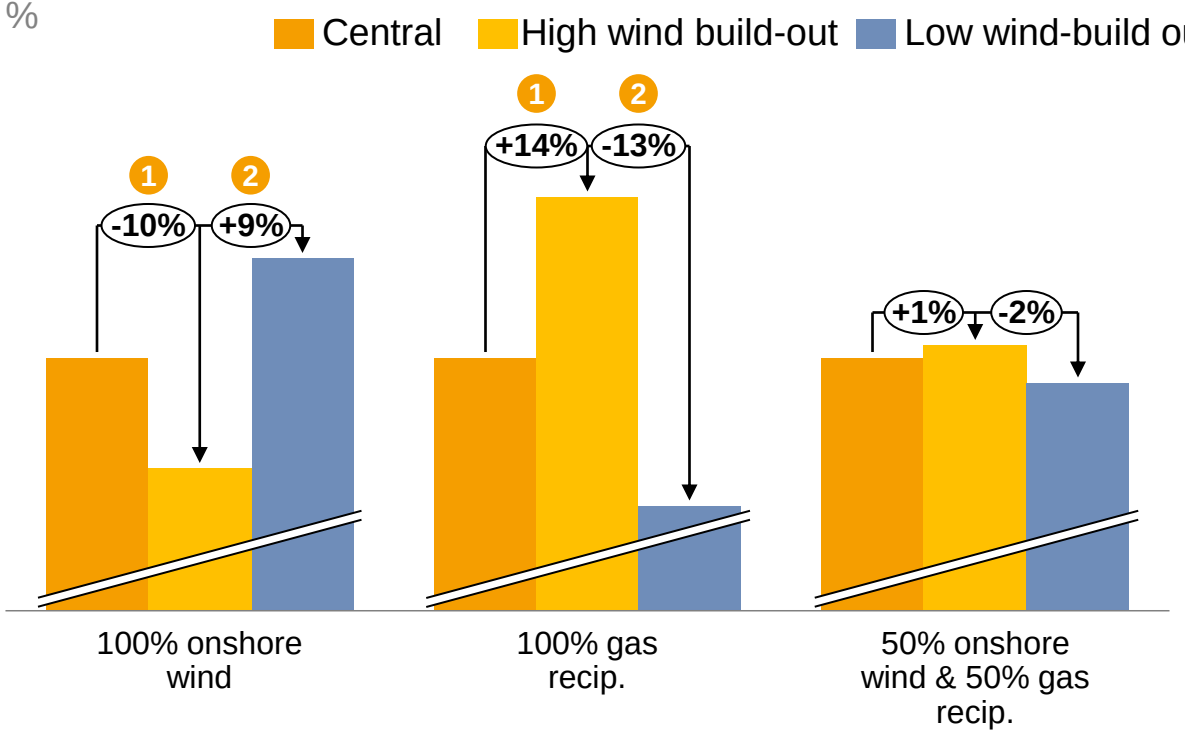
1) Wholesale-only model does not build endogenously within model until late 2030s. 2) Assumes a capacity de-rating factor of 20%.

Source: Aurora Energy Research

A diversified portfolio can protect from risks and ensure that a constant return is maintained

Example: Gas recips + wind

Internal Rate of Return (IRR) for new build assets in 2025 across different portfolios, %



1. In a high wind build-out scenario:
   - Wind capture prices drop, balancing cots increase and IRRs decline
   - Gas recip returns increase driven by higher price volatiliy, higher need for flexiblity and lower CCGT capacity
2. In a low wind build-out scenario, the converse is true

- A diversified portfolio can protect against both downsides, maintaining returns within a narrow corrdior

Source: Aurora Energy Research

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Chief Executive, Scottish Renewables

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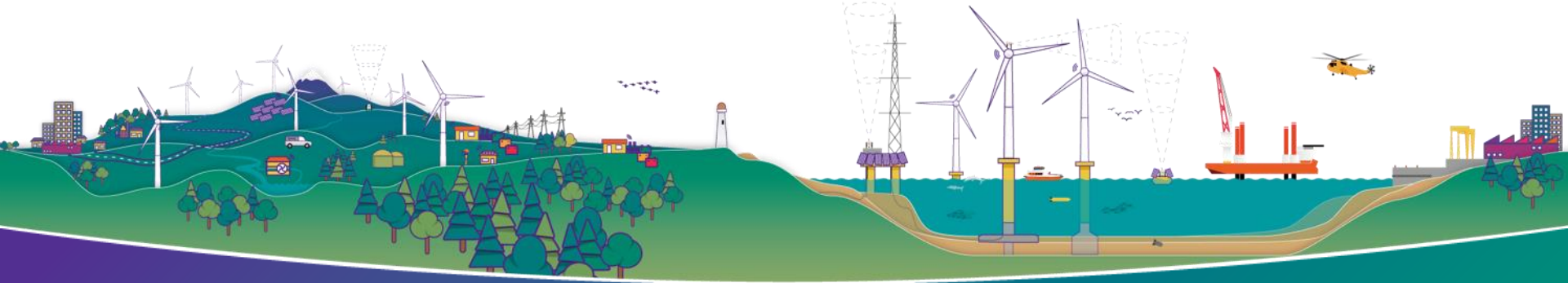
Director of Operations
& Asset Management
Natural Power

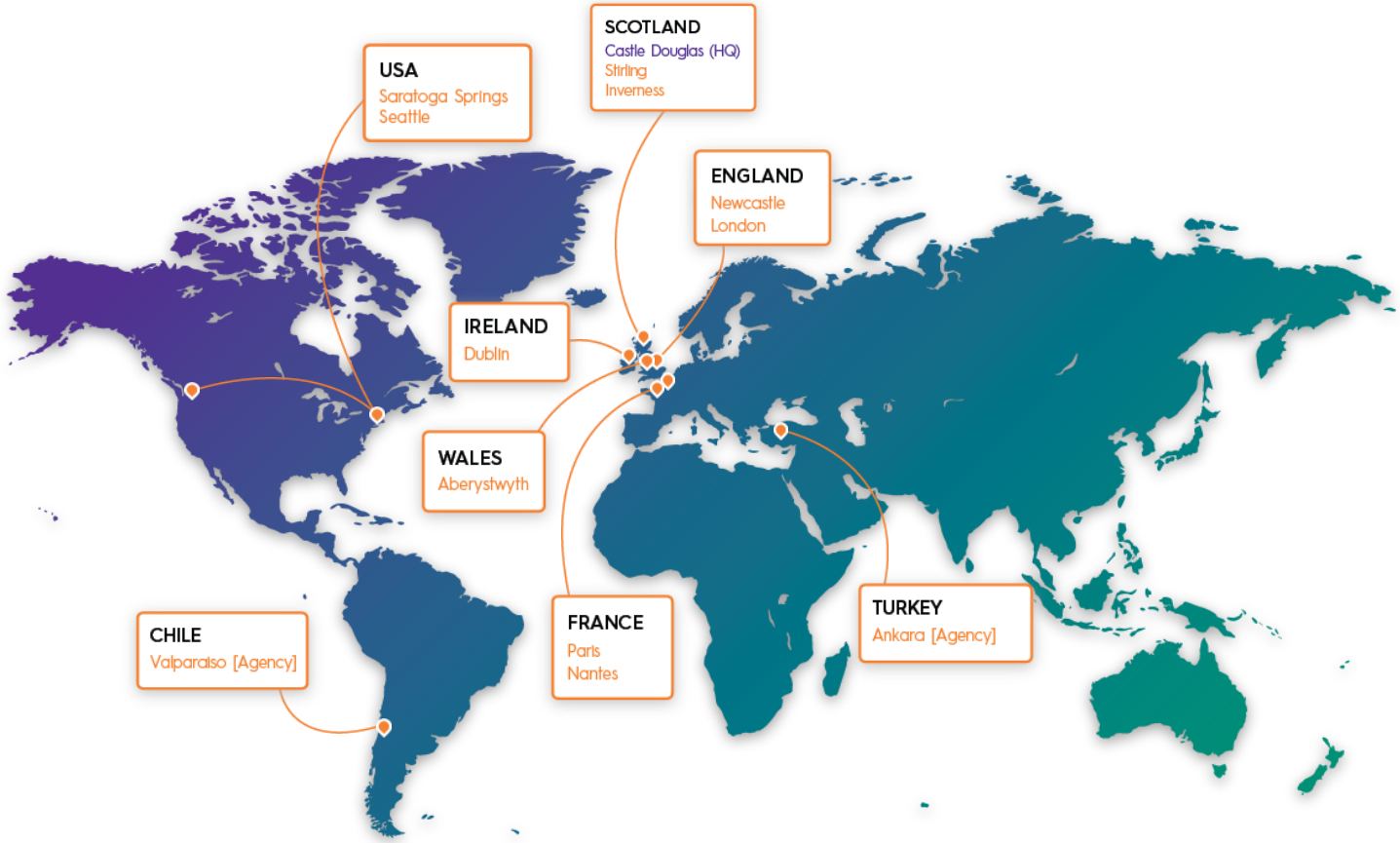
Performance Optimisation

Date: 12th June 2018

Presented by: Euan Fenelon



Worldwide offices



Wind farm performance optimisation

Context

Mature market = ageing assets + ↓ regulatory support + ↑ competition

Subsidy-free market + competitive pressures = bespoke strategies to ensure profit margins

Asset downtime impacts revenue streams

Performance optimisation => ↑ generation and ↓ operational costs

What is driving wind farm performance optimisation

View of the long-term future

Wind farm performance optimisation

The future of wind farm operations

OPEX minimisation

- Reliability centred maintenance
- Life extension programmes
- Avoid unplanned maintenance
- Automation
- “Lean” Practice

Performance improvements

- Over powering
- Up-powering
- Benchmarking
- Control
- Environmental optimisation
- Spinning reserve

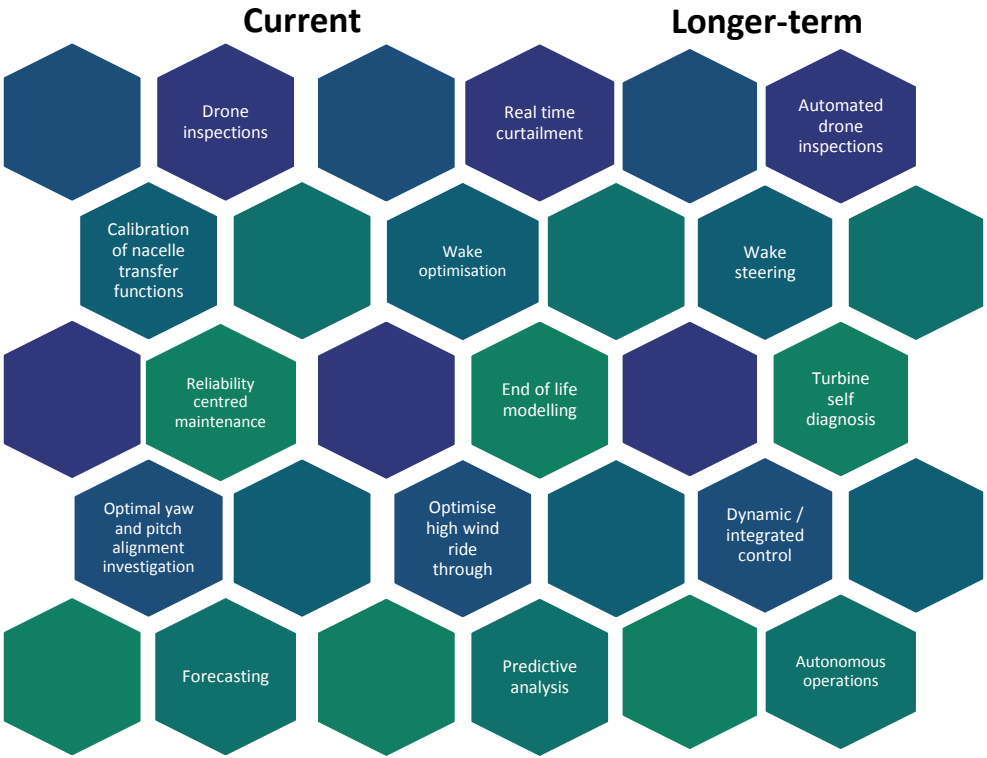
End of life

- Repowering
- End of life predictions
- Energy reforecasting
- Life extension

Wind farm performance optimisation

How to deliver the future

Timescale



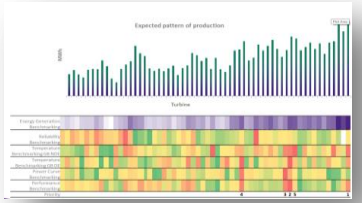
Wind farm performance optimisation

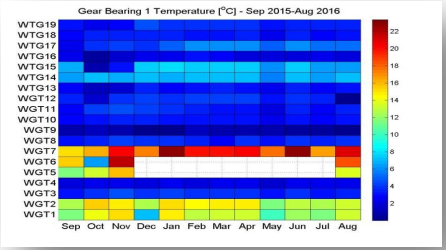
Tier 3 – Industry Anonymised & Independent Benchmarking (WEBS)

The **Wind Energy Benchmarking Service** (WEBS), that Natural Power advocates

Tier 2 – Site or Portfolio (Natural Power, Client Portfolios)

Secondary metrics, calculated from SCADA data & ControlCentre
Focus on WTG & site performance/reliability/availability/maintenance





Tier 1 – WTG Level

(Natural Power Client Project / Single Site)

Wind farm performance optimisation

Its all about the data!

