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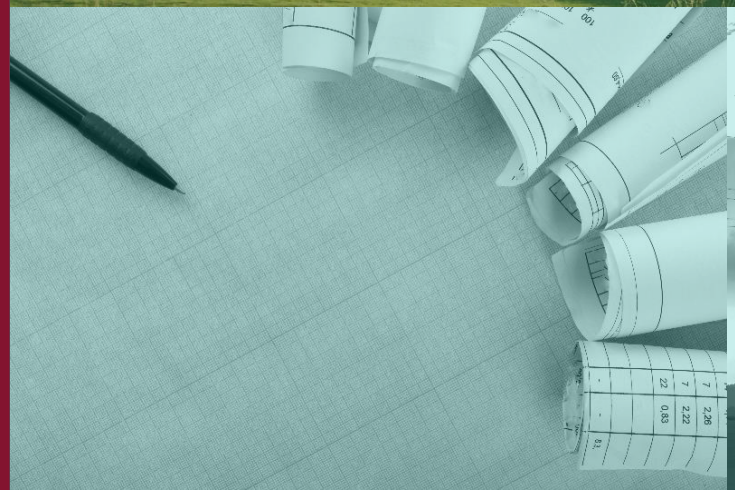
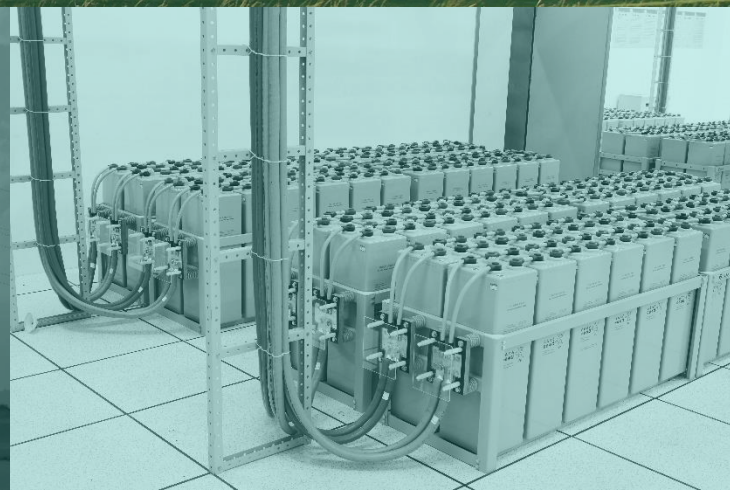
ONSHORE WIND IN SCOTLAND: opportunities for reducing costs and enhancing value





An Everoze report, commissioned by Scottish Renewables

August 2016

ONSHORE WIND IN SCOTLAND:
OPPORTUNITIES FOR REDUCING COSTS AND ENHANCING VALUE

A Everoze report, commissioned by Scottish Renewables August 2016

Context and objective

Onshore wind in Scotland already offers policy-makers one of the lowest cost means of decarbonising our electricity system. Yet, currently a range of barriers are preventing the sector from cutting costs even further.

Scottish Renewables commissioned Everoze to undertake an analysis of onshore wind costs and revenues with the aim of providing industry and government stakeholders with an objective assessment of a range of opportunities and interventions which could reduce the levelised cost of energy.

The analysis presented here is based on qualitative and quantitative assessments of selected opportunities, based on bottom-up modelling, moderated by targeted stakeholder interviews and a wider industry survey*. Ten interventions have been examined across three broad themes; planning, grid and revenue. These interventions are applicable specifically to the existing Scottish onshore wind pipeline, comprising the 7GW of capacity which is currently in the planning system.

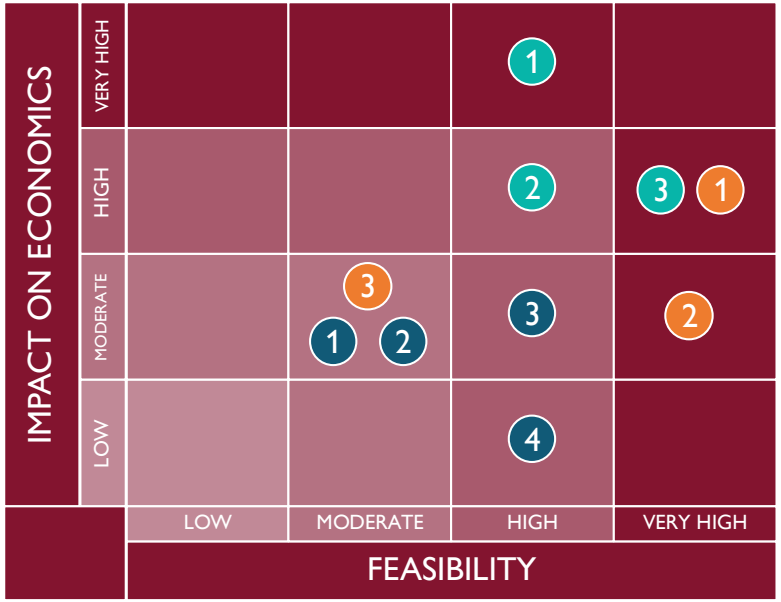
This document is structured in two sections:

1. The remainder of this executive summary, providing highlights from the analysis.
2. A series of "Intervention Sheets" providing more detail, including key modelling assumptions for each of the 10 interventions, included as an Appendix to this document.

* Interviews and surveys were carried out on the assumption that long-term power contracts will be available to onshore wind developments.

Key findings

The summary graphic below shows that costs can be reduced and investment encouraged significantly via a smarter planning system, a transformed grid and a revolution in revenue models. Many of the interventions are highly feasible and would have a significant impact on the levelised cost of onshore wind in Scotland in the years ahead.



The feasibility and impact of the 10 interventions explored in this report, clustered into three themes.

1	USE THE LATEST TURBINES	SMARTER PLANNING
2	COHERENT CONSENTING	
3	REDEVELOP	
1	REFORM SYSTEM CHARGING	TRANSFORM THE GRID
2	ADOPT SMART CONNECTIONS	
3	ICP OR SELF BUILD CONNECTIONS	
4	LOWER COST OF TRANSMISSION ASSETS	
1	EXTEND ASSET LIFE	REVENUE REVOLUTION
2	NEW OFFTAKE ARRANGEMENTS	
3	DEPLOY STORAGE	

ONSHORE WIND IN SCOTLAND:
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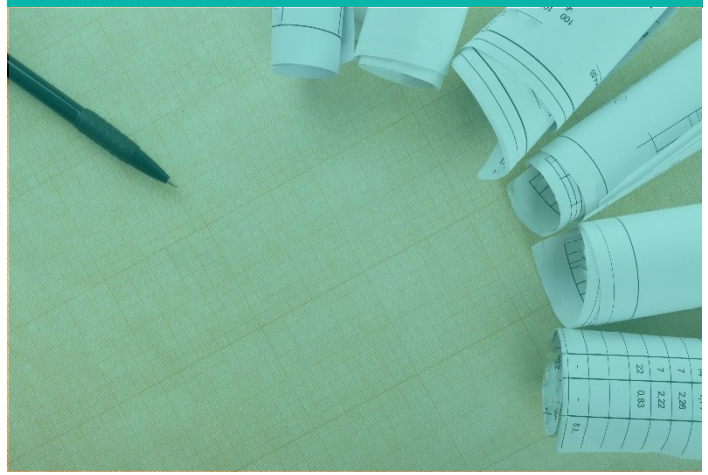
SMARTER PLANNING



1. USE THE LATEST TURBINES

What

Deploy newest turbine models to increase yield and competition.

