



Offshore Wind Leasing Round 4

Innovation Discount Policy



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Glossary

Innovation Area	a suggested innovation route for a technological, market or regulatory challenge included in the Technology Roadmaps
Innovation Discount Policy	TCE's approach to determining which innovations would qualify for a rental discount under Round 4 as published on TCE's website
Innovative Test and Demonstration Elements	see the Windfarm Agreement for Lease for definition
Innovative Test and Demonstration Elements Specification	see the Windfarm Agreement for Lease for definition
Levelized Cost of Energy (LCoE)	the net present value of the unit-cost of energy produced over the lifetime of a generating asset
Offshore Renewable Energy (ORE) Catapult	the UK's leading technology innovation centre for offshore wind, wave and tidal energy
Offshore Wind Innovation Hub (OWIH)	the UK's primary coordinator (delivered jointly by ORE Catapult and the Knowledge Transfer Network) for innovation, focusing on offshore wind energy cost reduction, maximising UK economic impact and removing barriers to growth
Offshore Wind Leasing Round 4	TCE's offshore wind leasing tender process
Qualifying Criteria	the criteria selected from the Technology Roadmaps to define which innovations would qualify for a rental discount under Round 4
Review Form	the template customers should complete in order to enable TCE assess whether or not a proposed innovation would qualify for a rental discount under Round 4
Scorecard	the scoring matrix TCE will use to verify if a customers proposed innovations meet the Qualifying Criteria
Technology Readiness Level (TRL)	a type of measurement system used to assess the maturity level of a particular technology
Technology Roadmaps	the series of technology roadmaps that ORE Catapult has developed as part of the Offshore Wind Innovation Hub (OWIH)
Windfarm Agreement for Lease	the agreement for lease in respect of a the Round 4 project to be entered into between TCE and the customer which provides the seabed rights for the development period, prior to entry into the Wind Farm Lease
Windfarm Lease	the lease in respect of a Round 4 project to be entered into between TCE and the customer in accordance with the Wind Farm Agreement for Lease

Innovation Discount Policy

1. Background

Offshore Wind Leasing Round 4 is designed to deliver a robust pipeline of new offshore wind projects that can deliver reliable, clean electricity, at commercial scale, in the late 2020s and beyond. As such we have focused on waters suitable for fixed foundation technology (i.e. relatively shallow waters, up to 60m, where the sector has proven itself at scale and at low cost, and where we are seeing the focus of market appetite).

Looking ahead, however, we recognise that innovation will be key to delivering a sustainable pipeline of new projects over the longer term, within an increasingly busy marine environment. The sector will need to explore projects in more diverse and technically challenging areas, and/or integrate with other energy technologies.

Therefore, as the UK's offshore wind industry continues to evolve and mature, The Crown Estate (TCE) is working in partnership with the sector to facilitate and unlock opportunities for innovation, as part of Round 4 and beyond.

We are doing this in a number of ways, including by offering rental discounts for Round 4 projects that incorporate qualifying innovation.

2. Objective

The objective of this Innovation Discount Policy is to set out TCE's approach to determining which innovations would qualify for a rental discount under Round 4. The approach has been designed to provide clarity to our customers whilst retaining the flexibility to capture future innovations as they emerge.

We have worked with specialists at the Offshore Renewable Energy (ORE) Catapult to define a set of transparent, fair and objective criteria that customers can use themselves to determine which innovations would qualify for a rental discount. These criteria are based on the series of technology roadmaps that ORE Catapult has developed as part of the Offshore Wind Innovation Hub (OWIH) (Technology Roadmaps). The Technology Roadmaps are available online at <https://offshorewindinnovationhub.com/about-roadmaps/> and are regularly reviewed by an advisory group of independent experts and updated in accordance with key developments in innovation in offshore wind.

TCE will use relevant criteria (Qualifying Criteria) within these Technology Roadmaps to define which innovations would qualify for a rental discount under Round 4. More detail on the approach to determining qualifying innovations is provided at Section 3 below. Appendix 1 of this Innovation Discount Policy describes the OWIH and the Technology Roadmaps.

Consultation on the approach to determining qualifying innovations was undertaken as part of the Round 4 Leasing process. The consultation responses received have informed this Innovation Discount Policy.

3. Innovative Test and Demonstration Elements: Approach to Determining Qualifying Innovations

Innovation routes that are within one of the Technology Roadmaps (an Innovation Area) and that meet all of the Qualifying Criteria as set out in Table 1 below would qualify to be included in the project as 'Innovative Test and Demonstration Elements' as defined in the Windfarm Agreement for Lease. Subject to the approvals set out in the Windfarm Agreement for Lease, the Innovative Test and Demonstration Elements would be eligible for a rental discount.