Performance Analytics

a holistic approach to turbine performance analysis through the use of big data

Reliability

Temperature

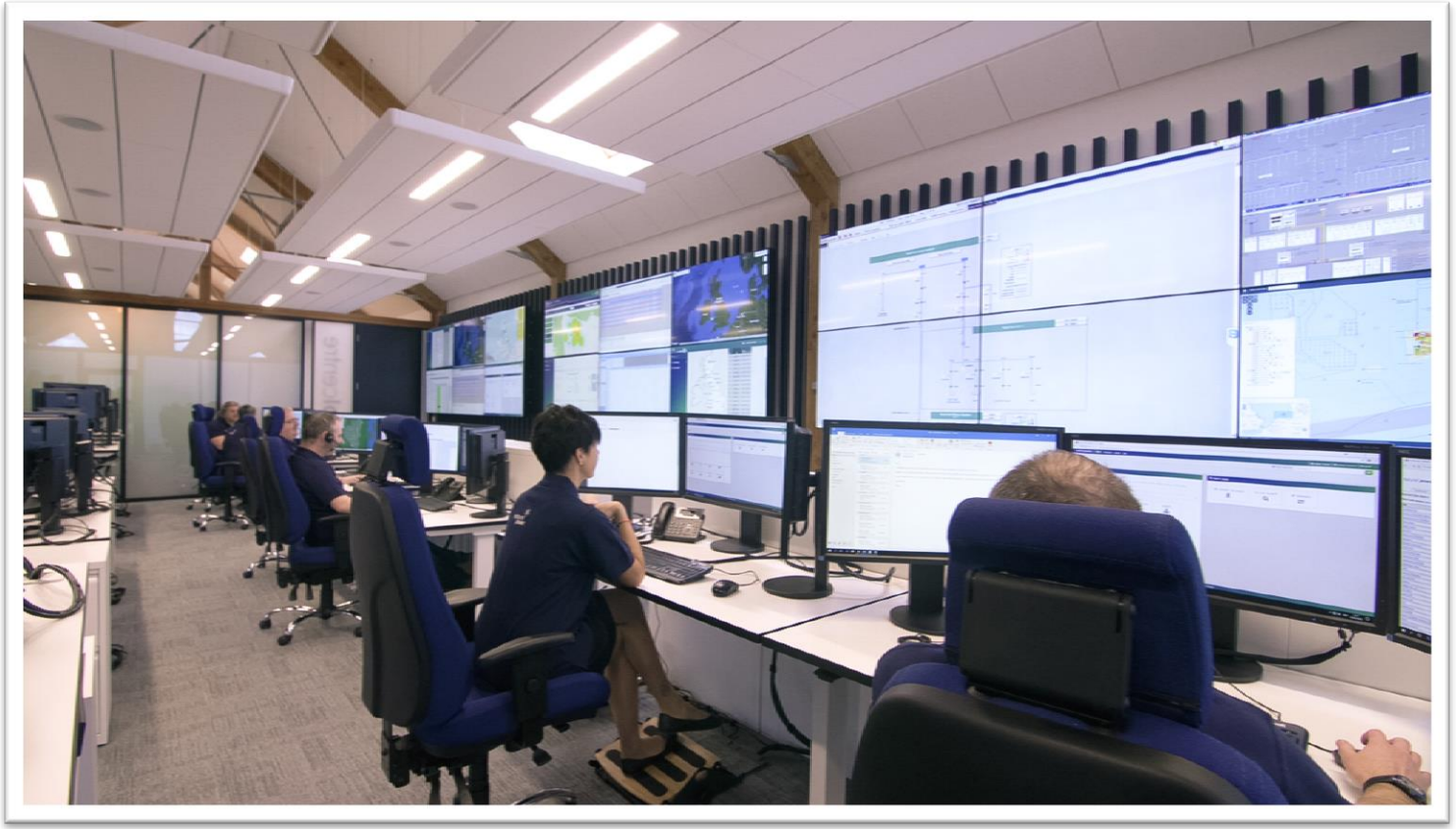
Power curve

Energy performance

Industry level benchmarking

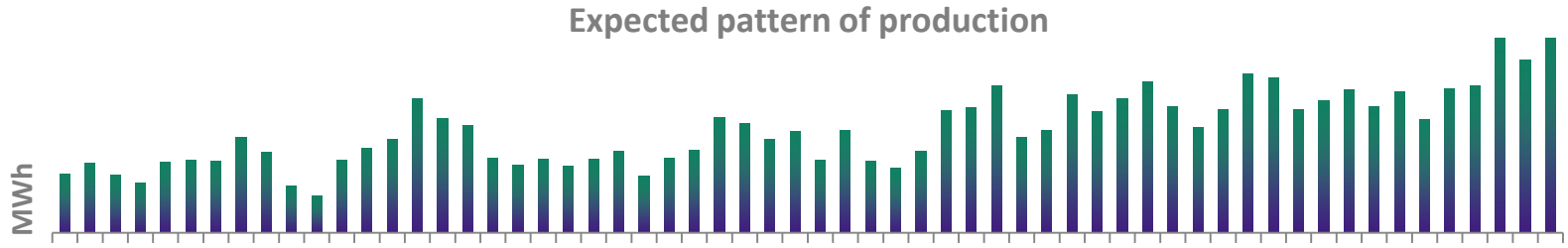
Wind farm performance optimisation

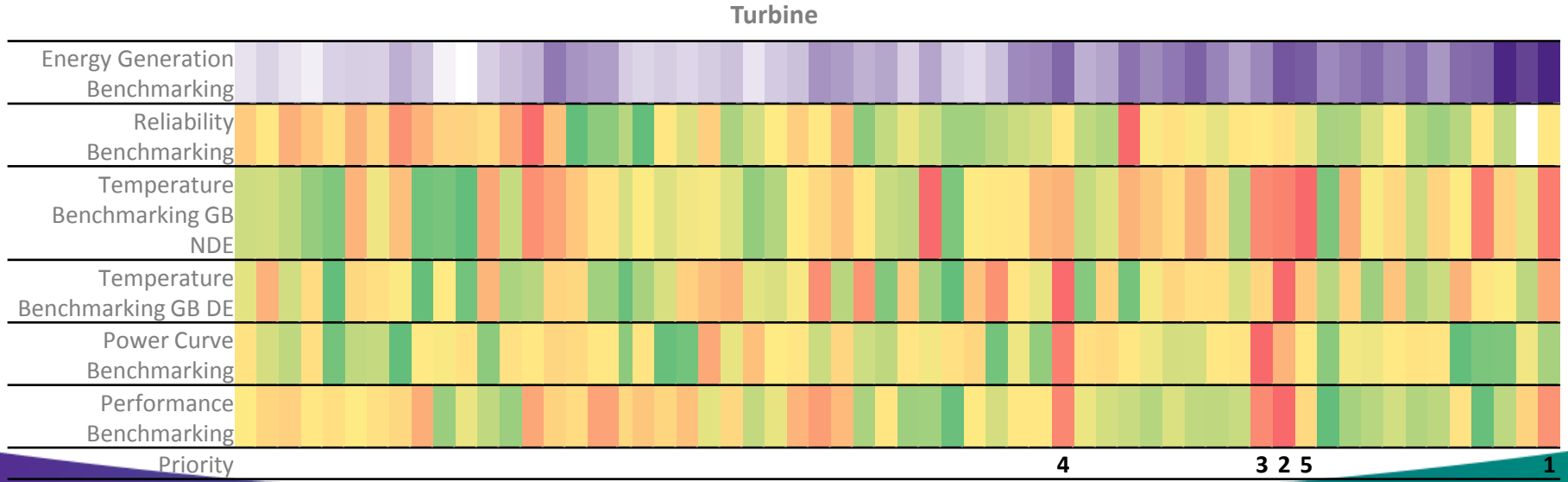
ControlCentre



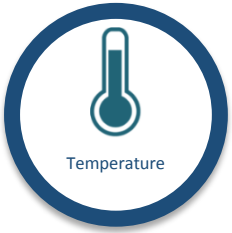
Wind farm performance optimisation

Performance analytics exercise – a case study

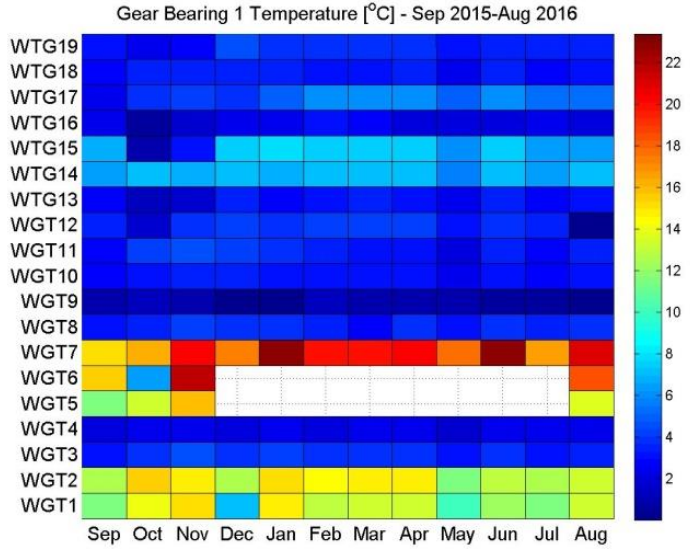


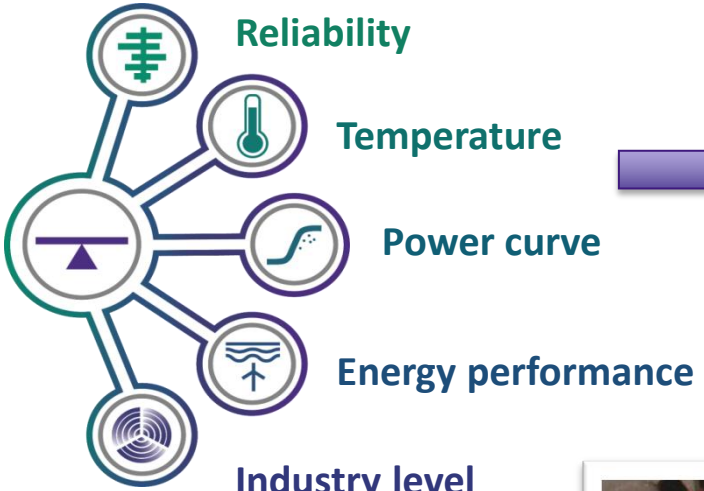


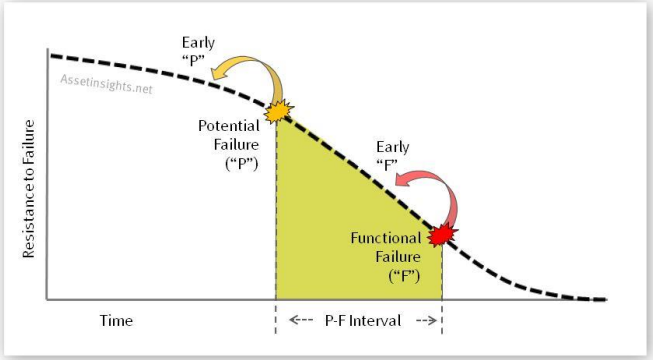
Wind farm performance optimisation - Performance



- Component temperature benchmarking compares the SCADA temperature signals
- Identifies anomalous component operations through KPIs:
  - Exceedance of normal operating limits
  - Drive and non drive end temperature decoupling
  - Deviation between generator and gearbox temperatures
  - Application:
    - used to inform inspections
    - Early indication of failure – automatic alerts of thresholds and rate of change




Reliability
Temperature
Power curve
Energy performance
Industry level benchmarking


Assetinsights.net
Early "P"
Potential Failure ("P")
Early "F"
Functional Failure ("F")
Resistance to Failure
Time
<--- P-F Interval -->

Wind farm performance optimisation

Service delivery

A Site Based Team – reducing availability impact risk

Improving Productive Hours

Reducing reliance on OEM & support agreement

Whole Site O&AM management – synergy of service

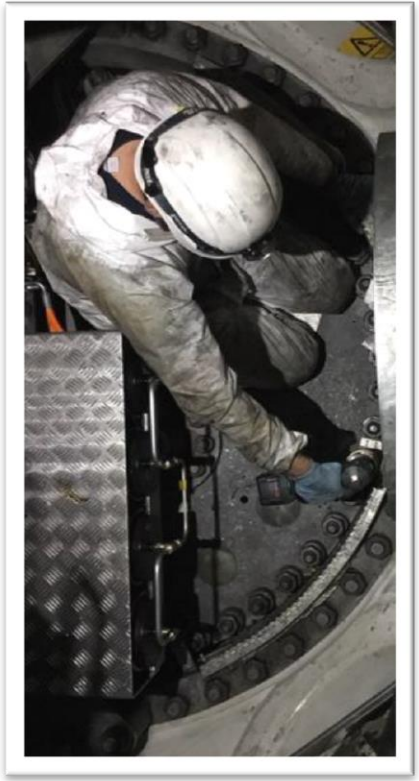
Procurement Focus

Internalising additional Services:

- Large component change out
- Second line SCADA support
- Inspections
- HV works

Continuously driving improvements:

- Engineering
- Spares
- Consumables



Thijs Bauer

Managing Director

Colville Partners

Onshore Wind Refinancing

James Barry

Chief Executive

Renewable Parts

Scottish Renewables on-shore conference

June 12th June 2018

Renewable Parts Ltd
More than just parts

Living beyond subsidy

Today's talking points …

1. Observations from an adjacent industry
2. Three areas where we must innovate
3. Benefits from on-shoring capability
4. A look to the future