Why

11 £ / MWh

Average reduction in LCoE across the Scottish onshore wind pipeline

16% more energy for 3% lower total cost

How

Industry to work with Scottish Government, planning authorities and key stakeholders to ensure planning guidelines encourage consideration of the latest technologies with increased rotor diameter and hub height. Ensure relevant stakeholders understand the benefits of larger more technologically advanced turbines.

Impact on economics: Very high *Feasibility: High*

2. COHERENT CONSENTING

What

Improve consenting process, to increase certainty for all.

Why

4 £ / MWh

Average reduction in LCoE across the Scottish onshore wind pipeline

£79M / year reduction in total cost of Scottish onshore wind pipeline

How

Work with stakeholders to improve consistency of interpretation of planning guidelines. Develop guidelines and provide support to ensure more effective pre-application discussions between planning authorities and developers.

Impact on economics: High *Feasibility: High*

3. REDEVELOP

What

Enhance design, efficiency and yield of existing sites through redevelopment, replanting or repowering.

Why

5 £ / MWh

Average reduction in LCoE across the Scottish onshore wind pipeline

1.0GW additional pipeline capacity, generating 16% more clean energy

How

Develop guidelines for planners and industry on how to make best use of available experience and data from existing assets so as to improve efficiency of EIA and planning process for redevelopment, replanting and repowering project proposals.

Impact on economics: High *Feasibility: Very high*

The planning system exists to act in the public interest balancing the needs of a wide range of stakeholders from across society. Our research shows there to be a very high potential to reduce the cost of onshore wind in Scotland across 3 interventions, through changes to the planning system and the way in which industry engages with it.

We call on:

- Scottish Government to ensure consistency of interpretation of existing planning guidelines: unlocking the massive cost reduction potential of new larger wind turbines, helping to restore damaged investor confidence in the sector and speeding-up the delivery of more clean, secure energy for Scotland.
- Industry participants to step-up collaborative effort on data gathering and sharing and to redouble efforts to communicate the benefits of onshore wind to the economy and the fight against climate change.

"The easiest way to make turbines financially viable is to increase height and rotor diameter…We need to achieve changes to Scottish Government guidelines to encourage taller, more efficient turbines in the appropriate locations."

Leading developer

ONSHORE WIND IN SCOTLAND:

OPPORTUNITIES FOR REDUCING COSTS AND ENHANCING VALUE

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TRANSFORM THE GRID

1. REFORM SYSTEM CHARGING

What

Further reform grid charging in line with changing requirements of a flexible energy system to reduce cost burden currently placed on Scottish generators

Why

3 £ / MWh

Average reduction in LCoE across the Scottish onshore wind pipeline

£63M / year reduction in total cost of Scottish onshore wind pipeline

How

Work with Ofgem to examine the case for a reduced locational component within the grid charging framework.

Boost research and investment into long duration energy storage technology and new business models to reduce need for future transmission upgrades

Impact on economics: Moderate *Feasibility: Moderate*

2. ADOPT SMART CONNECTIONS

What

Accelerate conditional connections to make better use of existing grid assets, avoiding reinforcements.

Why

2 £ / MWh

Average reduction in LCoE across the Scottish onshore wind pipeline

£58M / year reduction in total cost of Scottish onshore wind pipeline

How

Rewrite Security & Quality of Supply Standard (SQSS) to enable and encourage adoption of flexible connections. Support and accelerate system roll-out of Active Network Management. Increase industry awareness of commercial practice and financing based on smart connections.

Impact on economics: Moderate *Feasibility: Moderate*

3. ICP OR SELF-BUILD CONNECTIONS

What

Adoption of self-build or Independent Connection Providers to reduce the cost of contestable works.

Why

2 £ / MWh

Average reduction in LCoE across the Scottish onshore wind pipeline

£50M / year reduction in total cost of Scottish onshore wind pipeline

How

Work with SP Energy Networks and SSE Power Distribution to disaggregate their connection services into wayleaves plus consenting and procurement plus construction to allow separate contracting.

Impact on economics: Moderate *Feasibility: High*

4. LOWER TRANSMISSION ASSET COSTS

What

Application of new regulations to introduce competition for ownership and operation of new onshore transmission assets.

Why

1 £ / MWh

Average reduction in LCoE across the Scottish onshore wind pipeline

£23M / year reduction in total cost of Scottish onshore wind pipeline

How

Work with Ofgem to facilitate the creation of an effective and fair "CATO" regime, based on lessons learnt from OFTO experience. Seek to mitigate programme risks associated with planned upgrades as a result of regulatory change.

Impact on economics: Low *Feasibility: High*

The grid exists to deliver energy where and when it is needed to end consumers. Our research shows there to be high potential to reduce the cost of onshore wind in Scotland across 4 interventions, through changes to grid regulation as well as the way in which industry engages with the grid. We call on:

- Ofgem and Scottish Government to review practice in other EU jurisdictions when considering further reform of grid charging, to continue pursuing a CATO regime (where it is applied fairly to Scotland) to help drive down the cost of future grid infrastructure in Scotland and to fund new research and investment in long duration storage applications specifically targeting Scotland's grid challenges.
- Industry participants and system operators to work together constructively to accelerate efforts to improve connection practices for onshore wind, including significant revisions to the SQSS and an even more flexible commercial approach to contestable works.

ONSHORE WIND IN SCOTLAND:
OPPORTUNITIES FOR REDUCING COSTS AND ENHANCING VALUE

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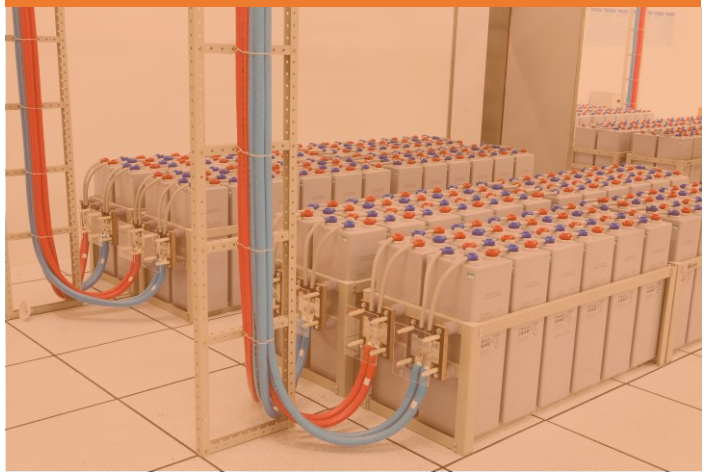
REVENUE REVOLUTION



1. EXTEND ASSET LIFE

What

Increase term of new consents to increase economic life of new assets and extend life of existing assets.

Why

7 £ / MWh

Average reduction in LCoE across the Scottish onshore wind pipeline

10% more energy for 1% total cost increase

How

Awareness raising campaign including leading OEMs and developers to catalyse a faster shift to 30-year design life and increase or removal of consent time limits.

Develop industry standard protocols for extending life of existing assets.

Impact on economics: High *Feasibility: Very high*

2. NEW OFFTAKE ARRANGEMENTS

What

Contract direct with corporate offtakers to increase revenue

Why

3 £ / MWh

Average reduction in LCoE across the Scottish onshore wind pipeline

How

Bring relevant commercial parties together to help align incentives for greater deployment of both corporate PPA and private wire models in Scotland.