Category	Qualifying Criteria
Start Technology Readiness Level (TRL)	TRL4 ¹ to TRL7
Forecast finish date	The Innovation Area must be expected to reach TRL9 after offshore construction is complete. ^{2 3}
Case for intervention	Score as High or Medium
Potential to reduce Levelized Cost of Energy (LCoE); AND/OR health, safety & environmental (HSE) impact	Innovation Area must score as High or Medium in at least one of these categories
Requires implementation as part of an offshore wind project	Yes

Table 1: Qualifying Criteria

Full descriptions and justifications for the Qualifying Criteria set out in Table 1 are detailed in Appendix 1 of this Innovation Discount Policy.

¹ Innovation Areas with TRL lower than 4 have been excluded, as they are not likely to mature in line with the expected 'forecast finish date'. However, Innovation Areas with a lower start TRL may be acceptable if the customer can evidence that they have been working in this area and they can meet the 'forecast finish date'.

² as stated in the approved Development Plan at Annex 5 to the Windfarm Agreement for Lease.

³an exception to this criteria is when an Innovation Area reaches TRL 9 earlier than this date as a result of its application to the project, the Innovation Area must not be commercially available / in use on any other project.

Table 2 below provides an explanation of the TRLs relevant for the Qualifying Criteria.

Level	Explanation
TRL 4	Technology validated in lab. Basic technological components are integrated: Basic technological components are integrated to establish that the pieces will work together.
TRL 5	Technology validated in relevant environment. Fidelity of breadboard technology improves significantly: The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include “high fidelity” laboratory integration of components.
TRL 6	Technology demonstrated in relevant environment. Model/prototype is tested in relevant environment: Represents a major step up in a technology’s demonstrated readiness, which is well beyond that of TRL 5. Examples include testing a prototype in a high-fidelity laboratory environment or in simulated operational environment.
TRL 7	System prototype demonstration in operational environment. Prototype near or at planned operational system: Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment.
TRL 8	System complete and qualified. Technology is proven to work: Actual technology completed and qualified through test and demonstration.
TRL 9	Actual system proven in operational environment. Actual application of technology is in its final form: Technology proven through successful operations. Includes competitive manufacturing in the case of key enabling technologies.

Table 2: Explanation of TRL Levels

The Medium and High Qualifying Criteria used to assess the proposed innovation’s potential to reduce LCoE, case for intervention, and health, safety and environmental impact are detailed in Table 3 below. Examples of the application of these criteria can be found in Appendix 1.

	Medium	High
Potential to reduce LCoE	1-2% within the timescales and TRL range provided for this Innovation Area	>2% within the timescales and TRL range provided for this Innovation Area
Case for intervention	Innovation area may progress without support – delays will occur or costs will be higher.	Innovation area will not progress without support - significant delays will occur or costs will be significantly higher.
Health, safety & environmental impact	Some improvements that would reduce severity of an incident and its likelihood or an environmental issue, but would not be revolutionary.	Significant improvements that reduce severity of an incident and its likelihood of occurrence e.g. requirement for personnel in offshore environment, risky maintenance, major failure prevention. Significant improvements on environmental issues e.g. landfill reduction, marine life or aquaculture improvements.

Table 3: Definitions for Medium and High Qualifying Criteria

Appendix 2 of this Innovation Discount Policy contains the Review Form customers will be required to complete to enable TCE to verify that the proposed innovations qualify for a rental discount. Customers are required to submit, to TCE, a completed Review Form as part of the Innovative Test and Demonstration Elements Specification. This should be submitted to TCE in line with the contractual terms of the Windfarm Agreement for Lease (see Section 5 below).

TCE will verify whether an innovation suggested by the customer in this Review Form fulfils the Qualifying Criteria. We will score the completed Review Form against the Qualifying Criteria (see the Scorecard Appendix 2) and we will then share it confidentially with ORE Catapult for a technical review against the latest Technology Roadmaps.

Customers whose proposed innovations are included in the Technology Roadmaps will be required to complete part 3a of Table 1 of the Review Form (see Appendix 2).

Whilst the Technology Roadmaps are the most extensive register of UK offshore wind innovation needs and are compiled by experts, we recognise that some innovations may not be included (such as those developed in house) or that our customers may have additional information in some areas that supersedes the roadmap scores. Where a customer believes that their suggested innovation would fulfil the Qualifying Criteria, they should complete part 3b of Table 1 of the Review Form (see Appendix 2) and submit it to us for assessment. A sufficient level of supporting evidence to prove that the innovation meets the Qualifying Criteria should be submitted alongside the Review Form.

The Review Form will be checked by TCE against the contractual terms as described in Section 5 below. Only one Review Form may be applied per proposed Innovative Test and Demonstration Element. In the event that the innovation proposed in the Review Form does not qualify, the customer will have the opportunity to revise and resubmit the Review Form.

4. Innovative Test and Demonstration Elements: Reporting

The customer is required to submit a report to TCE detailing the progress of the Innovative Test and Demonstration Elements. The first report is required on the one year anniversary of the approval of the Innovative Test and Demonstration Elements Specification and annually thereafter until TRL9 is reached. The report should provide, for that period, details of the maturation of the innovation TRL, an update of the realised benefits to the Round 4 project from the innovation, and an overview of the key risks and opportunities associated with maturation of innovation to TL9 for the forthcoming year.