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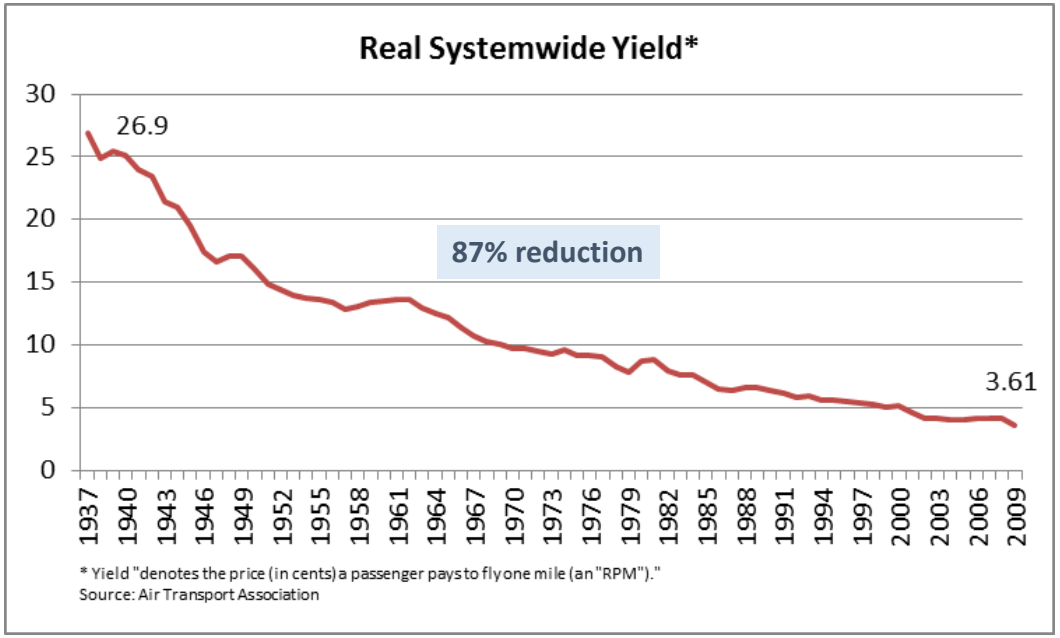
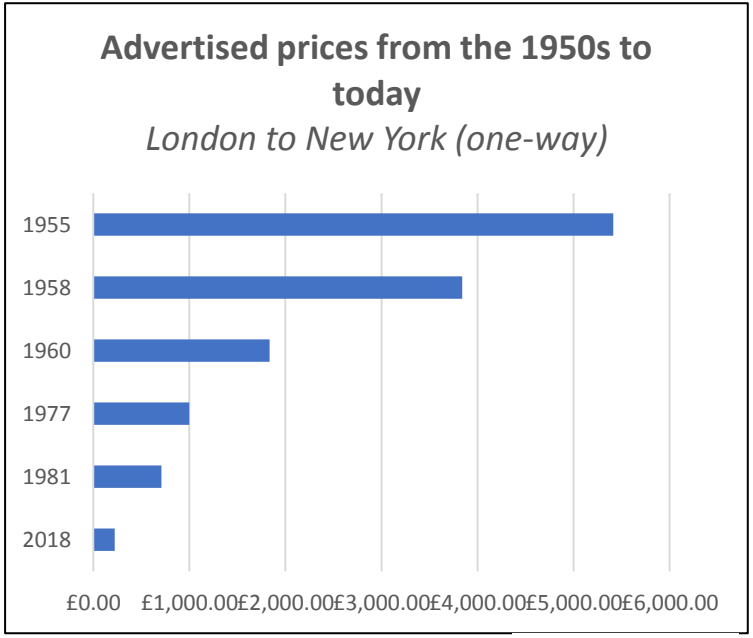
The realities of a mature sector

- Aerospace, more than any other sector, has used innovation to reduce cost





Greater innovation meeting customer expectation

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A glimpse at Aerospace

- The Wind sector must utilise the UK's extensive expertise in Life Cycle Cost modelling, Condition Monitoring and Refurbishment Engineering
- The similarities between the Wind and Aerospace sectors are striking, we do not need to re-invent the wheel

Refurbishment Engineering

Inventory Management - JiT

Condition Monitoring

Learning from others will accelerate progress

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Targets for innovation

- Our industry must become bolder and more innovative to realise system efficiencies. Renewable Parts' priorities are:

1. Refurbishment Engineering
2. Data analytics to optimise inventory holding
3. Parts wear out prognostics Condition Monitoring

Cost of manufacture versus cost of refurbishment

Data fidelity and analysis remains elementary

Aerospace has proven 100% predictability on parts failure

Success through collaboration

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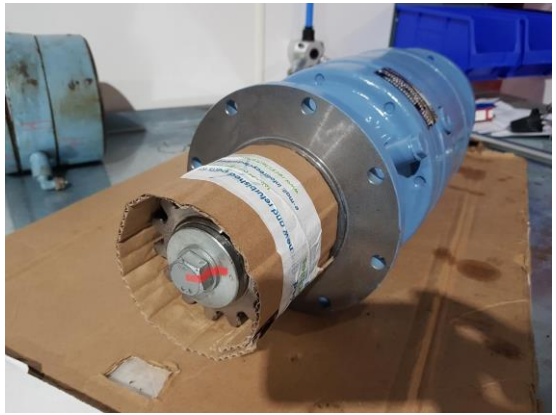
Refurbishment Engineering

- Refurbishment offers enormous potential to strengthen the supply chain, reduce waste and improve cost and lead-time
- Developing local skills and capabilities is key – we have the resource, expertise but do we have the ambition and are we willing to change?
- We are a Green energy source but are we following a Green Aftermarket agenda?



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Reducing our cost and carbon footprint

Assumptions:
1000 miles trip to OEM
9 mile/ gallon
2.62kg CO_2 / litre

10kg CO_2 / yaw gear
400kg CO_2 to fabricate new

- For illustration we take a Siemens 2.3MW yaw system:
  - Turbine has 8 yaw gears with an average life of 5 years
  - Each yaw gear weights ~250kg and costs ~£3,000 new

- Yaw gear refurbishment is seldom utilised despite offering cost and environmental benefits

Carbon equivalent to a flying a 747 for 1 minute

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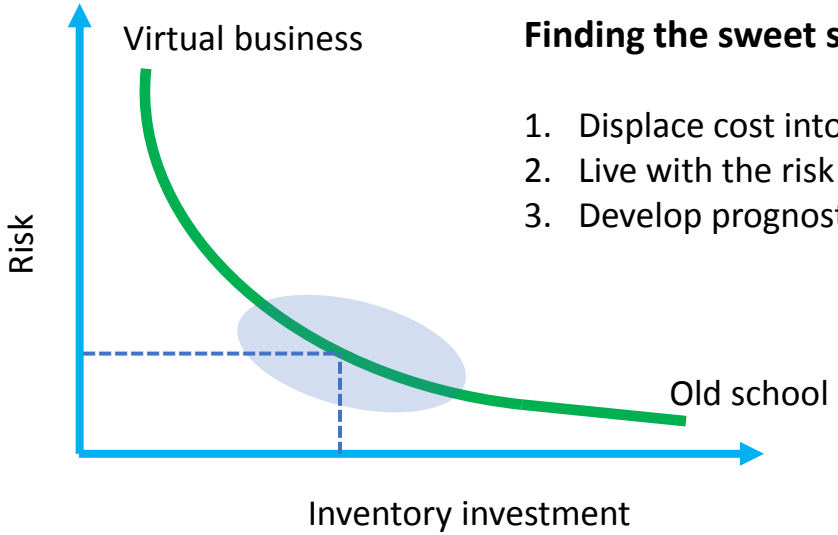
Inventory – striking the right balance

- The depth and understanding of demand data is key to optimising inventory strategies
- Turbine availability levels come at a price, but how are businesses striking the optimum balance?



Finding the sweet spot is tricky

1. Displace cost into supply chain
2. Live with the risk and pay elevated pricing
3. Develop prognostic capability

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Inventory optimisation, insights from a multi MW site

- Optimising inventory is a complex, dynamic challenge. It is a data hungry and requires advanced analytical techniques
- Our experience from data mining a large MW site demonstrates significant opportunities for cost reduction

25, the fleet size

250, the number of critical line items

£200k, the inventory holding

10, the number of parts related lost days p.a.

0.1% availability lost due to parts

£3,500, Inventory cost per MW

40%, the potential reduction in inventory holding

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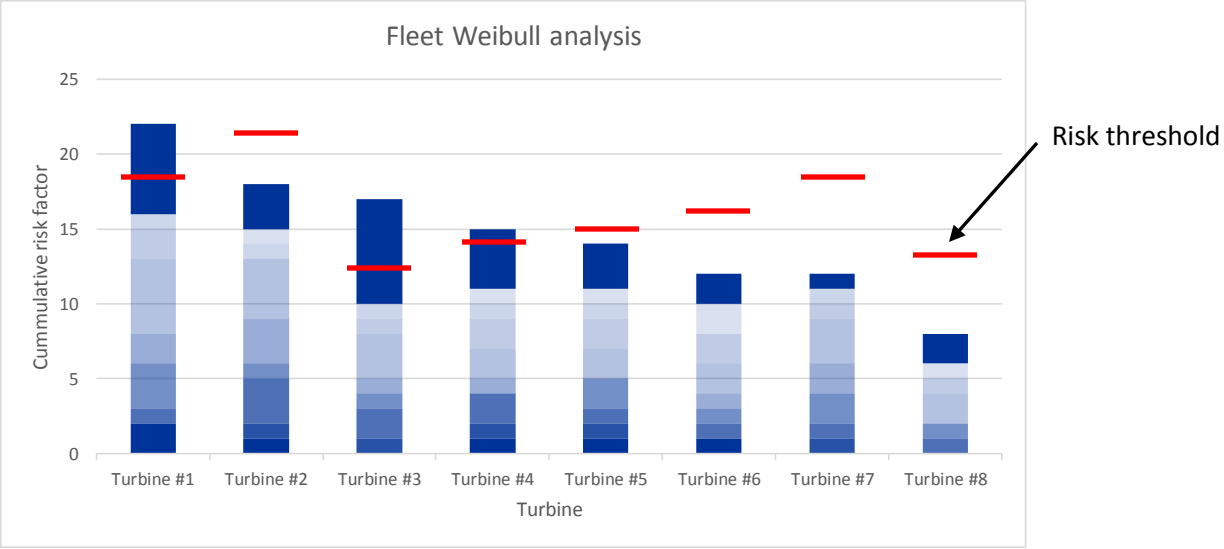
Aerospace condition monitoring

- Aerospace can now predict with close to 100% certainty failure rates of components to time horizons – if it's predictable they can predict it
- Businesses decide on risk levels and set alerts accordingly, safety being paramount



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Condition monitoring

- CM in the Wind industry has advanced dramatically in recent years in both cost and its effectiveness, however we remain significantly behind adjacent sectors

- The next generation of CM will provide full prognostic parts wear out capability that can be integrated into procurement systems

Early CM systems	**Expensive, limited effectiveness, failure to identify problems and some spurious non-existent problems**
Current best CM systems	**Inexpensive lease per month, >90% detection effectiveness and accuracy, user notification on action requirements**
Advanced CM systems H1 2019	**Detection and high probability of parts required integrated into procurement / sourcing systems**

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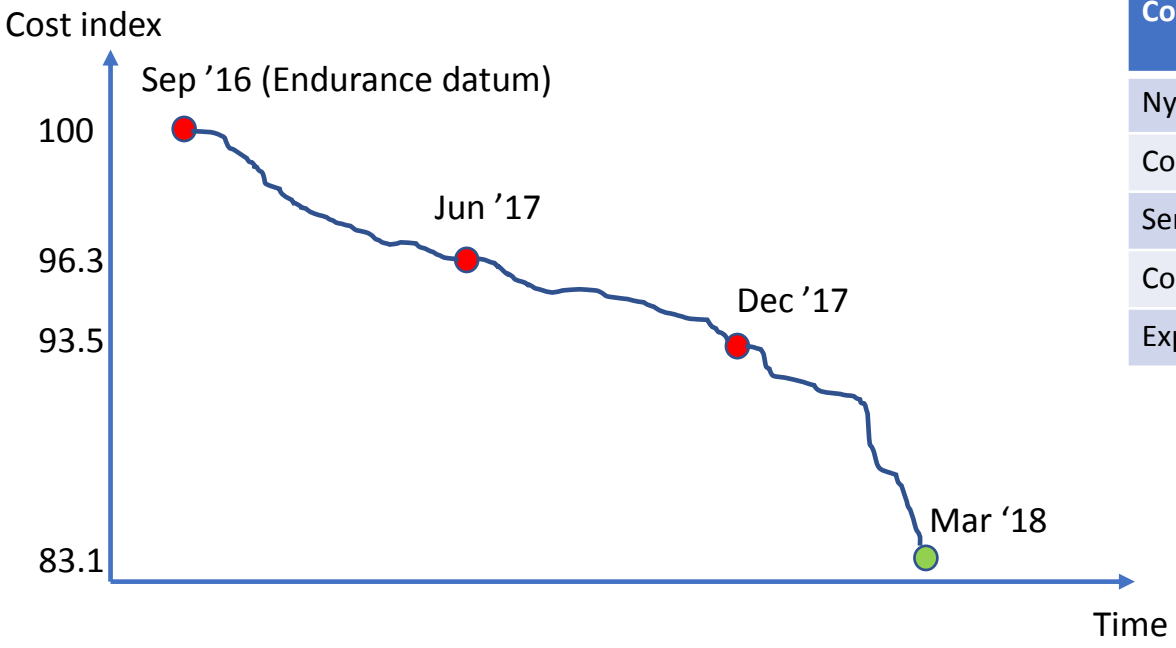
Building a UK supply chain

- Significant reduction in parts pricing over the last 12 months. Our price index shows a 17% reduction since September ’16, with much more to come



Component	Endurance (£)	RPL price (£) index
Nyloil sleeves	£1,230	£906 (0.73)
Couplings	£1,599	£1,323 (0.82)
Service kits	£383	£146 (0.38)
Contactors	£741	£648 (0.87)
Expander pins	£2,400	£1,920e (0.80)