Impact on economics: Very high *Feasibility: Very high*

3. DEPLOY STORAGE

What

The ability to become low cost competitive service provider to the grid - lowering costs to the consumer and improving revenue

Why

3 £ / MWh

Average reduction in LCoE across the Scottish onshore wind pipeline

How

Raise awareness of additional revenue streams available to onshore wind asset owners through deployment of storage.

Work with Ofgem to ease regulatory barriers for Capacity Market participation for onshore wind plus storage, work to reduce perceived subsidy and State Aid concerns.

Impact on economics: Very high *Feasibility: Moderate*

Onshore wind revenues to date have largely been driven by relatively simple long-term Power Purchase Agreements which have been available across the project design life of 20 years. Our research shows there to be a very high potential to increase revenues and value from onshore wind in Scotland across 3 interventions, through changes to engineering, technology and commercial arrangements. We call on:

- Industry participants to work collaboratively to develop standard protocols for project life extensions.
- Industry participants to work collaboratively to align incentives and standardise practice for new offtake arrangements for onshore wind in Scotland including corporate PPA and private wire models.
- Ofgem to examine and ease regulatory barriers to combined storage and onshore wind projects from operating in the Capacity Market and providing other ancillary services.

"Energy storage has to be part of the future of onshore wind in Scotland. As developers we need to improve our understanding of what can be achieved now and in the future".

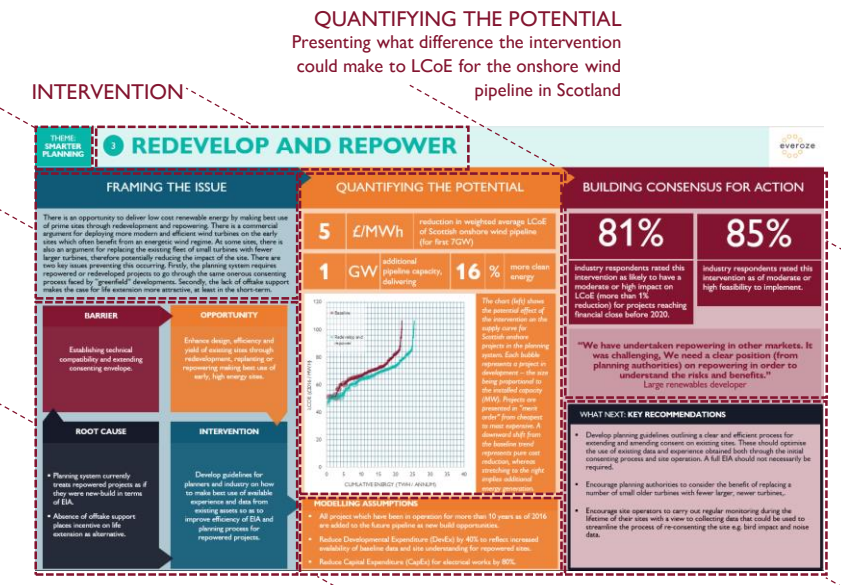
Onshore wind developer

ACKNOWLEDGEMENTS

Scottish Renewables and Everoze would like to thank all those who contributed to this study through participation in interviews and the online survey.

INTERVENTION SHEETS

There follows an analysis of the risks and benefits of the ten proposed interventions to reduce the cost of electricity generated by onshore wind in Scotland. The sheets are designed to be used as stand-alone resources. A user-guide is provided to the right.



THEME: **SMARTER PLANNING**

1 USE THE LATEST TURBINES

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FRAMING THE ISSUE

For a significant majority of the 7GW onshore wind pipeline in Scotland, planning applications are for an upper tip height of 125m or less, above ground level. In other comparable markets such as Sweden or Germany, tip heights well in excess of 150m are the norm. In Scotland, lower tip heights may be accepted to expedite the consenting process but this limits the size of rotor and tower height that can be used on a site. As a result, the range of wind turbine models available for deployment is limited, often to relatively outdated technology, as newer models are targeted at less constrained markets. The combination of reduced energy capture from smaller rotors and shorter towers, and outdated technology significantly reduces the productivity of sites, increasing consumer costs.

BARRIER

Planning system and approaches to development have led to limited tip heights of ~125m, preventing latest technology with larger rotors and towers from being deployed .

OPPORTUNITY

Deploy newest turbine models to unlock techno-economic and commercial benefits, ultimately reducing the cost of energy.

ROOT CAUSE

- Inertia created by industry "rules of thumb". Disconnect between energy and planning policy.
- Market conditions which pressurise development teams to expedite consenting process.
- Fixed consenting envelopes do not reflect that technology has moved on during consenting process.

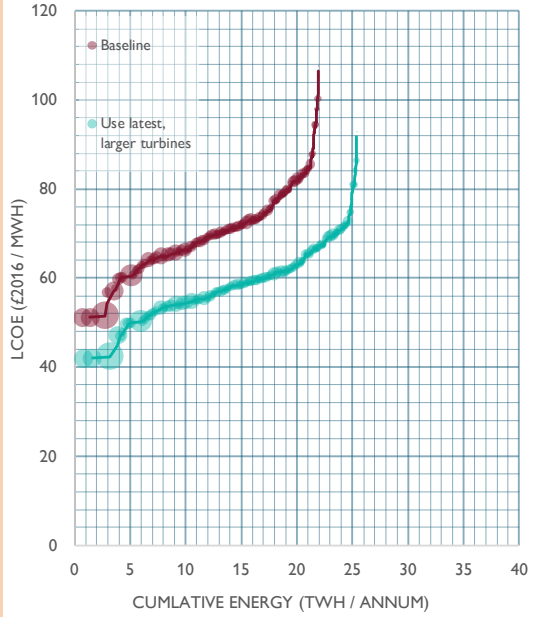
INTERVENTION

- Ensure planning guidelines encourage consideration of the latest technologies with increased rotor diameter and hub height
- Ensure industry, planning authorities and relevant stakeholders understand the benefits of larger more technologically advanced turbines

QUANTIFYING THE POTENTIAL

11 £/MWh reduction in weighted average LCoE of Scottish onshore wind pipeline

16 % more energy for **3** % **lower** total cost



The chart (left) shows the potential effect of the intervention on the supply curve for Scottish onshore projects in the planning system. Each bubble represents a project in development – the size being proportional to the installed capacity (MW). Projects are presented in "merit order" from cheapest to most expensive. A downward shift from the baseline trend represents pure cost reduction, whereas stretching to the right implies additional energy generation.

MODELLING ASSUMPTIONS

- Average tip height increase from 120m to 145m, leading to average rotor diameter to increase by 15m.
- Increase in hub height of 10m to accommodate larger rotors, providing access to higher wind speeds due to wind shear.
- Latest IEC I & II turbines deployed: improved technical performance and competitive conditions for supply contracts.

BUILDING CONSENSUS FOR ACTION

85%

industry respondents rated this intervention as likely to have a moderate or high impact on LCoE (more than 1% reduction) for projects reaching financial close before 2020.

78%

industry respondents rated this intervention as of moderate or high feasibility to implement.

"The easiest way to make turbines financially viable is to increase height and rotor diameter... We need to achieve changes to Scottish Government guidelines to encourage taller, more efficient turbines in the appropriate locations."

Leading developer

WHAT NEXT: **KEY RECOMMENDATIONS**

- Industry to work with Scottish Government, planning authorities and key stakeholders to ensure planning guidelines encourage consideration of the latest technologies with increased rotor diameter and hub height. This should be developed in conjunction with development of clear guidelines on local and regional landscape capacity.
- Ensure industry, planning authorities and relevant stakeholders understand the benefits of larger more technologically advanced turbines. Consider a roadshow using virtual reality technology to bring the experience of different landscape options to life, in the context of their impact on LCoE.