When the innovation area reaches TRL9, the customer is required to provide TCE with a presentation of the innovation as commercialised through Round 4 and include details of how the benefits can be transferred to other offshore wind farm assets in the UK and/or globally.

5. Innovative Test and Demonstration Elements: Contractual Arrangements

The approach to determining qualifying innovations set out in Section 3 refers to the mechanism that governs which innovations would qualify to be included in a project as Innovative Test and Demonstration Elements, rather than the contractual arrangements to secure and access a rental discount.

Full details of the contractual arrangements please refer to:

- the Windfarm Agreement for Lease (clause 5.9) which includes details of how and when the Innovative Test and Demonstration Elements Specification should be submitted for approval.
- the Windfarm Lease (Schedule 4 (rent): paragraph 7) which includes commercial details of the Innovative Elements Discount.

In addition, the following points apply to the Innovative Test and Demonstration Elements:

- The Innovative Elements Discount applies only once to the Innovative Elements Capacity (i.e. the generating capacity in MW of the Innovative Test and Demonstration Element).
- In the event that an Innovative Test and Demonstration Element ceases to operate there is no requirement to refund to TCE any previously received Innovative Elements Discount.
- Any change to the Innovative Elements Capacity will be reflected in the Innovative Elements Discount.
- Confidentiality relating to the Innovative Test and Demonstration Elements shall be governed by the Windfarm Agreement for Lease and the Windfarm Lease unless otherwise agreed with TCE.

Where there is a conflict between the Innovation Discount Policy and the Windfarm Agreement for Lease and/or the Windfarm Lease, the Windfarm Agreement for Lease and the Windfarm Lease prevail.

Appendix 1 – ORE Catapult TCE Offshore Wind Innovation Mechanism

THE CROWN ESTATE OFFSHORE WIND INNOVATION MECHANISM



DATE // October 2020

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1 Offshore Wind Innovation Hub

The Offshore Wind Innovation Hub (OWIH) is the UK's primary coordinator for innovation, focusing on offshore wind energy cost reduction, maximising UK economic impact and removing barriers to growth. OWIH's mission is to coordinate across the entire innovation landscape for offshore wind in the UK, presenting innovation priorities, supply chain growth potential and a comprehensive view of the funding opportunities available. OWIH is delivered jointly by ORE Catapult and Knowledge Transfer Network to provide the sector-wide coordination of innovation by a multi-disciplinary support team.

The OWIH has been established to:

- Simplify and coordinate the landscape for innovators
- Establish a common set of priorities across the offshore wind industry and communicate these to public bodies
- Increase the success of the industry in securing grant funding for innovation projects

In order to achieve this OWIH has built technology roadmaps – a register of industry challenges and ways to solve them. The roadmaps have been developed in collaboration with industry, supply chain, and academia to present an impartial sector-wide view of priority areas for offshore wind. As a map, they contain information of where the sector is now, the destination and a network of paths that offer different ways of getting there. It creates a holistic view of the sector's technology priorities as it tracks progress of distinct areas of innovation within each roadmap (Innovation Areas) and individual projects that support these Innovation Areas. In addition to the Innovation Areas that make up the technology roadmap there are also ongoing R&D projects.

Roadmaps are publicly available on [OWIH website](https://offshorewindinnovationhub.com/about-roadmaps/)¹ and are updated at least every six months to ensure an accurate reflection of the sector's needs.

¹ <https://offshorewindinnovationhub.com/about-roadmaps/>

2 Technology Roadmaps

OWIH roadmaps build on previous innovation prioritisation work undertaken in the sector, such as the Cost Reduction Monitoring Framework. Based on this foundation, OWIH created a series of roadmaps which were reviewed and moderated with industry and academia through the Technical Advisory Group.

There are four OWIH roadmaps, each representing a different part of the offshore wind supply chain. Each roadmap is further divided into different categories each representing a different element of that part of the offshore wind supply chain:

- Electrical infrastructure - moving to next generation electrical infrastructure including array cabling, power transmission, onshore & offshore substations. It also includes Innovation Areas related to grid integration (storage, smart energy systems) and hybrid projects that integrate offshore wind generation with other offshore infrastructure.
- O&M and Windfarm Lifecycle - optimising and future-proofing all services associated with offshore energy, including site development, installation, operations, maintenance, condition monitoring, and decommissioning.
- Turbines - Developing the next generation of offshore turbines, incorporating all the technology that forms the structural and operational elements of the turbine generator and rotor.
- Substructures - Innovations in fixed and floating foundations and substructures, but also including transition pieces and towers.