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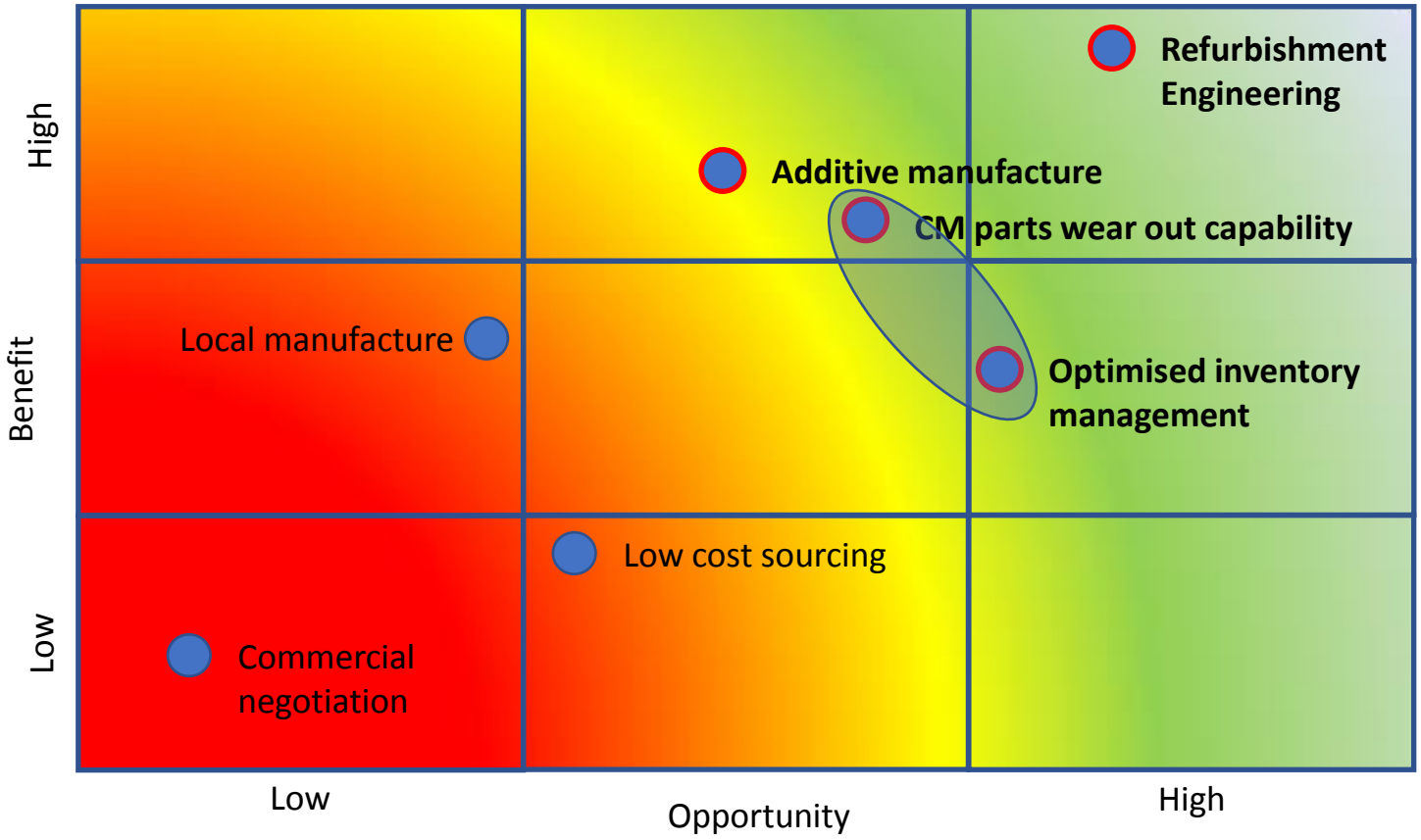
Where might our best interests lie?



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Conclusions

- Our industry is advancing rapidly but we can learn much from adjacent sectors
- There are significant opportunities to increase efficiency and reduce cost – realising them will require us to think and behave differently
- We may be a green energy source but cannot extend that claim to our Aftermarket – we all have a responsibility to do more!
- Developing more UK based capability lies in all our interests….

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More than just parts

Jenny Hogan
Deputy Chief Executive, Scottish Renewables

Euan Fenelon
Director of Operations & Asset Management, Natural Power

Thijs Bauer
Managing Director, Colville Partners

James Barry
Chief Executive, Renewable Parts

scottish renewables

ONSHORE WIND CONFERENCE

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reNEWS

George Baxter

Head of Strategic Relations
(Generation Development)
SSE

Brendan Turvey

Policy Manager, Renewables/
Operations Manager Tayside and Grampian
Scottish Natural Heritage

Assessing the impact of repowered wind farms on nature

Brendan Turvey

12th June 2018

Outline

- Why develop guidance ?
- What we mean by “repowering”
- Key issues
- Industry seminar
- Next steps

Why ?

- Applications starting to emerge
- Important contribution to targets
- Need a consistent approach
- Clarity for applicants on what is expected

What ?

- In this guidance “repowering” means removing one set of wind turbines and replacing these with new wind turbines

- Same principles relevant to other scenarios, eg variations / life extensions

- Baseline for assessment
- Survey work
- Visualisations

Baseline

- Must assess full impacts
- Schemes are mutually exclusive
- Existing wind farm will be removed – need to be consistent with ‘planning baseline’

Baseline

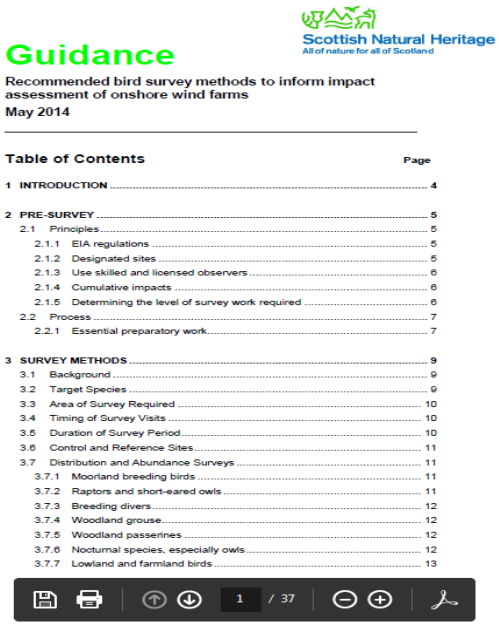
- Baseline is technical basis for EIA assessment
- Existing wind farm is a material consideration (SPP para 174)
- Comparative assessment can be provided

In this decision I primarily consider the benefits, impacts and overall acceptability of the new 13 turbine proposal in its own right, rather than the significance or otherwise of the difference in impact compared to the permitted scheme. **It cannot be the case that successive applications can necessarily 'ratchet up' the scale of a development on the basis that the difference in impact from a permitted proposal is small.** That said, there are many similarities between the two proposals and it is material to the consideration of this appeal that the overall level of impact associated with the permitted scheme has been found to be acceptable

Tom nan Clach decision letter 2016

Survey - birds

- Traditional bird survey methods wont work due to existing turbines
- Use existing data, modelling and judgement
- Use desk study to identify risks
- Carry out survey if new species / issues to consider



Scottish Natural Heritage
All of nature for all of Scotland

Guidance

Recommended bird survey methods to inform impact assessment of onshore wind farms
May 2014

Table of Contents Page

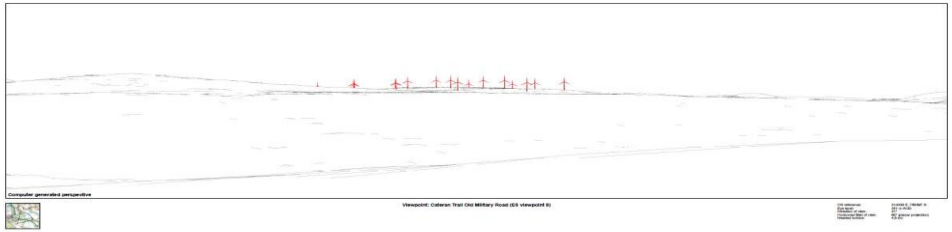
1 / 37

Other surveys…

- Normal survey methods appropriate
- Focus on changes that have occurred

Images in the ES

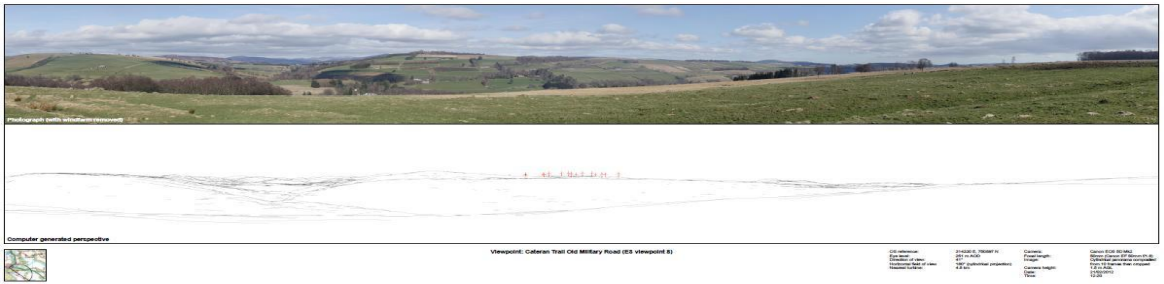
90º to 360º baseline photo and cumulative wireline



wireline

photomontage

Comparative images



Existing

Existing and proposed (in different colours)

25th June

Scottish Renewables,

46 Bath Street,

Glasgow

Email: PLANNINGRENEWABLES@snh.gov.uk

to book a place…

Next steps

- Consultation closes 31st August
- Email responses to brendan.turvey@snh.gov.uk
- Guidance published by end 2018

Lesley McNeil

Head of Onshore Wind Policy

Scottish Government

Onshore Wind in Scotland

Lesley McNeil
Head of Onshore Wind Policy

OVERVIEW:

1) Scottish Energy Strategy and Onshore Wind.
2) Onshore Wind Sector in Scotland
3) The Scottish Government Onshore Wind Policy Statement
4) Repowering
5) Barriers to Deployment

‘Whole-system’ view

- Economic modelling, informing view of Scotland’s future energy supply and demand
- Integrated approach to heat, power and transport
- New 50% ‘all energy’ 2030 renewables target
- Renewed focus on energy efficiency and energy demand reduction

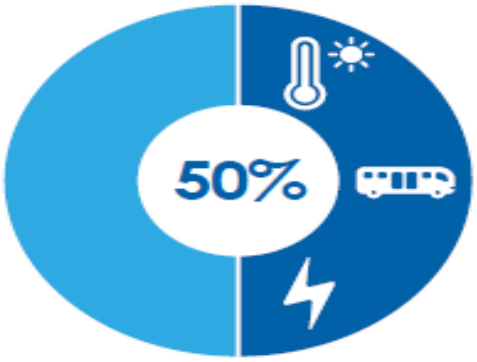
Stable energy transition

- Long-term plan, consistent with requirements of the Climate Change Plan
- Flexible to future changes in technology and patterns of energy use
- Managed transition of energy supply, post-nuclear

A smarter model of local energy provision

- Encouragement for new localised models of energy supply and use
- Enhanced role for local planning and local ownership
- New economic opportunities of energy storage and ‘smart’ energy solutions

Two new and ambitious targets for 2030:

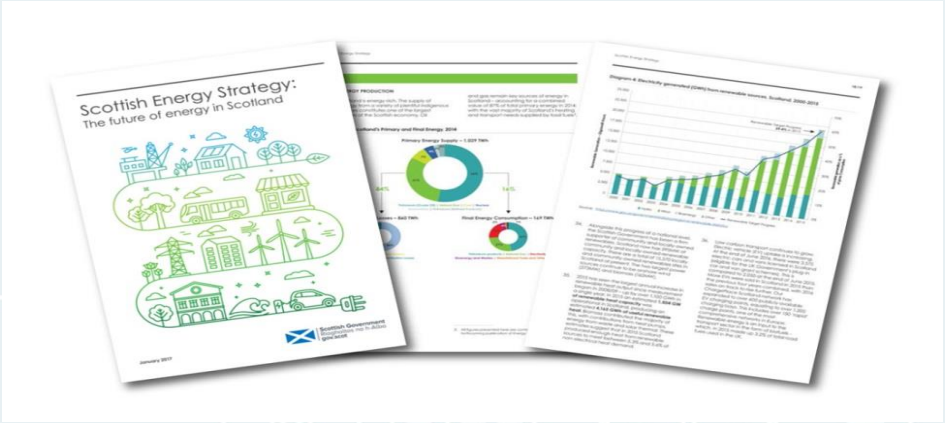


THE EQUIVALENT OF **50%** OF THE ENERGY FOR SCOTLAND'S HEAT, TRANSPORT AND ELECTRICITY CONSUMPTION TO BE SUPPLIED FROM RENEWABLE SOURCES

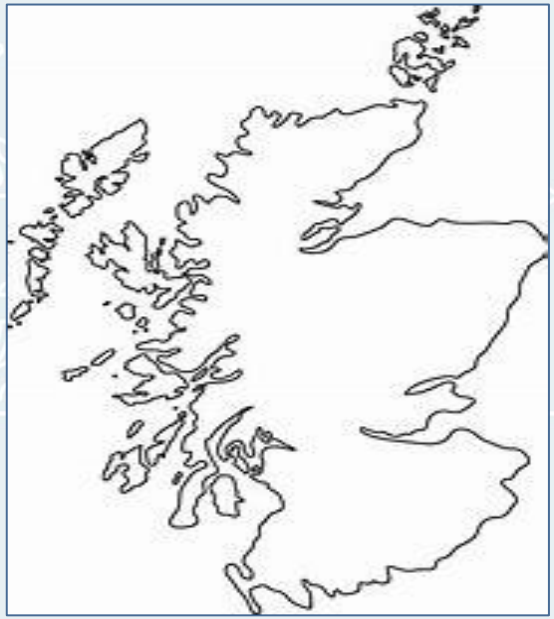
AN INCREASE BY **30%** IN THE PRODUCTIVITY OF ENERGY USE ACROSS THE SCOTTISH ECONOMY

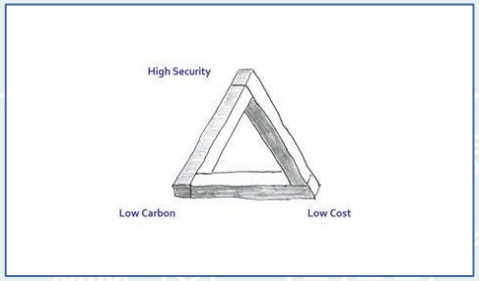
Sustainable, inclusive growth

- Stimulating investment;
- Supporting research and innovation;
- Strengthening supply chains;
- Creating new business models;
- Developing necessary skills;
- Boosting inclusive growth;
- Cultivating regional partnerships; and
- Supporting internationalisation.