THEME: **SMARTER PLANNING**

2 COHERENT CONSENTING

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FRAMING THE ISSUE

The planning system for onshore wind projects in Scotland is robust and rigorous - taking account of a wide range of interests and potential impacts. For this reason, it can be a very lengthy and uncertain process for project developers. Whilst improvements have been made in recent years, it can still be considered to be a significant development risk – above and beyond that of comparable jurisdictions in the rest of Europe. There are two main inter-related issues. Firstly, the devolved remit of 34 local planning authorities has led to inconsistencies in the interpretation of national planning guidelines and a lack of predictability in process and outcome. Secondly, the long and inflexible process which developers must go through to achieve consent has led to the perception that onshore wind development in Scotland carries high risks. These factors have introduced significant additional cost to the sector through financing the risk, covering the cost of failed applications and an inability to optimise sites.

BARRIER

Protracted and inconsistent consenting processes leads to higher uncertainty for developers and stakeholders.

OPPORTUNITY

Improve current consenting process, to increase certainty for all.

ROOT CAUSE

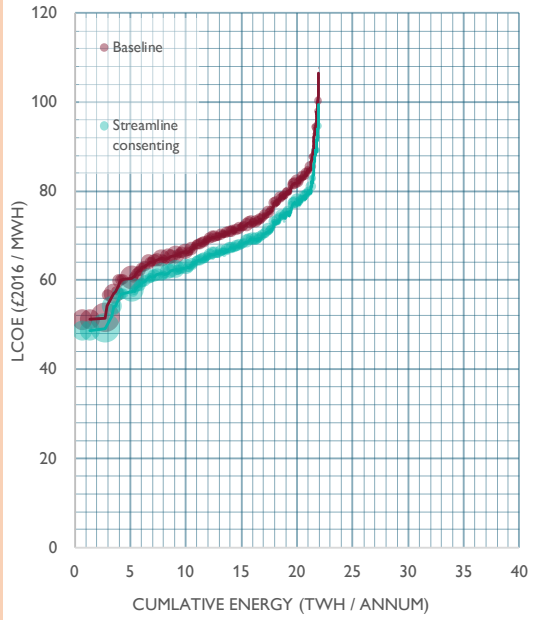
- The absence of a common interpretation of national planning guidelines by Scotland's 32 local authorities and 2 national parks.
- Lack of data sharing and collaboration between developers in same region.

INTERVENTION

- Work with stakeholders to improve the consistency of interpretation of planning guidelines.
- Establish a framework for exchange of development data and informal collaboration.
- Develop guidelines and support to ensure more effective pre-application discussions between planning authorities and developers.

QUANTIFYING THE POTENTIAL

4	£/MWh	reduction in weighted average LCoE of Scottish onshore wind pipeline
79	£M / year	reduction in total cost of Scottish onshore wind pipeline



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MODELLING ASSUMPTIONS

- Reduce Developmental Expenditure (DevEx) by 30% to reflect increased pre-consent certainty and reduced risk profile and premiums.

BUILDING CONSENSUS FOR ACTION

57%

industry respondents rated this intervention as likely to have a moderate or high impact on LCoE (more than 1% reduction) for projects reaching financial close before 2020.

75%

industry respondents rated this intervention as of moderate or high feasibility to implement.

"Planning in Scotland can take up to 5 years. Turbines have moved on and the site understanding is better but the sites can't be optimised due to the restrictive planning envelopes." Independent onshore wind developer

"I just want planning to be rooted in reality. We need more consistency between planning authorities and more clarity on likelihood of getting consent." Independent onshore wind developer

WHAT NEXT: **KEY RECOMMENDATIONS**

- Ensure consistency of approach to Schemes of Delegation across local authorities. Work with Scottish Government, SNH and planning authorities to develop a common interpretation of existing guidelines to increase consistency and predictability.
- Develop guidelines and provide support to ensure more effective pre-application discussions between planning authorities and developers. Planning authorities should review EIA process to ensure only relevant information is required and sign-post where relevant information might be available from other consented projects (wind or otherwise) in the area.
- Undertake detailed scoping of a formalised and accessible framework for exchange of site data between developers.

THEME: **SMARTER PLANNING**

3 REDEVELOP

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FRAMING THE ISSUE

There is an opportunity to deliver low cost renewable energy by making best use of prime sites through redevelopment and repowering. There is a commercial argument for deploying more modern and efficient wind turbines on the early sites which often benefit from an energetic wind regime. At some sites, there is also an argument for replacing the existing fleet of small turbines with fewer larger turbines, therefore potentially reducing the impact of the site. There are two key issues preventing this occurring. Firstly, the planning system requires repowered or redeveloped projects to go through the same onerous consenting process faced by "greenfield" developments. Secondly, the lack of offtake support makes the case for life extension more attractive, at least in the short-term.

BARRIER

Establishing technical compatibility and extending consenting envelope.

OPPORTUNITY

Enhance design, efficiency and yield of existing sites through redevelopment, replanting or repowering making best use of early, high energy sites.

ROOT CAUSE

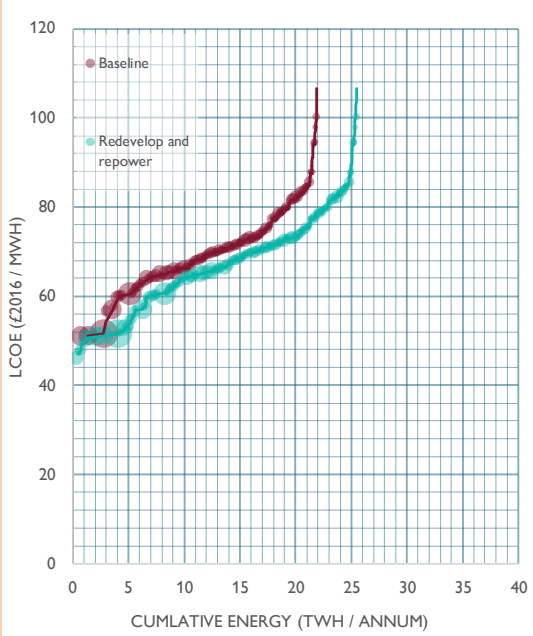
- Planning system currently treats repowered projects as if they were new-build in terms of EIA.
- Absence of offtake support places incentive on life extension as alternative.

INTERVENTION

Develop guidelines for planners and industry on how to make best use of available experience and data from existing assets so as to improve efficiency of EIA and planning process for repowered projects.

QUANTIFYING THE POTENTIAL

5	**£/MWh**	reduction in weighted average LCoE of Scottish onshore wind pipeline (for first 7GW)
1	**GW**	additional pipeline capacity, delivering
16	**%**	more clean energy



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MODELLING ASSUMPTIONS

- All projects which have been in operation for more than 10 years as of 2016 are added to the future pipeline as new build opportunities.
- Reduce Developmental Expenditure (DevEx) by 40% to reflect increased availability of baseline data and site understanding for repowered sites.
- Reduce Capital Expenditure (CapEx) for electrical works by 80%.

BUILDING CONSENSUS FOR ACTION

81%

industry respondents rated this intervention as likely to have a moderate or high impact on LCoE (more than 1% reduction) for projects reaching financial close before 2020.

85%

industry respondents rated this intervention as of moderate or high feasibility to implement.