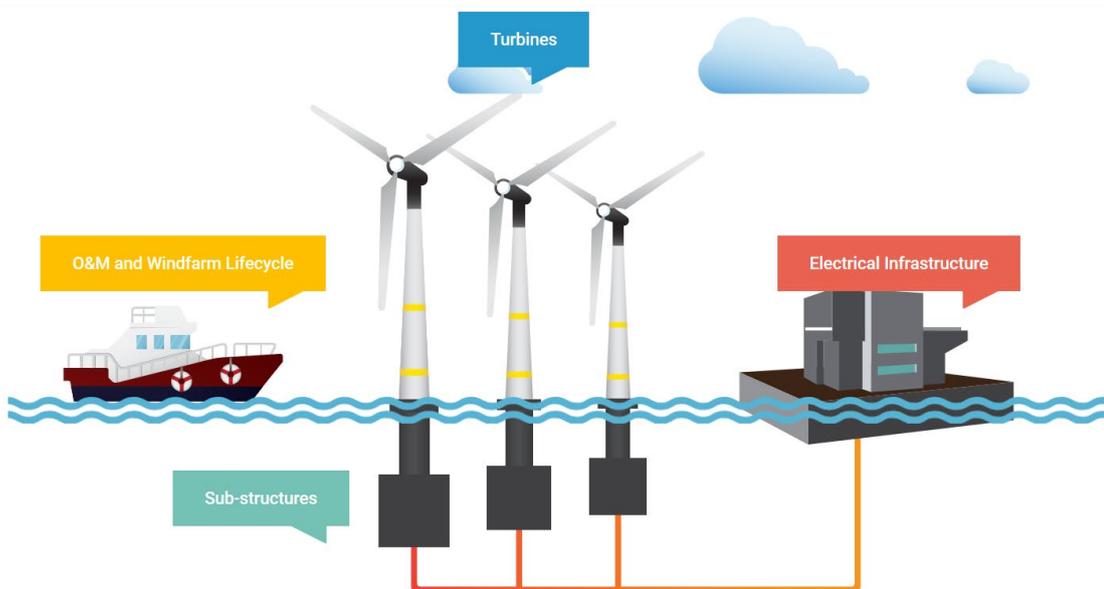


Figure 1 The four OWIH roadmaps

Each category within a roadmap is divided in categories and subcategories. Each roadmap contains 40 to 80 Innovation Areas. In Figure 2 below the *Two bladed turbines* Innovation Area belongs to *Turbines* roadmap, *Rotors* category and *Disruptive blades* subcategory.

Roadmap	Expand all fields	Start/End date
Turbines		
Rotors		
Disruptive blades		
Recyclable thermoplastic blades		2020 - 2025
Two bladed turbines		2020 - 2025
Development of radically different blade structure		2020 - 2024
Demonstration of radically different blade structure		2020 - 2025
Extremely lightweight offshore wind blade		2020 - 2020



Download the roadmap data

File size: 67 KB
Format: XLSX

[Download](#)

Figure 2 Website screenshot with example Innovation Areas and download button

There are two types of entry in each roadmap:

- Innovation Area – A suggestion of innovation route for a technological, market or regulatory challenge. In Figure 2 above they are shaded in grey.
- Ongoing R&D project – An existing project that aims to answer a challenge in offshore wind industry. In order to appear on the list, it had to be publicly announced and be of significant value. In Figure 2 above an example of ongoing R&D project is 'Extremely lightweight offshore wind blade' which is shaded in light blue.

All roadmap information is accessible online and can be browsed in two ways: online by clicking on individual Innovation Areas or by downloading the spreadsheet using *Download the roadmap data* button located to the right of the table with data (Figure 2).

Each Innovation Area is described and scored in detail as per Table 1 below. Please note that categories and subcategories are indicative only and do not include further details. An explanation of the scores for Low, Medium and High are provided in Table 2, alongside an illustration of how the scores are applied for example Innovation Areas.

Name of the detail	Explanation	Example – Non-rare earth PM generator (see below)
Description	Background information on the challenge and suggested innovation	(See below)
Forecast start and finish date 	When significant progress in this Innovation Area is expected to start and finish at the Technology Readiness Level (TRL) scale provided.	It is believed that the work on this Innovation Area is <u>ongoing now</u> at TRL ₅ and by <u>2027</u> it will reach TRL ₉ .