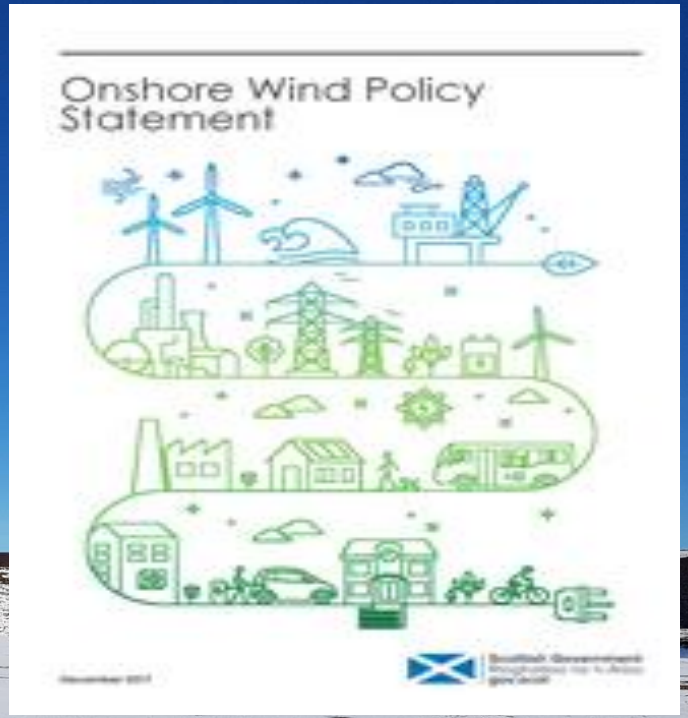


gov.scot

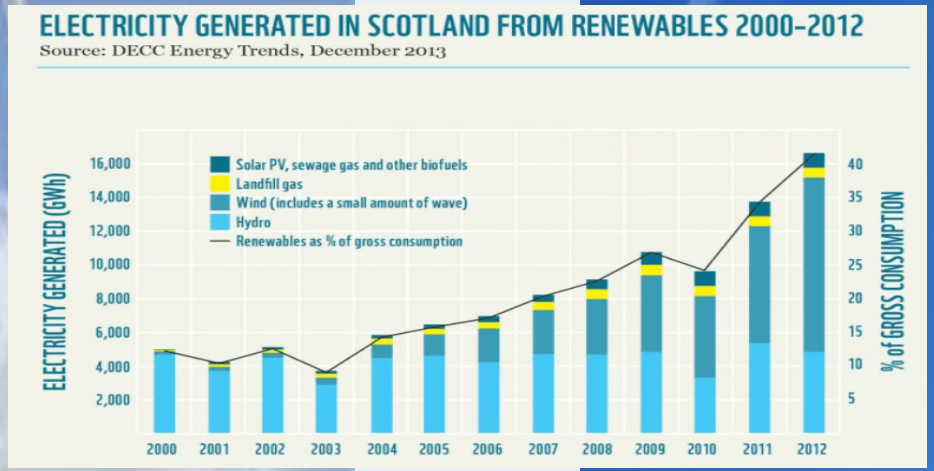




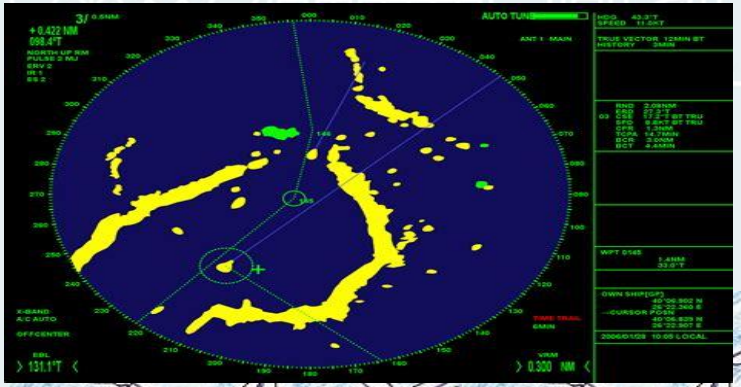
ONSHORE WIND IN SCOTLAND


Onshore Wind Policy Statement

Repowering


ELECTRICITY GENERATED IN SCOTLAND FROM RENEWABLES 2000–2012
Source: DECC Energy Trends, December 2013
ELECTRICITY GENERATED (GWh)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
Solar PV, sewage gas and other biofuels
Landfill gas
Wind (includes a small amount of wave)
Hydro
Renewables as % of gross consumption
40
35
30
25
20
15
10
5
% of GROSS CONSUMPTION
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012

Barriers to Deployment



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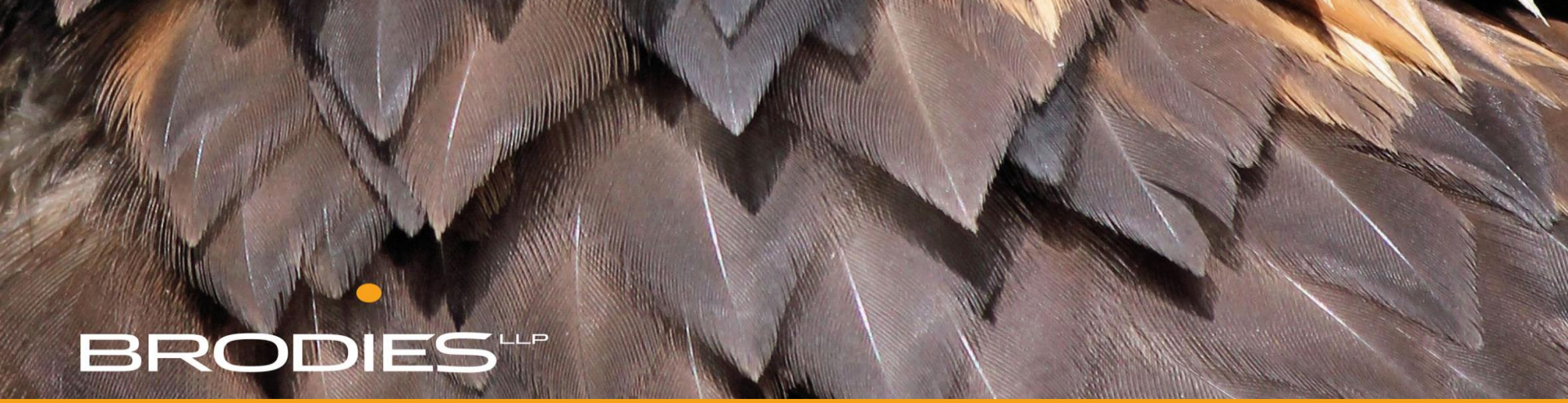
Neil Collar

Partner

Brodies LLP



BRODIES LLP

Consenting – current issues and trends

Neil Collar
Head of Planning Law

Consenting – current issues + trends

Varying existing consents:

- Industry needs v legal uncertainties
- Unwillingness to approve as Non Material Variation

Consenting – current issues + trends

Environmental Impact Assessment

- New Regs = new uncertainties – eg. human health
- Lack of proportionality
- Fear of JR – unjustified?

Section 36 decisions

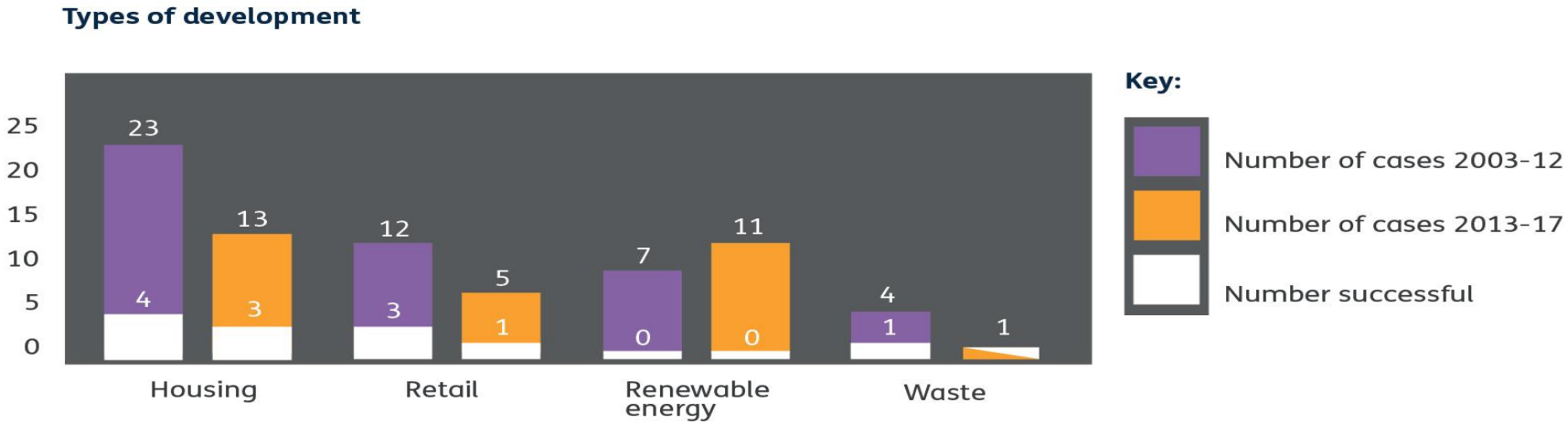
Year	Decisions	Successful	%
17	11	9	82%
16	7	5	71%
15	12	6	50%
14	13	9	69%
13	6	3	50%

Planning Permission Appeals – Multiple Turbines

Year	Appeals	Successful	%
17/18	11	6	55%
16/17	22	15	68%
15/16	29	13	45%
14/15	36	15	42%
13/14	40	16	38%

I FOUGHT
THE LAW,
BUT THE LAW WON

Judicial Review



The Future

Planning Bill

- Equal right of appeal?


DON'T PANIC

George Baxter
Head of Strategic Relations (Generation Development), SSE

Brendan Turvey
Policy Manager, Renewables / Operations Manager Tayside and Grampian, Scottish Natural Heritage

Lesley McNeil
Head of Onshore Wind Policy, Scottish Government

Neil Collar
Partner, Brodies LLP

scottish renewables

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David Cameron
Director of Scottish Policy
EDF Energy

Neil Douglas

Director

BVG Associates

Strategy consulting. Practical thinking.

Navigating the new technology landscape

Onshore 2.0: the next generation

Scottish Renewables Onshore Conference 2018

June 2018

Neil Douglas - Director

BVGassociates

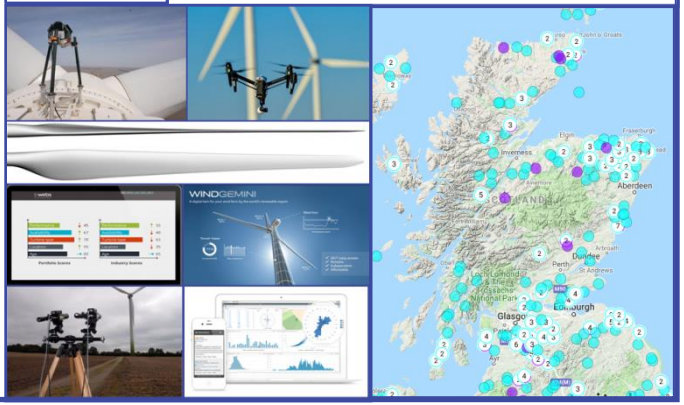
Onshore Wind 2.0: the next generation

Navigating the new technology landscape

Contents

1. BVG Associates
2. What is driving new technology
3. What is out there
4. What are the barriers
5. Applying a methodology

Hardware	Software	Systems
Turbine mounted lidar	SCADA aggregation	Benchmarking
Drones	SCADA analysis	Digital twins
Blade upgrades	Mobile work-flow and reporting	Oil sampling
Control system	Knowledge management	Predictive analytics
Advanced inspection	Decision support tools	Performance analytics
SCADA upgrade	Spares management	Condition monitoring



BVG Associates

Our Expertise

Who we are, what we do

Founded in 2006

Over 280 Clients

150 years staff
industry experience

40 landmark publications

Strategy consulting. Practical thinking.

Economics

Business

Technology

Onshore wind

Offshore wind

Energy Systems

Wave and tidal

Onshore Wind 2.0: the next generation

Navigating the new technology landscape

What is driving new technology?

- Industry wide cost reduction agenda
- Maturing fleet, ageing assets
- Owners maximising value from existing assets

- Driving innovation in secondary technology market

Onshore Wind 2.0: the next generation

Navigating the new technology landscape

What is out there?

Hardware	Software	Systems
Turbine mounted lidar	SCADA aggregation	Benchmarking
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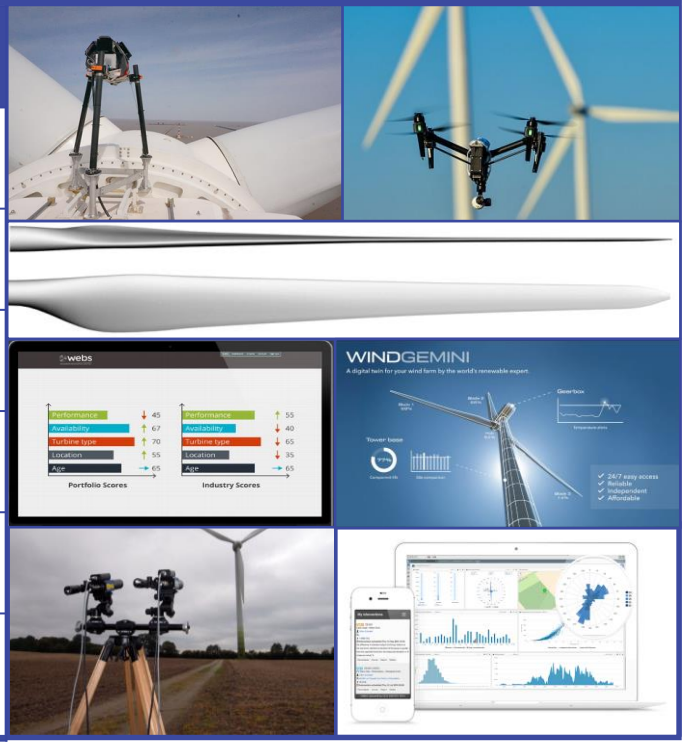

Onshore Wind 2.0: the next generation

Navigating the new technology landscape

What is out there?