"We have undertaken repowering in other markets. It was challenging. We need a clear position (from planning authorities) on repowering in order to understand the risks and benefits."

Large renewables developer

WHAT NEXT: **KEY RECOMMENDATIONS**

- Consenting authorities to develop planning guidelines outlining an appropriate process for extending and amending consent on existing sites. These should optimise the use of existing data and experience obtained both through the initial consenting process and site operation. It may be that a full EIA is not required.
- Encourage planning authorities to consider the benefit of replacing a number of small older turbines with fewer larger, newer turbines.
- Encourage site operators to carry out regular monitoring during the lifetime of their sites with a view to collecting data that could be used to streamline the process of re-consenting the site e.g. bird impact and noise data.

THEME: **TRANSFORM THE GRID**

1 REFORM SYSTEM CHARGING

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FRAMING THE ISSUE

Ofgem has recently completed an independent review of electricity transmission charging and associated connection agreements. This review, known as Project TransmiT has resulted in significant revisions to the system charges previously planned for the UK and in particular for zones located in Scotland. However, estimated Transmission Use of System (TNUoS) charges for Scotland in 2020 will be on average £13k / MW / year higher than then UK average. Post-TransmiT engagement between industry and the System Operator, National Grid, on the issue of potential inconsistencies between distribution system charges (G-DNUoS) and transmission charging, suggests that further reform of the entire system of charging is likely. Other relevant trends include additional generation on the distribution system, large transmission connected assets coming offline and a smaller pool for levying the cost of the transmission network.

BARRIER

Project TransmiT now complete with legal challenges seemingly resolved and CMP 213 adopted, though a further round of reform is anticipated

OPPORTUNITY

Further reform grid charging in line with changing requirements of a flexible energy system to reduce cost burden currently placed on Scottish generators.

ROOT CAUSE

- System charging for generators based on anticipated investment required for future upgrades within that zone.
- System penalises "infrastructure poor" areas.
- Complex and potentially conflicting charging mechanisms at distribution and transmission voltages.

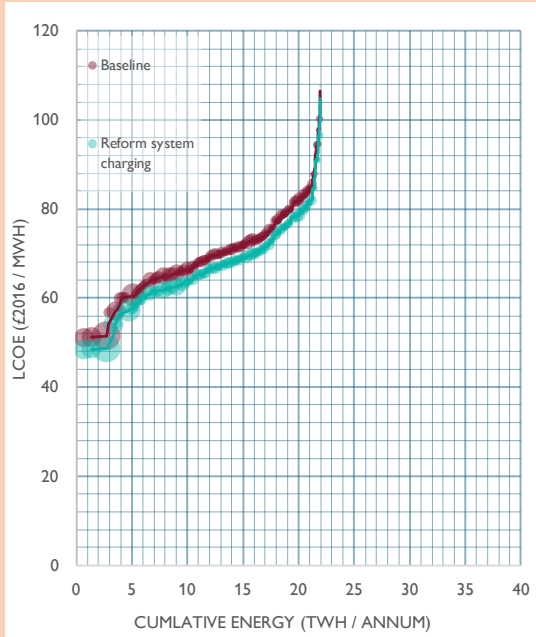
INTERVENTION

Work with Ofgem to examine the case for a reduced locational component within the grid charging framework.

Boost research and investment in long duration energy storage technology and new business models to reduce need for future transmission upgrades.

QUANTIFYING THE POTENTIAL

3	**£/MWh**	reduction in weighted average LCoE of Scottish onshore wind pipeline
63	**£M / year**	reduction in total cost of Scottish onshore wind pipeline



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MODELLING ASSUMPTIONS

- Reduce assumed TNUoS charges for projects with capacity greater than 50MW to average of current levels and the whole system average in 2020, leading to a saving of up to 50% on grid charges.
- Reduce assumed G-DNUoS charges for projects with capacity <50MW by 30%. Reduced benefits from Triad avoidance noted by not captured.

BUILDING CONSENSUS FOR ACTION

69%

industry respondents rated this intervention as likely to have a moderate or high impact on LCoE (more than 1% reduction) for projects reaching financial close before 2020.

62%

industry respondents rated this intervention as of moderate or high feasibility to implement.

"Grid connection and system charging costs didn't come from a wind perspective. In the past we had power stations close to load, now the "fuel" is now located far from population centres."
Large renewables developer

"System charging needs changing, just to make it fair to wind, particularly in rural areas."
Independent onshore wind developer

WHAT NEXT: **KEY RECOMMENDATIONS**

- Industry to work with Ofgem to quantify the economic impact of a grid charging regime with a reduced locational component. As part of this work, examine the role of grid charging in supporting energy policy objectives, including a review of regulatory provision in other EU jurisdictions and the interface between distribution and transmission charging.
- Industry to undertake review and analysis work to examine the economic impact of alternative grid charging mechanisms specifically for rural and island communities in Scotland.
- Scottish public agencies to invest in research and investment for both technologies and new business models which facilitate longer duration energy storage, as a means of avoiding anticipated transmission upgrades in Scotland.

THEME: **TRANSFORM THE GRID**

2 ADOPT SMART CONNECTIONS

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FRAMING THE ISSUE

Current industry practice limits the availability of flexible grid connection offers to onshore wind developers in Scotland. From a network operator's perspective, the challenge is to move from a philosophy of "invest and connect" to "connect and manage" – a transition which is linked to the ongoing RIIO process. Those wind farm developers who are able to access flexible connection offers face commercial and financing challenges associated with curtailment risk. Underlying the difficulties associated with this transition is the Security & Quality of Supply Standard (SQSS), which limits flexibility and inhibits the adoption of "smart" principles – imposing a top-down, inflexible requirements. It is noted that some network operators are taking the first steps in this direction already with their Active Network Management schemes - but more could be done.

BARRIER

"Connect & manage" grid connection not always available or acceptable.

OPPORTUNITY

Adopt conditional connections to make better use of existing grid assets, avoiding reinforcements.

ROOT CAUSE

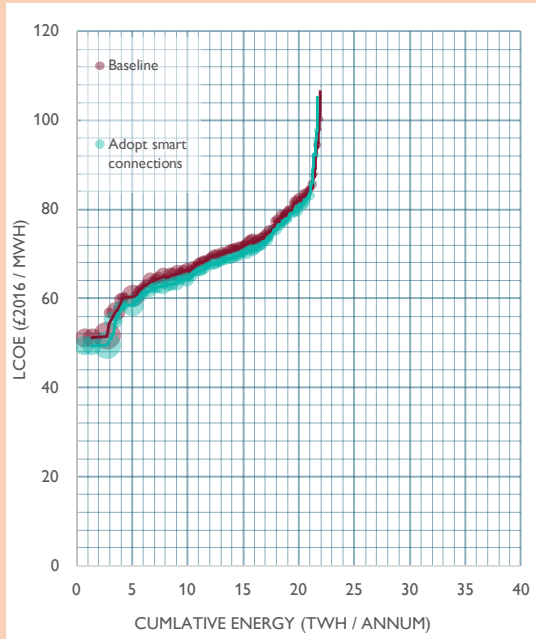
- Developers are not often given the option for conditional access, triggering the need for upgrades.
- Those which are offered conditional access can face financing challenges or at least a lack of commercial familiarity with curtailment risks.
- Conservative underlying connection standard (SQSS).

INTERVENTION

- Rewrite Security & Quality of Supply Standard (SQSS) to enable and encourage adoption of flexible connections.
- Support and accelerate system operators' trials of Active Network Management for this to become business as usual.
- Increase industry awareness of commercial practice and financing based on smart connections.