<p>Start and Target TRL</p> 	<p>Technology Readiness Level (TRL) at the start and end of the Innovation Area at timescales provided.</p>	<p>It is believed that this Innovation Area is at <u>TRL5</u> right now (as tests of 250kW generators are accomplished in a simulated environment) and by 2027 it will reach <u>TRL9</u>.</p>
<p>Enabler</p> 	<p>Target type of organisation likely to take a lead on this Innovation Area delivery:</p> <ul style="list-style-type: none"> • Academia • Catapult • Industry/SMEs • Research Technical Organisations (RTOs)* • Other 	<p>Main enabler are <u>RTOs</u> responsible for testing generators. However, the close to the TRL9 the more involvement of the industry will be necessary.</p> <p>* RTOs are specialised knowledge organisations, frequently non-profit dedicated to the development, testing, validation and transfer of science and technology to the benefit of the economy and society.</p>
<p>Beneficiary</p> 	<p>Part of the supply chain that would benefit from a solution in this Innovation Area:</p> <ul style="list-style-type: none"> • Original Equipment Manufacturers (OEMs) • Owner Operators • Other Suppliers 	<p><u>OEMs</u> would be manufacturing these generators and they would benefit the most from this Innovation Area.</p>
<p>Strategic Outcome</p>	<p>One of 3 general strategic outcomes this Innovation Area can contribute to:</p> <ul style="list-style-type: none"> • Enabling disruptive innovation • Commercialising >15MW turbine platforms • Maximising operational performance of existing wind farms 	<p>Non-rare earth PM generator would be a radical different technology to the one that is used currently and would <u>enable disruptive innovation</u>.</p>
<p>UK Benefit</p>	<p>How well placed is the UK to play a role in the development and maturing of the specific Innovation Area and benefit from the outcomes. This includes export</p>	<p>UK Benefit is <u>high</u> as UK is currently pioneering in development in this technology.</p>

	<p>potential, IP creation, jobs created, GVA increase. Each Innovation Area is scored:</p> <ul style="list-style-type: none"> • Not applicable (n/a) • Low • Medium • High 	
<p>Potential to Reduce LCoE</p> 	<p>Within the context of the technology area what contribution could the specific innovation make reducing Levelised Cost of Energy. Each Innovation Area is scored:</p> <ul style="list-style-type: none"> • Not applicable (n/a) • Low • Medium • High <p>Detailed score explanation is listed in the table below.</p>	<p>Potential to reduce LCoE is <u>medium</u>. It could be high if it allows direct drive and lowers weight, but at the moment this is unlikely.</p>
<p>Case for Intervention</p> 	<p>What is the probability that industry would not take this innovation forward without additional support. This can include necessity for third party coordination, testing facilities, investment risk. Support can come in multiple forms e.g. financial, legal, technical or coordination. Each Innovation Area is scored:</p> <ul style="list-style-type: none"> • Not applicable (n/a) • Low • Medium • High <p>Detailed score explanation is listed in the table below.</p>	<p>Case for Intervention is <u>high</u>. The issue of market volatility and potential issues with decommissioning has been recognised internationally, but private sector did not focus on it yet. Without a support from public sector, it will be difficult or lengthier to bring this innovation to the market.</p>
<p>Health, safety & environmental (HSE) impact</p> 	<p>What contribution could the specific Innovation Area make to reduce health & safety risk and/or environmental impact:</p> <ul style="list-style-type: none"> • Not applicable (n/a) • Low • Medium • High <p>Environmental risk is understood as local environmental impact e.g. mitigating an</p>	<p>HSE impact is <u>medium</u> as thanks to this Innovation Area the dependency on rare earth magnetic material would decrease and important environmental issue would be addressed. From the perspective of a turbine lifecycle it is not an</p>

	<p>impact on commercial fisheries, reduction of unrecyclable material. Scoring in this area should not include long-term impact on climate change as all Innovation Areas in offshore wind will mitigate this risk to some extent.</p> <p>Scoring is based on a contribution of this Innovation Area to an HSE risk e.g. an Innovation Area that will have a small effect on high severity risk (fatality) will be scored as Low.</p> <p>Most Innovation Areas that are an interim step to significantly impact HSE, relate to testing or provide an insignificant material saving are scored as n/a.</p>	<p>environmental change significant enough to score 'high'.</p>
<p>Requires implementation as part of an offshore wind project</p>	<p>This Innovation Area requires implementation as part of an offshore wind project. It includes innovations that are part of the project itself (even if they are physically located onshore) but not those associated with a supply chain or standardisation.</p> <p>For instance, <i>Industry-wide standardisation of nodes</i> from Substructures roadmap would not require implementation offshore. Manufacturing of substructures is suboptimal due to too many geometries of jackets and the standardisation of manufactured parts would reduce the cost by improving quality inspections and reduce cost / lead time of components. As it is an improvement in supply chain it would not require implementation offshore.</p>	<p>New type of generator would have to be tested and then demonstrated which means it would <u>require implementation as part of an offshore wind project</u>.</p>