Hardware	Software	Systems
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Advanced inspection	Decision support tools	Performance analytics
SCADA upgrade	Spares management	Condition monitoring

All seek to reduce project levelised cost of energy (LCOE) by:

- Improving revenue
- Reducing costs
- Extending operational life

…often, a combination of the above

Onshore Wind 2.0: the next generation

Navigating the new technology landscape

What are the barriers?

- Finding the time
- Finite investment budgets
- It's a busy market place
- Portfolio complexity and diversity
- Knowing what you want to achieve

Hardware	Software	Systems
Turbine mounted lidar	SCADA aggregation	Benchmarking
Drones	SCADA analysis	Digital twins
Blade upgrades	Mobile work-flow and reporting	Oil sampling
Control system	Knowledge management	Predictive analytics
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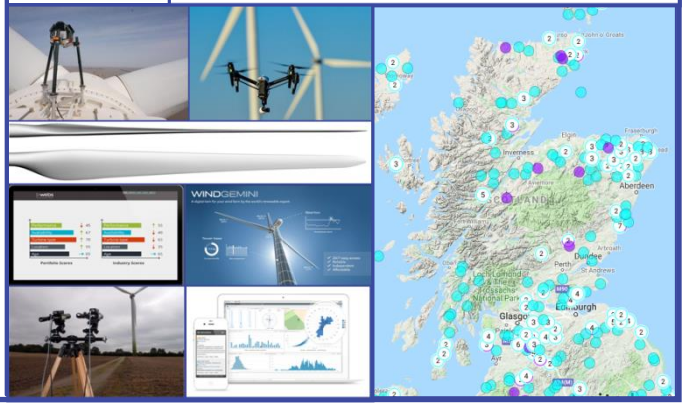
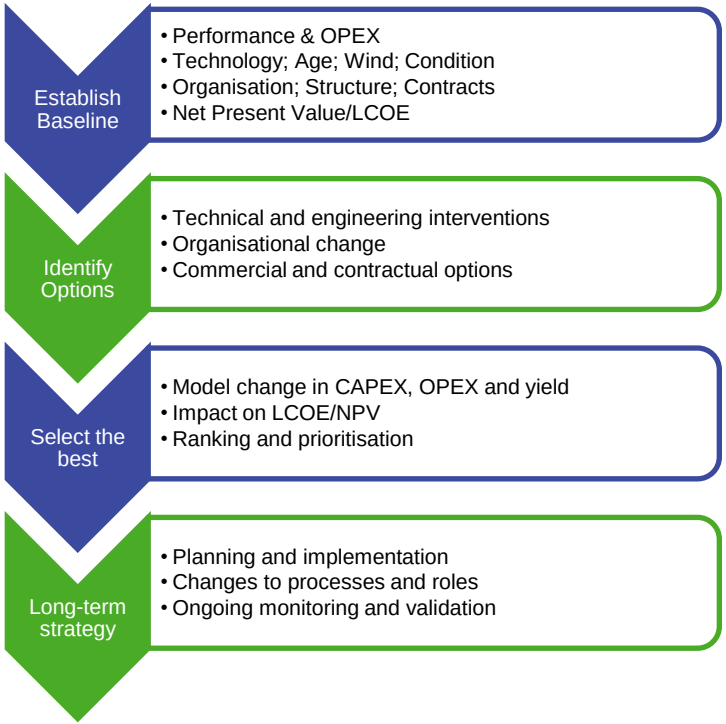


Onshore Wind 2.0: the next generation

Navigating the new technology landscape

Applying a methodology

- Logical process in a consistent framework
- Coherent portfolio and site level view
- Capture and compare the benefits
- Allows rational investment decisions to be made
- Implement and follow-up



Onshore Wind 2.0: the next generation

Navigating the new technology landscape

Apply a methodology - where does the OPEX go?

Level 1	£/MW/ year	Level 2	£/MW/ year	%	Level 3	£/MW/ year	%	Level 4	£/MW/ year	%	Level 5	£/MW/ year	%	Impact
Asset management services (AMS)	33,000	Operations	10,000	30%	Site mgt	3,500	11%	-			-			M
					HV switching		0%	-			-			H
					Commercial		0%	-			-			L
					Supply-chain mgt		0%	-			-			L
					CR - work flow		0%	-			-			M
					CR - grid		0%	-			-			M
					Asset optimisation		0%	Downtime / cost	250	0.8%	Software	25	0.1%	L
											Hardware	-	0.0%	L
											Analysis	225	0.7%	M
								Performance	750	2.3%	Software	20	0.1%	L
											Hardware	30	0.1%	M
											Analysis	700	2.1%	M
		Maintenance	16,000	48%	Planned maintenance inc. statutory inspectons	14,000	42%	Rotor	2,000	6.1%	Parts	500	1.5%	M
											Labour	1,000	3.0%	M
											Tools	500	1.5%	L
								Drive-train	8,000	24.2%	Parts	500	1.5%	L
											Labour	6,000	18.2%	M
											Tools	1,500	4.5%	M
								Other	4,000	12.1%	Parts	500	1.5%	L
											Labour	3,300	10.0%	M
											Tools	200	0.6%	L
					Non-statutory inspection		0%	Rotor	300	0.9%	Parts	-	-	-
											Labour	250	0.8%	M
											Tools	50	0.2%	M
								Drive-train	600	1.8%	Parts	-	-	-
											Labour	450	1.4%	H
											Tools	150	0.5%	M
								Other	100	0.3%	Parts	-	-	-
											Labour	75	0.2%	L
											Tools	25	0.1%	L
					Condition monitoring		0%	Rotor	150	0.5%	Parts	25	0.1%	L
											Labour	100	0.3%	M
											Tools	25	0.1%	M
								Drive-train	800	2.4%	Parts	50	0.2%	L
											Labour	750	2.3%	M
											Tools	-	0.0%	M
								Other	50	0.2%	Parts	-	0.0%	L
											Labour	50	0.2%	L
											Tools	-	0.0%	L
		Service	7,000.00	21%	In-situ service		0%	Rotor	1,200	3.6%	Parts	350	1.1%	M
											Labour	650	2.0%	M
											Tools	200	0.6%	M
								Drive-train	1,600	4.8%	Parts	250	0.8%	M
											Labour	850	2.6%	M
											Tools	500	1.5%	M
								Other	200	0.6%	Parts	25	0.1%	L
											Labour	150	0.5%	L
											Tools	25	0.1%	L
					Remove-repair-replace	4,000	12%	Rotor	1,000	3.0%	Parts	400	1.2%	M
											Labour	200	0.6%	M
											Tools	400	1.2%	M
								Drive-train	2,500	7.6%	Parts	350	1.1%	M
											Labour	1,800	5.5%	M
											Tools	350	1.1%	M
								Other	500	1.5%	Parts	150	0.5%	L
											Labour	300	0.9%	L
											Tools	50	0.2%	L

Establish Baseline
- Performance & OPEX
- Technology; Age; Wind; Condition
- Organisation; Structure; Contracts
- Net Present Value/LCOE

Identify Options
- Technical and engineering interventions
- Organisational change
- Commercial and contractual options

Select the best
- Model change in CAPEX, OPEX and yield
- Impact on LCOE/NPV
- Ranking and prioritisation

Long-term strategy
- Planning and implementation
- Changes to processes and roles
- Ongoing monitoring and validation

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Onshore Wind 2.0: the next generation

Navigating the new technology landscape

Apply a methodology – where are the potential gains?

	Operate and Maintain	Asset Optimisation	Logistics	Administration
Direct	OEM contract O&M Strategy	Performance and Improvement	Logistics strategy	SPV governance
Manage	Work orders HSE Control Room	Data analytics (L1 L2 L3) Reporting	Spares Supply Chain	Financial reporting PPA Compliance
Execute	Remote monitoring Forecasting Unplanned Inspections	SCADA CMS Lidar Machine Learning	Purchasing Stores, tooling and PPE Training	Finance e.g. AP, AR, assets Insurance Rent Metering

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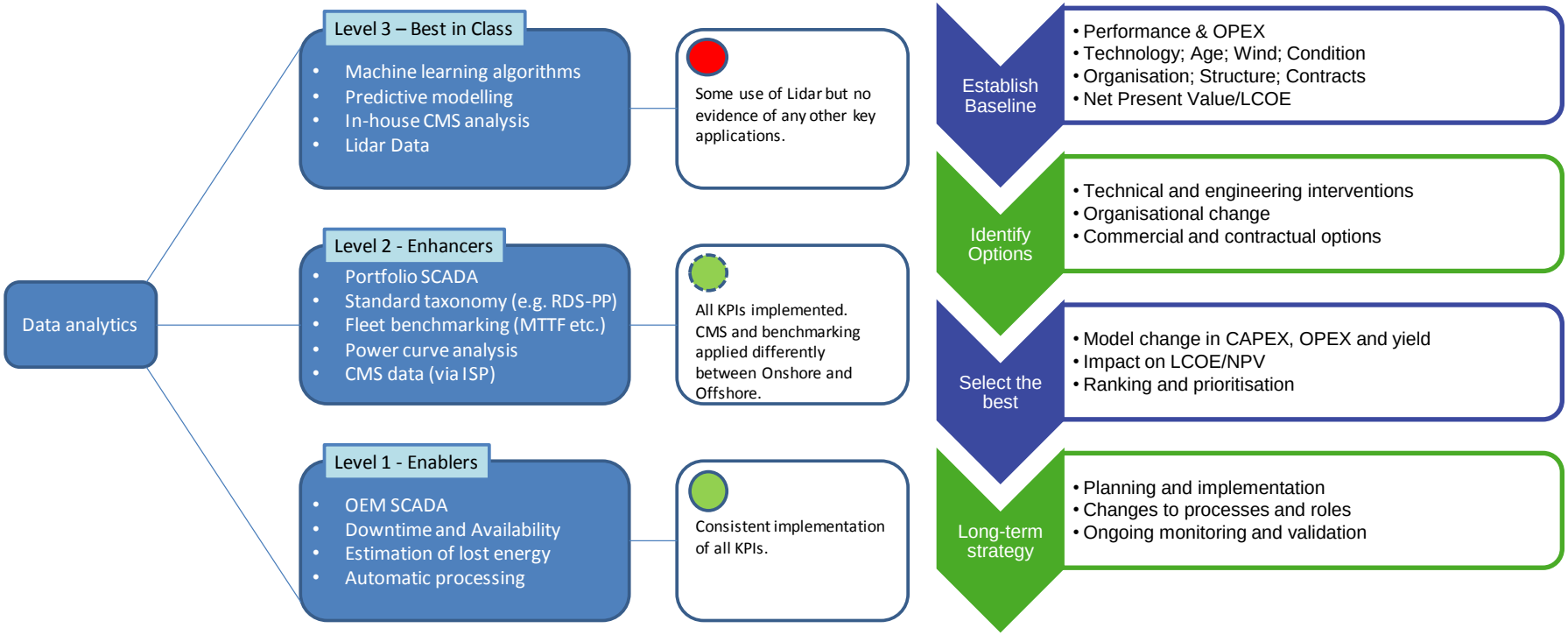
Onshore Wind 2.0: the next generation

Navigating the new technology landscape

Apply a methodology – map the detail

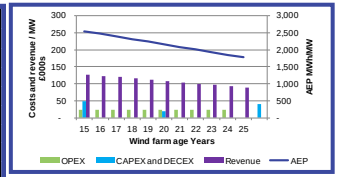


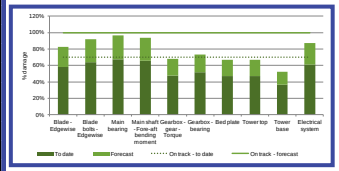
Onshore Wind 2.0: the next generation

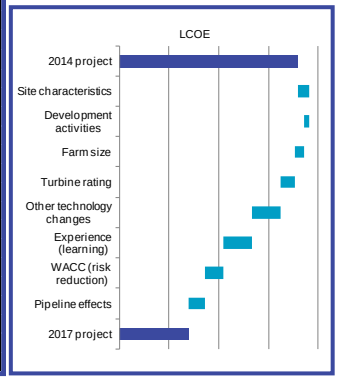
Navigating the new technology landscape

Apply a methodology – model baseline and upside LCOE/NPV

Parameter	Value	Unit
Project		
Currency	GBP	
Wind farm name	XX	
Wind farm rating (From connection agreements)	69	MW
Wind farm rating (From turbine data)	69	MW
Number of turbines - Total	30	#
Site annual mean wind speed at hub height	6.2	m/s
Site wind distribution shape factor	2	-
Weighted Average Cost of Capital (WACC)	7.5%	%
Average revenue (by year)	Distribuition	GBP/MWh
First operation date	2004	Date
Planned baseline operational life	24	yrs
Turbine		
Rating	2.3	MW
Rotor diameter	92	m
Power curve (if available, vs wind speed)	Power curve 13	#
Or average AEP	N/A	MWh/yr
Innovation X		
DEVEX	150,000	GBP/Client or X
Depreciation for above (to get to per project)	1	#
DEVEX	10,000	GBP/Project
DEVEX	0	GBP/Turbine
CAPEX	0	GBP/Client or X
CAPEX	5,000	GBP/Project
CAPEX	18,000	GBP/Turbine
Change in OPEX (or distribution by year)	20,000	GBP/Project/yr
Change in OPEX (or distribution by year)	-500	GBP/Turbine/yr
Change in AEP (or distribution by year)	Power curve 113	#
Or % change	N/A	%
Change in energy availability (absolute)(or distribution by year)	0.2	%
Starting year for innovation in operation	15	Yr
Change in operational life	0	Yrs
Change in revenue	12	GBP/MWh
Include in scenario X	Distribution	%