QUANTIFYING THE POTENTIAL

2	£/MWh	reduction in weighted average LCoE of Scottish onshore wind pipeline.
58	£M / year	reduction in total cost of Scottish onshore wind pipeline.



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MODELLING ASSUMPTIONS

- Reduce assumed TNUoS and DNUoS charges by 50% to represent lower than expected investment requirements and reduced connection charges for embedded generators.
- Reduce Annual Energy Production (AEP) by 1% to account for curtailment losses.

BUILDING CONSENSUS FOR ACTION

83%

industry respondents rated this intervention as likely to have a moderate or high impact on LCoE (more than 1% reduction) for projects reaching financial close before 2020

65%

industry respondents rated this intervention as of moderate or high feasibility to implement.

"We are pursuing a number of alternative solutions to get customers connected to the network either ahead of traditional reinforcement timelines or as a substitute for traditional reinforcement."
DNO / DSO

WHAT NEXT: **KEY RECOMMENDATIONS**

- Push for a root and branch overhaul of the Security & Quality of Supply Standard (SQSS) to enable and encourage adoption of flexible connections. Work with Ofgem to illustrate the need to align SQSS with the RIIO process.
- Support and accelerate adoption of flexible connection initiatives such as Active Network Management schemes and Export Limiting Devices (ELDs). Report, record and publicise experience to ensure rapid uptake of progressive practices.
- Develop best practice guidelines for commercial practice and financing of onshore wind projects based on smart or flexible connections.

THEME: **TRANSFORM THE GRID**

3 ADOPT ICP OR SELF-BUILD CONNECTIONS

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FRAMING THE ISSUE

Contestable works are the elements of the grid connection for an onshore wind project which would by default be carried out by the relevant Distribution Network Operator (DNO). Changes to regulation now allow such works to be awarded to a so called Independent Connection Provider (ICP) – a licensed independent contractor. This provides project developers with the opportunity to benefit from competition in the supply chain for these works, which, for some projects, can represent a significant cost element. This route is open and has already been adopted in some cases in Scotland. However, it is noted that DNOs have the advantage of being able to spread the risk of termination across multiple projects, whereas ICPs and the developers are fully exposed.

BARRIER

Contestable works primarily led by DNO or TSO at present with notable barriers for 3rd party involvement

OPPORTUNITY

Adoption of self-build or Independent Connection Providers to reduce the cost of contestable works

ROOT CAUSE

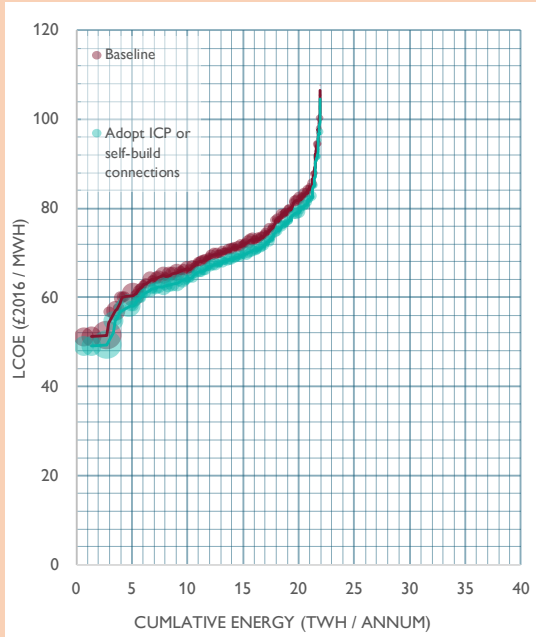
- DNO or TSO have greater leverage for securing wayleaves and consents quickly – including compulsory purchase powers.
- DNO or TSO benefit from natural risk spreading across multiple projects.

INTERVENTION

Work with SP Energy Networks and SSE Power Distribution to disaggregate their connection services into wayleaves plus consenting and procurement plus construction to allow separate contracting.

QUANTIFYING THE POTENTIAL

2	£/MWh	Reduction in weighted average LCoE of Scottish onshore wind pipeline
50	£M / year	Reduction in total cost of Scottish onshore wind pipeline



The chart (left) shows the potential effect of the intervention on the supply curve for Scottish onshore projects in the planning system. Each bubble represents a project in development – the size being proportional to the installed capacity (MW). Projects are presented in "merit order" from cheapest to most expensive. A downward shift from the baseline trend represents pure cost reduction, whereas stretching to the right implies additional energy generation.

MODELLING ASSUMPTIONS

- Reduce Capital Cost (CapEx) associated with Grid Connection by 30% for all projects, to reflect the anticipated impact of competitive pressure in the supply chain.

BUILDING CONSENSUS FOR ACTION

71%

industry respondents rated this intervention as likely to have a moderate or high impact on LCoE (more than 1% reduction) for projects reaching financial close before 2020

70%

industry respondents rating this intervention as of moderate or high feasibility to implement

"Developers have been chasing quickest connection to meet deadlines for ROCs, now the situation is changing. A review is needed to ensure we are really getting the lowest cost options and that planners will accept them."

Independent onshore wind developer

WHAT NEXT: **KEY RECOMMENDATIONS**

- Develop and launch a collaborative project with SP Energy Networks and SSE Power Distribution to review the extent to which multiple projects allows de-risking of network investment and the impact of this on final sums liabilities. This project should also review the experience to date with ICPs from the perspective of the network operator and wind farm developers with the objective of capturing good industry practice.
- Investigate the reasons for ICPs limited use to date in Scotland. Work with SP Energy Networks and SSE Power Distribution to investigate the possibility of splitting the development and construction elements of the contestable works, given the advantages these companies appear to have with respect to consenting and wayleaves.

THEME: **TRANSFORM THE GRID**

4 LOWER COST OF TRANSMISSION ASSETS

everoze

FRAMING THE ISSUE

The Transmission Operators in Scotland, Scottish Power Transmission and Scottish Hydro Electric, operate as "natural monopolies" for the development, construction and ownership of the high voltage system within their own defined onshore transmission areas. This stands in contrast to the approach adopted by Ofgem for offshore transmission assets, whereby individual projects are awarded to Offshore Transmission Owners (OFTOs) via a competitive process. It could be possible to reduce the cost of delivering future onshore transmission projects in Scotland by introducing for existing infrastructure upgrades that are new, high value and separable a Competitively Allocated Transmission Owners (CATO) regime – potentially reducing costs and attracting cheaper capital. It is noted that Ofgem are consulting on this topic with a view to tendering the first assets in 2017.

BARRIER

Regulated regional monopolies for significant new onshore transmission assets. Risk of significant change to onshore grid regulation causing delay to planned transmission assets.

OPPORTUNITY

Application of new regulations to introduce competition for ownership and operation of new onshore transmission assets.

ROOT CAUSE

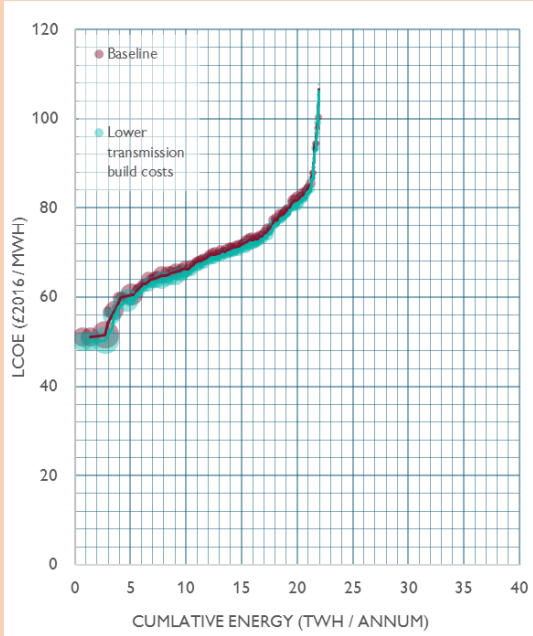
Current framework locks out private investors from construction and ownership of significant new onshore transmission infrastructure.