Table 1: Details against which Innovation Areas are scored

Score name	n/a	Low	Medium	High
Case for intervention	Innovation area will progress without any support e.g. it's related to company's IP or is already commercially driven.	Innovation area could progress without support but some delays might occur or benefits will not be captured in full.	Innovation area may progress without support – delays will occur or costs will be higher.	Innovation area will not progress without support - significant delays will occur or costs will be significantly higher.
	<i>Optimisation of design during FEED</i> - This is an area that substructure developers need to do to be successful.	<i>Advanced lifting</i> - It is likely that industry will create these technologies without an intervention as there is strong market push. Intervention may help SMEs manage their risk, and take more of a leading role, instead of solely the large companies.	<i>Offshore green hydrogen production</i> - Big industry players already investing and developing H2 technologies, both in renewable and O&G sector, but public support for large scale demonstrators is necessary. Intervention will be required in regulations, e.g. blending H2 into UK gas grid.	<i>Coordinated environmental monitoring</i> - Without funding, work on this area can slip and it will take more time than the forecast. The desire is strong across management, developers and groups that manufacture equipment, but needs funding and coordination body.
Potential to reduce LCoE	No or marginal cost reduction	<1% within the timescales and TRL range provided for this Innovation Area	1-2% within the timescales and TRL range provided for this Innovation Area	>2% within the timescales and TRL range provided for this Innovation Area
	<i>Generating & standardising social and economic impact methodology</i> – this innovation area does not relate directly to the LCoE, but rather to delays and risk to gaining consent.	<i>Multiple sub-converters</i> - once a fault happens, the turbine could still be available and operating at de-rated level but an extra cost of circuit breaker and circuit complexity would increase the CAPEX.	<i>Real time weld inspection</i> - More effective maintenance but not significant enough to be a game changer and human work would still be needed.	<i>20MW+ Powertrain</i> - Next generation of OSW turbine will boost power generation and significantly reduce LCoE.
Health, safety & environmental impact	No or marginal improvements including Innovation Areas that are an interim step to a significant HSE impact improvement (e.g. relate to testing or	Small improvements that would somewhat improve HSE impact e.g. decreasing the number of asset failures.	Some improvements that would reduce severity of an incident and its likelihood or an environmental issue, but would not be revolutionary.	Significant improvements that reduce severity of an incident and its likelihood of occurrence e.g. requirement for personnel in offshore

	provide an insignificant material saving).			environment, risky maintenance, major failure prevention. Significant improvements on environmental issues e.g. landfill reduction, marine life or aquaculture improvements.
	<i>Improved blade structure models</i> - Insignificant materials savings that would improve environmental impact.	<i>Satellite remote monitoring</i> - Could provide better wave height forecasting which minimises unsafe CTV transfer risks.	<i>Augmented reality applications</i> - Can bring significant improvements in training technicians and minimise number of O&M trips.	<i>Autonomous systems for subsea survey & environmental tasks</i> - Direct impact on H&S improvement as remote inspection techniques would reduce the requirement for human offshore inspection.

Table 2: Definitions for Low, Medium and High scores

Technology Readiness Levels (TRL) are a type of measurement system used to assess the maturity level of a particular technology. TRL are based on a scale from 1 to 9 with 9 being the most mature technology. The use of TRLs enables consistent, uniform discussions of technical maturity across different types of technology. TRLs, by themselves, may not always relate clearly to risk, cost and schedule. For instance, some technology at a low TRL can mature more quickly than another at a high TRL. Please find below detailed explanation of each TRL level:

Level	Explanation
TRL 1	Basic principles observed. Scientific research begins translation to applied R&D: Lowest level of technology readiness. Examples might include paper studies of a technology's basic properties.
TRL 2	Technology concept formulated. Invention begins: Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
TRL 3	Experimental proof of concept. Active R&D is initiated: This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
TRL 4	Technology validated in lab. Basic technological components are integrated: Basic technological components are integrated to establish that the pieces will work together.
TRL 5	Technology validated in relevant environment. Fidelity of breadboard technology improves significantly: The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components.
TRL 6	Technology demonstrated in relevant environment. Model/prototype is tested in relevant environment: Represents a major step up in a technology's demonstrated readiness, which is well beyond that of TRL 5. Examples include testing a prototype in a high-fidelity laboratory environment or in simulated operational environment.
TRL 7	System prototype demonstration in operational environment. Prototype near or at planned operational system: Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment.
TRL 8	System complete and qualified. Technology is proven to work: Actual technology completed and qualified through test and demonstration.
TRL 9	Actual system proven in operational environment. Actual application of technology is in its final form: Technology proven through successful operations. Includes competitive manufacturing in the case of key enabling technologies.

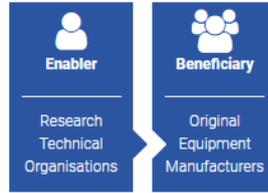
Non-rare earth PM generator

Type of Entry: Innovation Area

Turbines > Powertrain > Development of next generation generators

Description

Background: As turbines get bigger, the torque rating and hence permanent magnet content of the generator will tend to increase. Usage of NdFeB type magnet material depends on the supply from a single country China (~90+%) which increases price volatility and decreases security of supply. Innovation: New Permanent Magnet (PM) generator is less dependent on rare earth magnetic material which decreases cost volatility of raw materials. Tests of 250kW generators are accomplished. Innovation area consists of different types of research: materials might be RTO/academia, machine design is likely academia/industry, testing is RTO.