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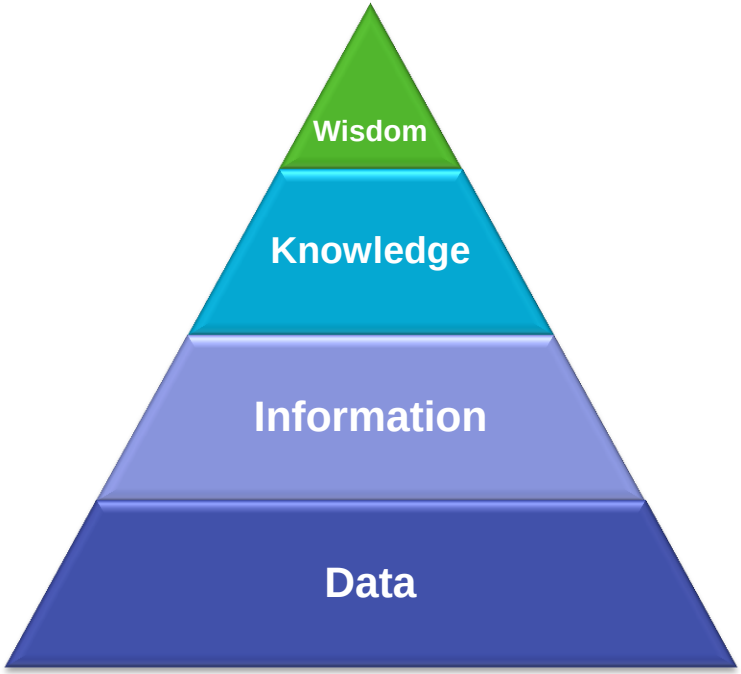
Onshore Wind 2.0: the next generation

Navigating the new technology landscape

Realising the benefits

- Realism – test the claims
- Early adoption – risk v gain
- Implement and validate
- Technology needs to work with people



Thank you

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Dr Laura Kane

Senior Consultant

Smarter Grid Solutions

Using grid-edge technology to make the most of onshore wind

- *Dr Laura Kane, Senior Consultant*
- *SR Onshore Wind Conference*
- *JUNE 2018*

smarter grid solutions

What We Do

INCREASE HOSTING CAPACITY

Manage voltage and thermal constraints

COORDINATE DER FLEXIBILITY

Manage operational complexity

STREAMLINED CONNECTIONS

More efficient interconnection

NON-WIRES ALTERNATIVES

Mitigate multiple constraints

COORDINATE MICROGRIDS

Leverage assets more effectively

STACKED VALUES

Monetizing benefits for multiple stakeholders

300+ MW
OF DER MANAGED

9+ YEARS
COMMERCIAL OPERATIONS

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The changing nature of development

There used to be two major challenges to development of a renewable site: **consenting and grid**

Now there are added challenges of finding new revenue streams.

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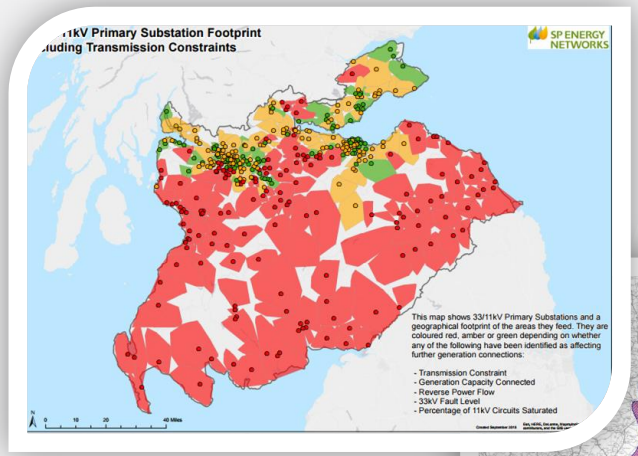
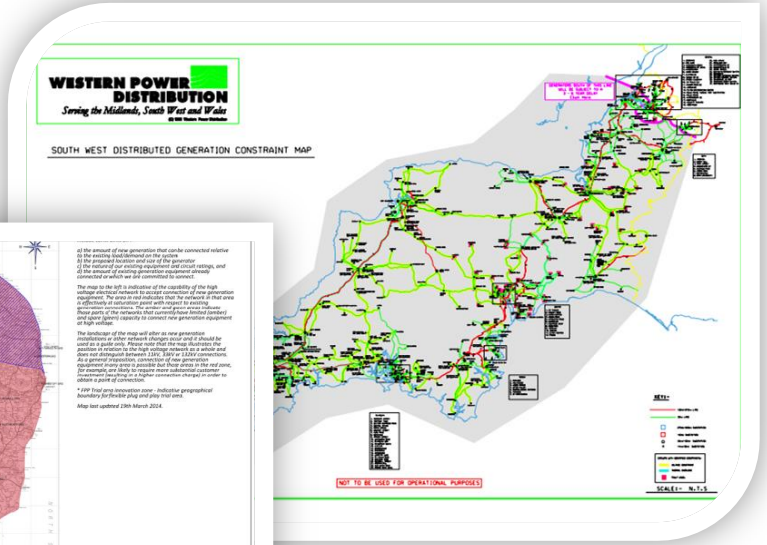
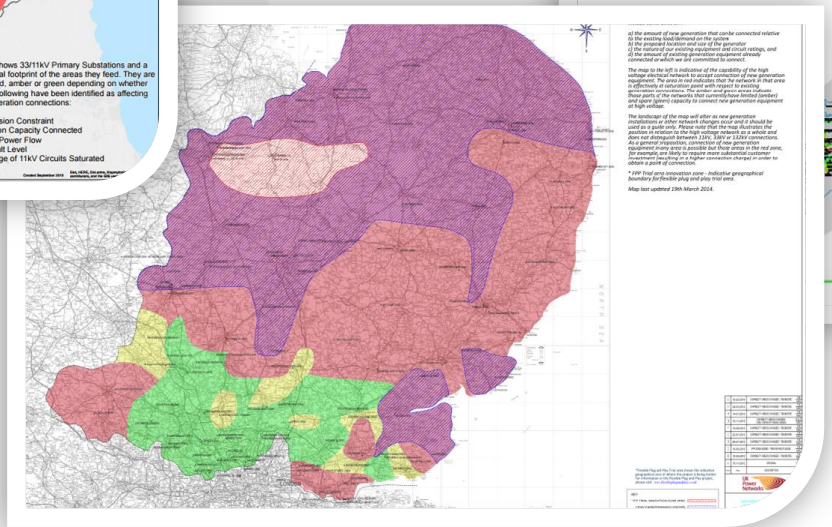
Grid connections are difficult to obtain







nationalgrid

ofgem

smarter grid solutions

Flexible Connections

- No longer assuming worse case conditions for network planning
- Active, Alternative, Flexible, Managed…
- Non-Wire Alternatives
- Different types of Flexible Connections:
  - *Export Limiting*
  - *Timed Connection*
  - *Soft-Intertrip*
  - *Active Network Management*
- Maximises (2-3x) grid hosting capacity by managing generator output in response to grid constraints in real time

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Managing export under outages

PROBLEM

- Large wind farm, limited to 25% capacity during N-1 conditions on the network
- No scope to increase this export due to incumbent generation with higher priority
- Lengthy periods of outage due to network upgrades

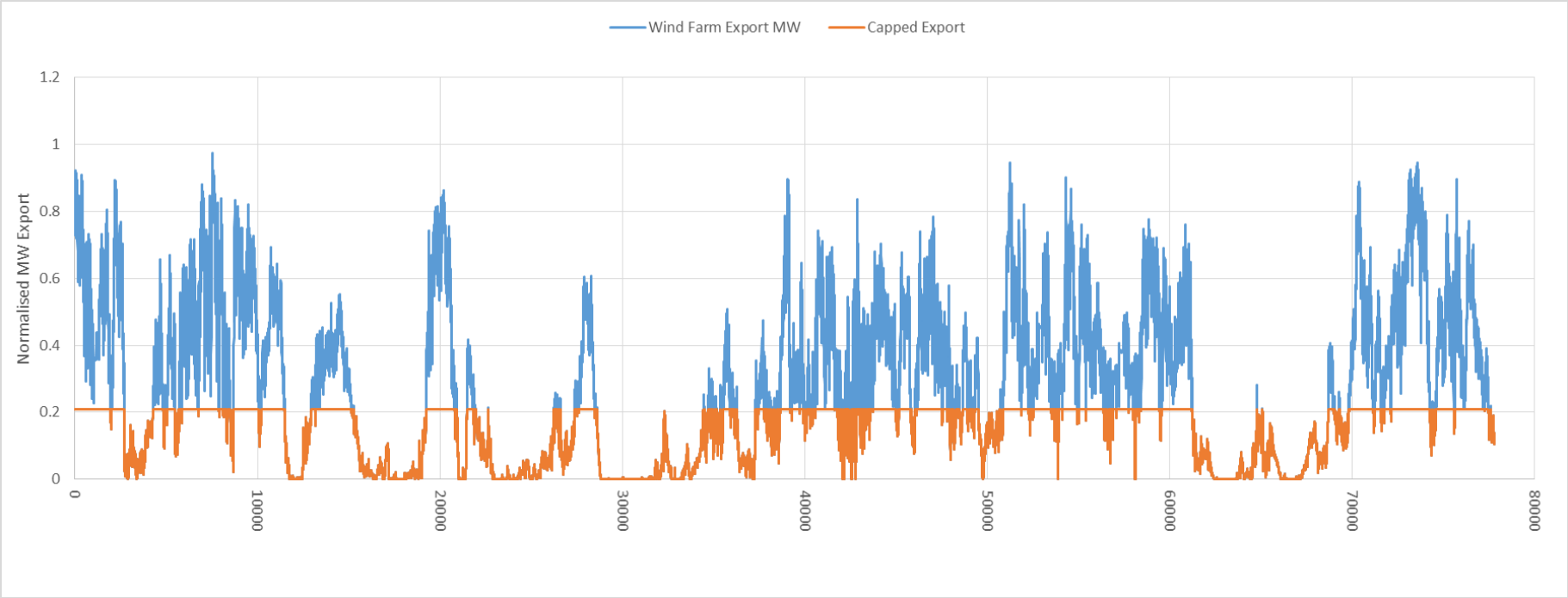
SOLUTION

- Connected to local ANM scheme and managed using real-time measurements during outage conditions

KEY POINTS

- Export increased when the site was able to export based on real-time capacity
- Constraint only applicable during N-1 conditions
- Part of wider ANM scheme that is a temporary measure while Transmission upgrade works are carried out.

Managing export under outages



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How ANM can help

- Flexible connections: can save you time and money
- Shared connections: stand-alone behind the meter solutions
  - *Connect multiple generators to same firm grid capacity*
- Scheduling connections:
  - *Real time optimisation*
  - *Utilise energy storage*
  - *Demand side management*
- Market participation:
  - *Control through aggregators*
  - *Respond to signals from system operators*

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Behind-the-Meter ANM

PROBLEM

- Lack of capacity available in area of development
- Local Tidal site not using full connection capacity

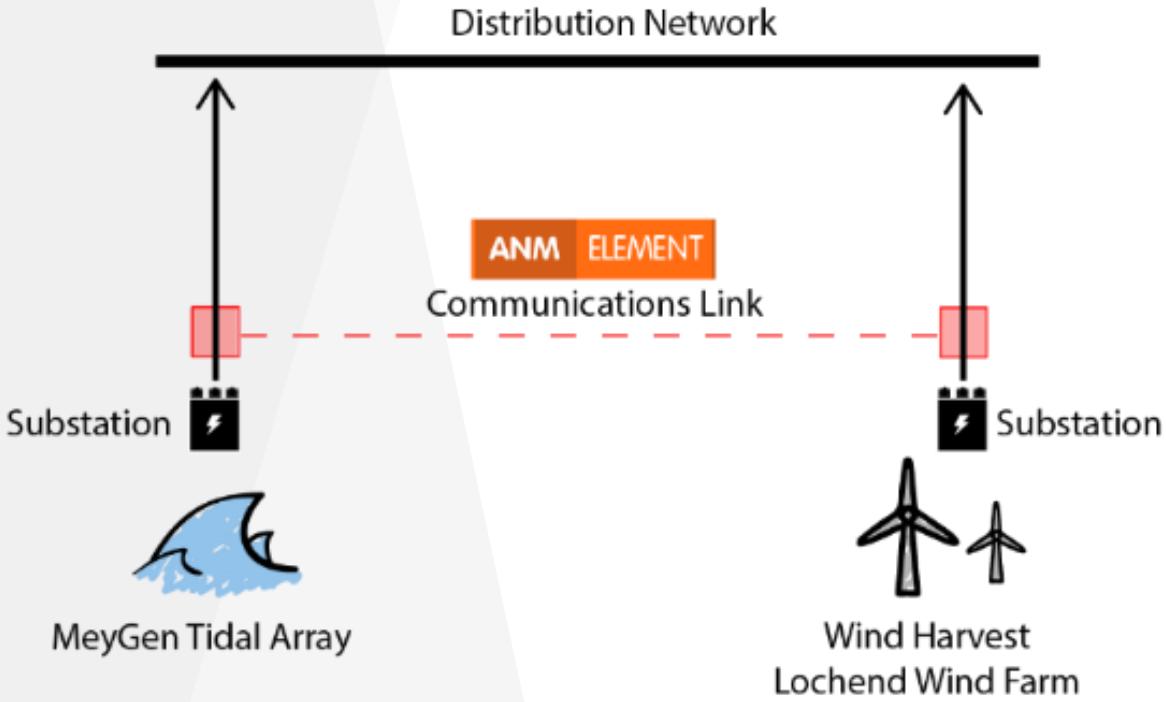
SOLUTION

- Behind the meter ANM system
- Two generators sharing the same connection grid capacity
- Controls wind farm to keep export levels within tidal array's firm export capacity

KEY POINTS

- First of its kind in the UK
- Lochend Wind Farm connected 3 years ahead of schedule
- Solution is applicable to any generation mix

Behind the Meter ANM



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The DNO to DSO Transition

- A work in progress…
- Opening up the market to smaller participants
- And creating new markets to support Distribution and Transmission system operators
- What does it mean for generators?
  - *Additional Revenue Streams*
  - *Diversification on site*
  - *New types of commercial and contractual arrangements*
  - *Embrace flexibility*

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Cloud Hosted ANM and Market Participation

PROBLEM

- Utility needed battery storage devices to provide flexibility during peak demand hours
- Developer wanted to explore participation in NYISO markets as well as distribution utility services

SOLUTION

- Developer installed ANM Element at each of the battery sites and bid in to NYISO Market when Utility isn't using battery
- ANM Strata hosted in the cloud
- Interaction with distribution and transmission

KEY POINTS

- Storage devices will be able to participate in NYISO services
- The platform allows the storage devices to received schedules from the utility, and also bid in to day-ahead and hour-ahead markets
- ANM Strata Platform is cloud hosted – developer can log in via a web interface and manage devices online.

smarter grid solutions

Where can I find out more?