INTERVENTION

Work with Ofgem to facilitate the creation of an effective and fair "CATO" regime, based on lessons learnt from OFTO experience.

QUANTIFYING THE POTENTIAL

1	£/MWh	Reduction in weighted average LCoE of Scottish onshore wind pipeline
23	£M / year	Reduction in total cost of Scottish onshore wind pipeline



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MODELLING ASSUMPTIONS

- Assume 25% lower Transmission Use of System (TUNoS) charges by 2020 as a result of lower than anticipated capital and finance costs for new grid assets.
- Only apply benefit for projects likely to connect to the Transmission System: >50MW (though potential knock-on savings at distribution are noted).

BUILDING CONSENSUS FOR ACTION

77%

industry respondents rated this intervention as likely to have a moderate or high impact on LCoE (more than 1% reduction) for projects reaching financial close before 2020

70%

industry respondents rating this intervention as of moderate or high feasibility to implement

"There is considerable scope for reducing capital cost by working smarter and if the grid companies start pulling in the right direction."

Anonymous respondent

WHAT NEXT: **KEY RECOMMENDATIONS**

- Establish a clear understanding of lessons learnt from the OFTO regime from the perspective of the UK wind sector. Work with Ofgem to ensure that such lessons are used in the design of the new CATO regime, the design is fit for purpose in the Scottish context and that ultimately any savings are passed through the system to consumers.
- Review proposed criteria for differentiating between routine upgrades and new CATO assets. Push for rigorous criteria to avoid marginalisation of the new CATO regime to HVDC links only.

THEME: **REVENUE REVOLUTION**

1 EXTEND ASSET LIFE

everoze

FRAMING THE ISSUE

A 20 year project design life has generally been assumed across onshore wind markets to date. There is no longer any technical or economic argument for assuming this value. For new projects, the latest turbine models assume a design life of at least 25 years. For existing projects, recent experience has shown that interventions are possible to extend life to at least 25 years. Across the UK, there is already 120MW of operational onshore wind capacity which is older than 20 years; many of these projects are in Scotland.

In some cases, consent conditions include a time limit of 20-25 years, potentially impeding extended life operation.

BARRIER

Adoption of industry standard 20-25 years for consents is unnecessarily short, given improved technical understanding.

OPPORTUNITY

- Increase or remove term of new consents to increase economic life of new assets.
- Extend life of existing assets.

ROOT CAUSE

- Established industry practice has become engrained.
- 20-25 years has also become standard practice for consenting, perhaps without sufficient challenge from construction and operations teams.

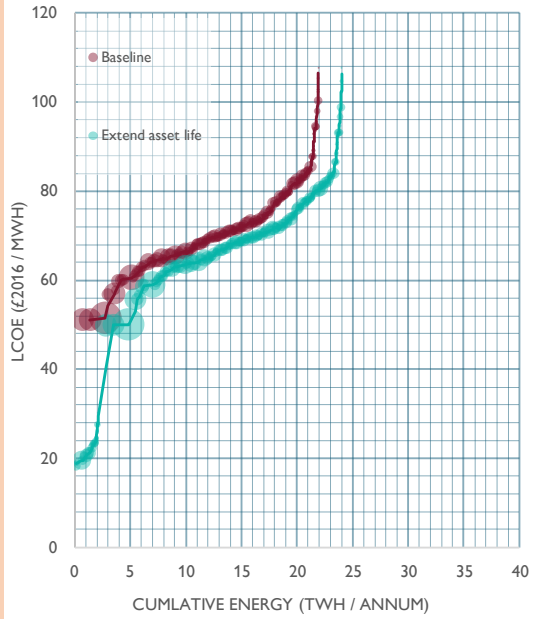
INTERVENTION

- Develop industry standard protocols for extending life of existing assets.
- Implement awareness raising campaign including leading OEMs and developers to catalyse a faster shift to 25-30 year design life assumptions.

QUANTIFYING THE POTENTIAL

7	**£/MWh**	reduction in weighted average LCoE of Scottish onshore wind pipeline (for first 7GW)

10	**%**	more energy for	**1**	**%**	**increase** in total cost



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MODELLING ASSUMPTIONS

- Currently operational projects which will be older than 15 years by 2020 added back into pipeline.
- Assumes 5 years additional life before decommissioning.
- Design life of existing pipeline increase to 25 years.
- Maintenance costs (turbine and balance of plant) increase by 50% to capture additional effort required to support longer life.

BUILDING CONSENSUS FOR ACTION

69%

industry respondents rated this intervention as likely to have a moderate or high impact on LCoE (more than 1% reduction) for projects reaching financial close before 2020

87%

industry respondents rated this intervention as of moderate or high feasibility to implement

"There is a clear benefit to life extension but developers need clarity on extending consents to give more certainty on how to approach their assets." Large renewables developer

"Setting out planning strategies with regard to life extension or repowering, where there are existing operational assets would be helpful." Large renewables developer

WHAT NEXT: **KEY RECOMMENDATIONS**

- Longer consenting terms need to be achieved for projects in the planning pipeline or such terms should be removed completely. Developers need to consider applying for consenting periods of up to 50 years. This should be supported by changes in planning guidelines and an awareness campaign.
- Developers should engage with leading OEMs to encourage a shift towards a 25-30 year design life and ensure spare parts and support for older models of turbines over a 30 year period. Changes to offshore design life assumptions show that a new approach may be adopted for onshore wind.
- The planning process should be refined to ensure a proportionate response to extension of consent period for existing wind farms.
- Industry protocol for asset life extension should be developed to set expectations and guidelines for both developers, planning authorities and OEMs. This should include safety best-practice for life-extended assets.

THEME: **REVENUE REVOLUTION**

2 ADOPT NEW OFFTAKE ARRANGEMENTS

everoze

FRAMING THE ISSUE

Private wire and corporate offtake arrangements are relatively new to the UK market, even though they have become increasingly common in other jurisdictions over the last few years. They offer wind farm developers and owners the opportunity to jump up the value chain, by getting closer to retail electricity markets. Private wire arrangements involves the construction of a special purpose electrical connection from the wind farm to the end user who is also the offtaker. An alternative approach is so called corporate PPAs (also known as "sleeving"), which involves the sale of power to private end-users, but with no direct grid link. It is this model which is specifically explored on this page.

BARRIER

- Lack of accepted contractual practice in UK.
- Unbundling forces licensed supplier to act as intermediary. Lack of supplier appetite for taking this role.

OPPORTUNITY

Contract direct with corporate offtakers to increase revenue

ROOT CAUSE

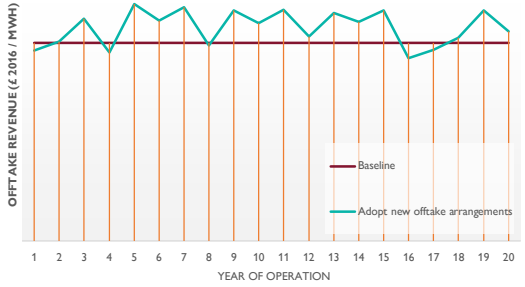
- Individual agreements require bespoke contracts increasing legal costs and delay.
- Lack of appetite amongst established suppliers to offer solutions because of perceived low margins and concept being far from core business.
- High grid charging due to applicability of both DNUoS and TUNoS.