Strategic Outcome

- Enabling disruptive innovation
- Commercialising >15MW turbine platforms
- Maximising operational performance of existing wind farms

Requires implementation offshore

- Yes
- No



Figure 3 An example of Innovation Area - 'Non rare Earth PM generator'

3 Technology Roadmap criteria and qualifying innovations for the Round 4 innovation mechanism

ORE Catapult has advised TCE on the approach for determining how innovations proposed by Round 4 projects could be qualified for a discount under the Round 4 Innovation Discount Policy. TCE will use the OWIH roadmaps (referred to as Technology Roadmaps for the purposes of the Round 4 Innovation Discount Policy) as the mechanism for assessing which innovations should qualify for rental discount.

Innovations proposed for a Round 4 project should meet an Innovation Area that is included in one of the Technology Roadmaps. The Innovation Area proposed by the Round 4 project will be scored against five criteria which have been selected from the standard set of scoring criteria used in the Technology Roadmaps (Qualifying Criteria). Those Innovation Areas which meet the Qualifying Criteria will qualify for a rental discount in line with the Innovation Discount Policy. The Qualifying Criteria are set out in the table below, a justification for the selection of each criteria is also provided.

Category	Qualifying Criteria	Justification
Start TRL	TRL ₄ ¹ to TRL ₇	Includes Innovation Areas that are not commercially available yet but for which initial R&D work has started. There is a risk that an innovation with TRL lower than 4 would not be ready to demonstrate. ¹ Innovation Areas with TRL lower than 4 have been excluded, as they are not likely to mature in line with the expected 'forecast finish date'. However, Innovation Areas with a lower start TRL may be acceptable if the Owner Operator accept the risk of developing a less mature innovation, can evidence that they have been working in this area and they can meet the 'forecast finish date'.
Forecast finish date	The Innovation Area must be expected to reach TRL ₉ after offshore construction of the offshore wind project is complete ² .	Excludes Innovation Areas that would be commercially available (, in or outside of the UK o), before offshore construction is complete for the offshore wind project. ² An exception to this criteria is when an Innovation Area reaches TRL 9 earlier than before commissioning date as a result of its application to the Round 4 project, (as long as the Innovation is not commercially available / in use on any other project elsewhere).

Case for Intervention	Score as <i>High or Medium</i>	Excludes Innovation Areas that would be commercially driven and do not require additional support.
Potential to reduce LCoE AND/OR Health, safety & environmental impact	Score as <i>High or Medium</i> in at least one of these categories	Excludes Innovation Areas that would have limited impact on enabling projects, reducing cost or improving HS&E.
Requires implementation as part of an offshore wind project	Yes	Excludes Innovation Areas that are not directly related to offshore site lease by The Crown Estate e.g. related to standardisation of parts, fabrication methods or improvements in supply chain productivity.

The Technology Roadmaps are the most extensive register of UK offshore wind innovation needs that are compiled to the best available knowledge of experts that compiled them. However, it may happen that some Innovation Areas that are developed in-house are not included in the Technology Roadmaps. Thus, if Owner Operators believe that their suggested innovation would fulfil the criteria above, they are encouraged to submit the suggestion to The Crown Estate which will be assessed according to the Qualifying Criteria. The Owner Operator shall provide sufficient level of documentation to prove that an Innovation Area meets the Qualifying Criteria.

Innovation Areas will have to be developed during Installation, Operations or Maintenance phase of an offshore wind project. Due to timescales innovations in Decommissioning phase are excluded from the programme.

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Appendix 2 – TCE Innovation Discount Policy Review Form

Review Form

Table 1: Detailed assessment form		Comment
1. Company & Wind Farm Project	Name of the company	
	Name of the project	
	Nameplate capacity of the proposed windfarm (MW)	
	Total number of turbines in the proposed windfarm	
2. Innovation	Name of the innovation	
	Summary	
	Name of the technology provider	
	Current TRL	
	Expected commercialisation date of the technology	
	Expected demonstration time (i.e. 5 years, end of project lifetime)	
	Related to an existing Innovation Area in OWIH roadmaps?	
3a. Eligibility (Innovation Area available in OWIH roadmaps)	Name of the Innovation Area	
	Description	
	Start TRL	
	Finish TRL	
	TRL comment (optional)	
	Forecast finish date	
	Case for Intervention	
	Potential to reduce LCoE	
	Health, safety & environmental impact	
	Requires implementation as part of an offshore wind project	
	Nameplate capacity of the proposed windfarm used for this innovation (MW)	
	Number of turbines innovation relates to (if applicable)	
	Other	
	3b. Eligibility (New Innovation Area suggested by Owner Operator, not captured in OWIH roadmaps yet)	Name of the proposed Innovation Area
Summary of the Innovation Area		
Start TRL		
Finish TRL		
Forecast start date		
Forecast finish date		
Case for Intervention		
Case for Intervention comment		
Potential to reduce LCoE		
Potential to reduce LCoE comment		
Health, safety & environmental impact		
Health, safety & environmental impact comment		
Requires implementation as part of an offshore wind project		
Nameplate capacity of the proposed windfarm used for this innovation (MW)		
Number of turbines innovation relates to (if applicable)		
Other		
4. Risks	What are the risks associated with implementing this innovation?	
	What measures are planned to mitigate the risks?	
5. Outcome	Innovation area eligibility	
	Reason for no	