- www.smartergridsolutions.com
- http://www.energynetworks.org/electricity/futures/open-networks-project/
- http://www.energynetworks.org/assets/files/news/publications/150205_ENA_ANM_report_AW_online.pdf
- https://www.spenergynetworks.co.uk/pages/connection_opportunities.aspx
- https://www.ssepd.co.uk/generationavailability/

Eustace Furtado

Manager, Value Engineering

GE Renewable Energy

Warming UP

X	X	X	X	O		X	O
				O			
				O			
		O		O			
		O	X	X	X	X	X
		O					
		O					
		O					

- Each player takes one turn at a time, marking either “X” or “0”.
- For 4 markings in a row (Horizontal or vertical) NOT DIAGONAL, you get one point.
- If you manage one more marking in the same row or column, you get a point.
- Keep going till page is full or time runs out.
- Player with maximum score wins

GE: Technology Innovation

SR Onshore Wind Conference
Glasgow, 12 June 2018

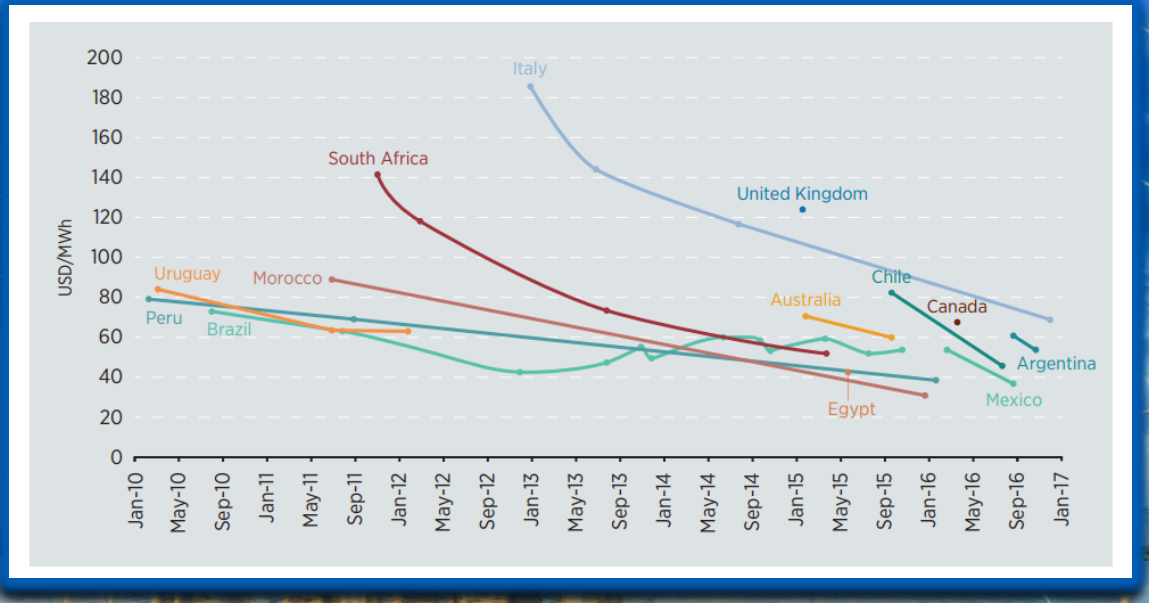
Eustace Furtado
Manager-Value Engineering
GE Renewables (Onshore)

Auctions Drive Down €/MWh

Auctions drive **market discovery** of €/MWh & procure the least cost supply

Range of decline per auction is 5-35% … ~20% is common from pre-auction tariff levels

Bid levels depend on country specifics - distinct cost drivers (EPC cost, wind resource, financing, offtake structure, etc.)



Source: IRENA, "Renewable Energy Auctions: Analysing 2016", June 2017

Evolution of average auction prices for onshore wind energy, January 2010-January 2017

Industry in Transition

The electricity industry is undergoing a transformation. This 100+ year old linear model of electricity is being challenged, tested, connected and recreated as the rules of electrification are shifting with wide-reaching impact.

5 BILLION
internet users
2020

Source: The Future of the Internet — 7 Big Predictions of 2020, Dospeedtest.com

3 TRILLION
IP devices
2030

Source: Cisco (50 Billion by 2020) and Morgan Stanley (75 Billion by 2020), GE Estimate

400 MILLION
electric cars
2040

Source: BNEF global EV sales forecast by geography, 2015–2040, Bloomberg New Energy Finance, 02/25/16, GE Estimate

50%
reduction in CO_2
2050

Source: European Commission — Climate Action

Top 10 Digital Disruption Trends

1. IMPACT OF RENEWABLES AND DISTRIBUTED ENERGY RESOURCES (DER)
2. BIG DATA ANALYTICS & ARTIFICIAL INTELLIGENCE (AI)
3. ELECTRIFICATION
4. MULTI-DIRECTIONAL IS THE NEW GRID
5. DECARBONIZATION
6. THE PROSUMER WAVE
7. CLOUD + EDGE IS THE NEXT IMPERATIVE
8. EMERGING TECHNOLOGIES (IIOT, VR/AR,DRONES, ETC)
9. THE PLATFORM ECONOMY
10. NEW BUSINESS MODELS

Samples: Drive solutions with partners

CUSTOMER OUTCOMES

@Farm level

1. Solar/ Storage
2. Transp + Install
3. BOP

@Component

1. Blades

@Finance

1. Development
2. Debt-Equity

turbine physics

economics

Complimentary technologies

Outcomes

Increase Revenue

- Availability ↑
- AEP ↑
- LCOE ↓

Reduce Cost

- Reduce BoP Costs
- Reduce schedule costs
- Reduce cost of financing

Reduce Risk

- Reduce schedule and other risks
- Manage risks of new technologies

Storage Solutions

OFFERING

Storage offering contains both
- large-scale bulk storage technology via Hydro & Pumped Storage, and
- Smaller-scale battery storage technology via GE Power with its legacy storage product and the new GE Reservoir

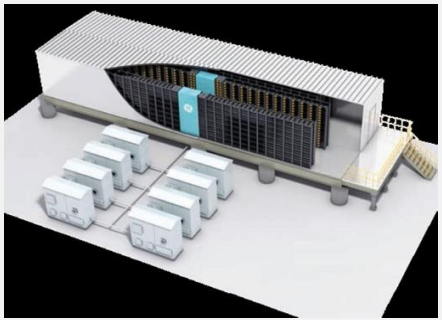
Note:
- 1st Reservoir product is a 20MW/4hr battery in a 20ft container primarily driving at Wind+Solar+Storage

Pumped Storage

Useful For
- Bulk storage large time periods
- Ancillary services
- Long life time
- Good round trip efficiencies

Challenged In
- Needs suitable geography
- Requires transmission capacity to remote locations
- Needs an 'energy arbitrage' market as a stand alone – difficult

Li-Batteries – as is



Useful For
- All kinds of fast responses
- Short duration, balancing
- and smoothing
- High round trip efficiency >80%
- Modular to achieve variable scale
- Scale manufacturing due to electric car market to reduce costs

Challenged In
- Energy and power are linked
- Environmental impact
- Low lifetime - multiple stack replacements over life

GE Reservoir - new

Useful For
- All kinds of fast responses
- Short duration, balancing and smoothing
- High round trip efficiency >80%
- Factory assembled & tested, ship to site – delivery times 3-6 mths
- DC or AC coupled

Challenged In
- Energy and power are linked
- Environmental impact
- Low lifetime – multiple stack replacements over lifetime

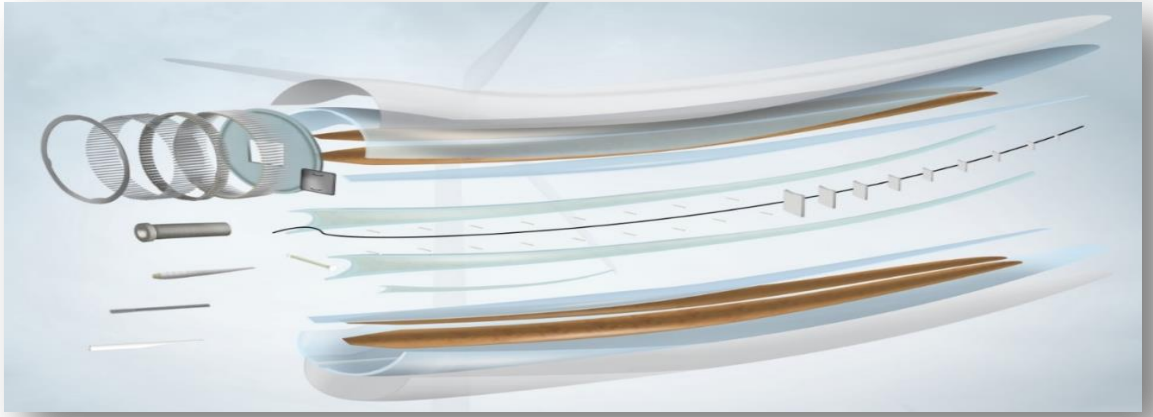
Bigger Blades

NEW CAPABILITIES

The next generation of GE onshore wind turbines (**4.8-158**) will have longer blades (158m rotor diameter) as we drive for lower cost of energy.

Expectation is that future products will have even longer rotor diameters.

With the addition of Blade Dynamics and LM Windpower to the GE family, we have been developing ways to go bigger and work longer and harder.



The 77-meter-long carbon blades leverage the strong track record and material innovations of LM Wind Power, and are their longest onshore blades to date. These carbon blades will enable flexibility, allowing GE to offer its customers a high efficiency product while continuing to drive down LCOE.

The blades also feature one of the industry's smallest Bolt Circle Diameters, keeping manufacturing and logistical costs to a minimum.

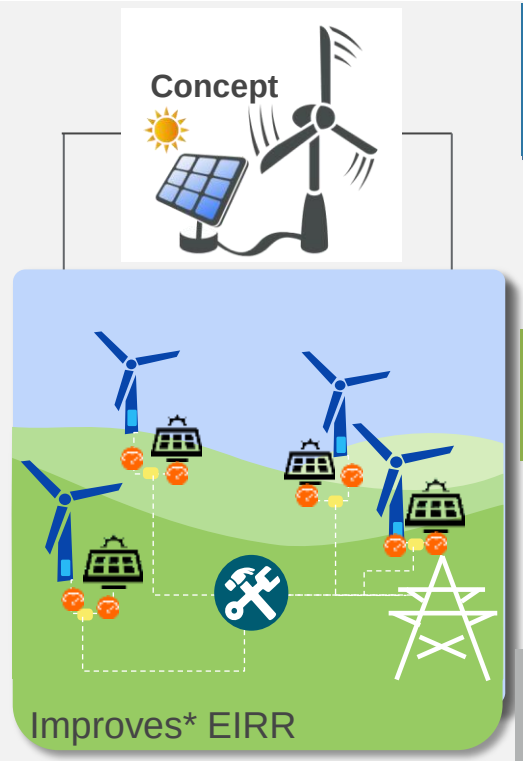
WiSE – Wind Integrated Solar Energy

ADVANTAGES

Lower CapEx with sharing of existing infrastructure
- Substation
- Switchgear
- Access to roads and land
- Grid connection

- **Lower O&M costs** as Wind O&Ms typically are capable of O&M activities for Solar as well
- **Higher Annual Energy Production (AEP)** & incremental revenues

NOTE: WiSE is only available on limited WTG platforms



* With separate metering and applicability of individual wind & solar payment structures

Hybrid Converter
- Elimination of Solar Inverter
- Hybrid Converter to source AC & DC power together
- Effective Utilization of Converter System

Common BOP
- Elimination of Solar BOP
- Effective utilization of Wind BOP

Hybrid Control Architecture
- Hybrid Integrated controls managing both Solar and Wind energy

Integrated SCADA
- Integrated SCADA to monitor & control both Wind and Solar systems

Source segregation w/Separate Metering
- Enabling viability for individual PPAs

Windfarm Optimization – Engineering Value

USING WHAT WE KNOW

Our partners are going though challenging times and returns are challenged

GE works with our partners to eliminate waste (Reduce Costs)

GE also works with some key partners to optimize the project economics through various tools within GE's portfolio

AEP Optimization

What we do
- Work with the EYA to identify areas where we can improve losses
- Look at engineering solutions to mitigate these losses

How
- Work with the partners IE to sell the solution
- Develop documentation/ data to provide comfort to the investors
- Partner with IEs and partners to develop commercial solutions to mitigate risk

BOP Optimization

What we do
- Work with BoP partners to identify areas to shave some costs or reduce schedule
- Translate those to value

How
- Study schedule and civil maps
- Study electrical/ grid designs

Financial Optimization

What we do
- Understand the economics and needs for a project
- Work with partners to develop financial solutions to debt-equity issues

How
- Partner with GE Global Growth & Operations
- Partner with GE Energy Financial Services

David Cameron
Director of Scottish Policy, EDF Energy

Neil Douglas
Director, BVG Associates

Dr Laura Kane
Senior Consultant, Smarter Grid Solutions

Eustace Furtado
Manager, Value Engineering, GE Renewable Energy

scottish renewables

ONSHORE WIND CONFERENCE

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