INTERVENTION

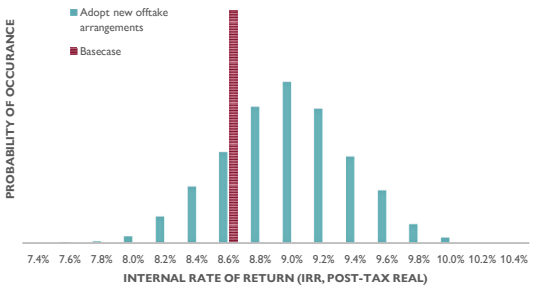
Bring key stakeholders together to help align incentives for greater deployment of both corporate PPA and private wire models in Scotland.

QUANTIFYING THE POTENTIAL

3 £/MWh Reduction in weighted average LCoE of Scottish onshore wind pipeline



The chart (left) contrasts offtake assumptions for the Basecase (long-term PPA) with a Sleeving approach, the latter requiring short-term contracts with less certainty, but with value uplift to reflect the "green premium" paid by the end user.



The second chart (left) shows the modelled impact of the sleeving approach on IRR. In the example, there is a 75% probability that IRR will increase over the Basecase as a result of adopting the sleeving offtake arrangement.

MODELLING ASSUMPTIONS

Basecase project

- 2.3MW turbines, 50MW
- 38% capacity factor, IEC I site
- CapEx: £1.6M / MW
- OpEx: £63k / MW / annum
- FID 2018, gearing 80%
- Revenue stabilisation via CfD type contract at new-build CCGT cost

Corporate PPA project

- As per Base case, plus:
- Grid charges increased by £10k / MW / annum
- Gearing reduced to 60%
- Variable revenue rate year to year in range -10% to +20% from basecase

BUILDING CONSENSUS FOR ACTION

85%

industry respondents rated this intervention as likely to have a moderate to significant impact on revenue for projects reaching financial close before 2020.

86%

industry respondents rated this intervention as of moderate or high feasibility to implement.

"UK onshore wind is stuck in the PPA paradigm - owners need to get used to a more liquid offtake market with shorter contracts."

Independent onshore wind developer

WHAT NEXT: KEY RECOMMENDATIONS

- Establish a short life working group to include leading suppliers, aggregators, wind farm developers and corporate offtakers to develop standard contract forms.
- Identify means of incentivising supplier engagement and to communicate / promote the opportunity to potential corporate offtakers across Scotland and the rest of the UK.
- Engage with Ofgem on fairness of grid charging for sleeving arrangements with a view to incentivising further uptake.
- Develop best practice and case studies to help communicate the opportunity to investors and the financial community.

THEME: **REVENUE REVOLUTION**

3 DEPLOY STORAGE

everoze

FRAMING THE ISSUE

The Capacity Market and ancillary services represent additional potential revenue streams for onshore wind assets in Scotland, but regulatory and technical barriers could inhibit access to this opportunity. The co-location of energy storage assets, such as batteries, with wind projects offers the potential for these barriers to be lowered. In addition, so called "time-shifting" of energy which would otherwise have been lost due to grid constraints, offers a potential mitigation to the downside of adopting flexible or "smart" grid connections.

BARRIER

Perceived or actual cost of storage technology and perceived or actual regulatory barriers.

OPPORTUNITY

The ability to become low cost competitive service providers - lowering costs to the consumer and improving revenue.

ROOT CAUSE

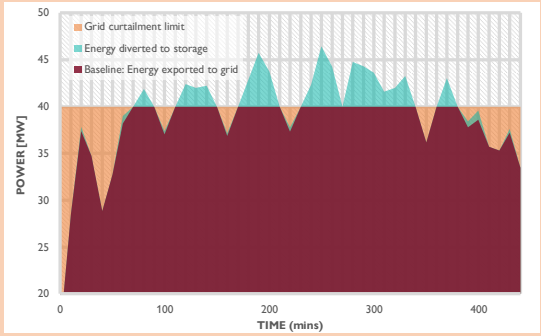
- Renewables generation excluded from Capacity Market in UK.
- Reactive power need is moving from transmission to distribution and likely to be dealt with via grid code in the future.
- Other ancillary services difficult to access, but storage can change this.

INTERVENTION

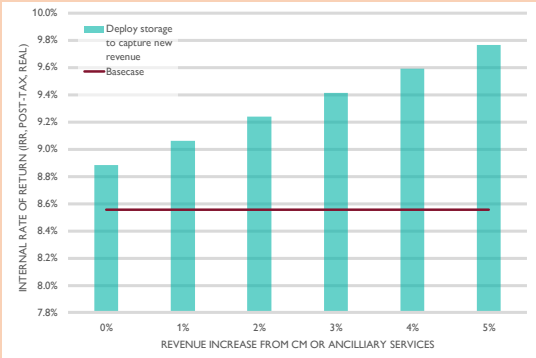
- Raise awareness of additional revenue streams available to onshore wind asset owners through deployment of storage.
- Work with Ofgem to ease regulatory barriers for onshore wind combined with storage to participation in the Capacity Market.

QUANTIFYING THE POTENTIAL

3 £/MWh Reduction in weighted average LCoE of Scottish onshore wind pipeline



The chart (left) illustrates the time shifting of energy which otherwise would have been lost due to a 40MW grid constraint, but is instead diverted to the storage unit – in this example a 1MW - 2MWh lithium-ion battery unit.



The second chart (left) shows the increase in IRR which is possible for every 1% increase in revenue due to the supplementary revenue streams, showing a net gain from reduced grid charges and curtailment losses, even at 0% additional revenue.

MODELLING ASSUMPTIONS

Basecase project

- 2.3MW turbines, 50MW
- 38% capacity factor, IEC I site
- CapEx: £1.6M / MW
- OpEx: £63k / MW / annum
- FID 2018, gearing 80%
- Revenue stabilisation via CfD type contract at new-build CCGT cost

Storage project

- As per Base case, plus:
- Grid charges reduced by £5k / MW / annum
- Capacity factor increased by 0.1%
- Assumed P50 revenue increase of 2% from ancillary services or CM
- Battery CapEx £900k / MW

BUILDING CONSENSUS FOR ACTION

79%

Industry respondents rated this intervention as likely to have a moderate to significant impact on revenue for projects reaching financial close before 2020.

50%

industry respondents rated this intervention as of moderate or high feasibility to implement.

"We see energy storage as one of the key distributed energy resources that will be available to us to meet future network challenges relating to onshore wind." DNO / DSO

"Energy storage has to be part of the future of onshore wind in Scotland. As developers we need to improve our understanding of what can be achieved now and in the future." Onshore wind developer

WHAT NEXT: **KEY RECOMMENDATIONS**

- Provide industry with a clear summary of the revenue streams available to energy storage and the potential implication of co-locating storage units with existing or planned onshore wind projects. Identify case studies of early deployment and disseminate. Work with enablers and system operators to direct innovation funding towards more demonstration projects.
- Work with Ofgem, National Grid, Scottish Government and DNOs to reduce perceived or actual barriers to participation of wind + storage projects in the ancillary services and capacity markets, including addressing subsidy and State Aid concerns.