Scorecard

Table 2: Scoring criteria		Qualifying	Not qualifying	Comment	Rationale	
	Name of the innovation area					
	Description			At least a few sentences summary of the innovation to allow a justification if proposed innovation matches the <i>Innovation Area</i> in roadmaps		
	Start TRL			TRL 1	Basic principles observed. Scientific research begins translation to applied R&D: Examples might include paper studies of a technology's basic properties.	Not mature enough to demonstrate in operational environment
				TRL 2	Technology concept formulated. Invention begins;	Not mature enough to demonstrate in operational environment
				TRL 3	Experimental proof of concept. Active R&D is initiated: This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.	Not mature enough to demonstrate in operational environment
			TRL 4		Technology validated in lab. Basic technological components are integrated: Basic technological components are integrated to establish that the pieces will work together.	Innovation not commercially available yet but basic R&D work has finished
			TRL 5		Technology validated in relevant environment. Fidelity of breadboard technology improves significantly: The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components.	Innovation not commercially available yet but basic R&D work has finished
			TRL 6		Technology demonstrated in relevant environment. Model/prototype is tested in relevant environment: Represents a major step up in a technology's demonstrated readiness, which is well beyond that of TRL 5. Examples include testing a prototype in a high-fidelity laboratory environment or in simulated operational environment.	Innovation not commercially available yet but basic R&D work has finished
			TRL 7		System prototype demonstration in operational environment. Prototype near or at planned operational system: Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment.	Innovation not commercially available yet but basic R&D work has finished
		TRL 8		System complete and qualified. Technology is proven to work: Actual technology completed and qualified through test and demonstration.	Innovation almost commercially available	

3. Eligibility

			TRL 9	Actual system proven in operational environment. Actual application of technology is in its final form: Technology proven through successful operations. Includes competitive manufacturing in the case of key enabling technologies.	Innovation almost commercially available
Start TRL comment	TRL 1 - TRL 3				Innovation Areas with start TRL 1-3 can be acceptable if Owner Operator will document that they have been working in this area and it would be ready to demonstrate
Finish TRL	Project dependent	Project dependent			
Forecast finish	TRL9	Project dependent		Expected to reach TRL9 after offshore construction is complete.	Excludes innovations that would be commercially available before the commissioning date of the project.
Forecast finish comment					An exception to this is when an Innovation Area reaches TRL 9 earlier than this date as a result of its application to the project, the Innovation Area must not be commercially available / in use on any other project.
Case for Intervention	High / Medium			The probability that industry would not take this innovation forward is high/medium and additional support is needed	Innovation is not commercially driven and requires additional support
Case for Intervention			Low / n/a	The probability that industry would not take this innovation forward is low - very low and additional support is not needed	Innovation commercially driven and does not require additional support
Potential to reduce LCoE	High / Medium			Within the context of the technology area what contribution could the specific innovation make reducing LCoE. Some innovations might be scored higher even if they do not contribute to LCoE reduction in isolation but remove barriers to growth instead	
Potential to reduce LCoE			Low / n/a	Within the context of the technology area what contribution could the specific innovation make reducing LCoE. Some innovations might be scored higher even if they do not contribute to LCoE reduction in isolation but remove barriers to growth instead	If proposed innovation is scored High/Medium for HSE impact then it can still qualify. If proposed innovation is scored Low/ n/a for HSE impact then it has a limited impact on enabling projects, reducing cost or improving HS&E and does not qualify
Health, safety & environmental impact	High / Medium			What contribution could the specific innovation area make to reduce health & safety risk and/or environmental impact	
Health, safety & environmental impact			Low / n/a	What contribution could the specific innovation area make to reduce health & safety risk and/or environmental impact	If proposed innovation is scored High/Medium for HSE impact then it can still qualify. If proposed innovation is scored Low/ n/a for HSE impact then it has a limited impact on enabling projects, reducing cost or improving HS&E and does not qualify.

	Requires implementation offshore	Yes		This innovation area requires implementation as part of an offshore project. It includes innovations that are part of the project itself (even if they are physically located onshore) but not those associated with a supply chain or standardisation.	
	Requires implementation offshore		No	Innovation does not require implementation as part of an offshore project	Innovation not directly related to offshore site lease by The Crown Estate
	Project capacity used for the innovation (MW)	Project dependent	Project dependent		Innovation applied to less than 10% of the project capacity
	Other				
4.Outcome	Innovation area eligibility				
	Reason for no				

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