End of Phase Report Section Guidance

Application Number 10067856	**Project Title** INCENTIVE
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Section 1 -	**Beta Phase – Executive Summary**

Project background

Inertia in the GB electricity network is falling. Without novel solutions, adding additional renewable generation capacity will become increasingly challenging, leading to significant instability events on the onshore networks (which are already occurring, but can be expected to get worse), and increasing the operating cost of the GB network system and therefore consumer bills. Historically, renewable generators have not treated system inertia as their problem as system inertia has been high due to the presence of (mostly fossil fuelled) synchronous generation. However, we are already seeing renewable generation curtailed due to low system inertia.

The INCENTIVE project has investigated how offshore wind farms (OWF) can provide inertia to the onshore networks. This will provide grid stability and reliability at a lower cost and reduce the need for additional infrastructure by co-developing and co-locating inertia services with OWF developments. OWFs and their associated grid infrastructure providing inertia to the onshore network is not an incremental innovation, but a step-change in thinking that could be replicated globally.

INCENTIVE has investigated OWFs with:

1.STATCOM with supercapacitor energy storage and grid forming converter (“INCENTIVE STATCOM”).

2.Battery energy storage system (BESS) with overrated grid forming converter (“INCENTIVE BESS”).

3.Synchronous condenser with flywheel.

Collectively, we refer to these as “INCENTIVE solutions”.

The Project brought together SSENT, NESO (formerly NGESO), OWF developers, technology suppliers and Ofgem, to help build a cross-industry understanding of how

offshore wind could provide inertia through the use of BESS with GFM converters and STATCOMS with grid forming converter and super capacitors.

Scope of the Project

The project consisted of five core work packages, and an additional sixth work package which was added during project delivery to ensure the dissemination and successful close out of the project.

WP1	Project management
WP2	Business model development
WP3	Technical assessment
WP4	Site selection
WP5	Stage 2 scoping
WP6	Additional work: preparing for posterity

Outcomes of Project

The main outcomes of the project can be summarised into two areas:

1) Clarity around the process of installing INCENTIVE solutions from a regulatory and commercial perspective. Specifically, identifying key routes to enabling market participation of these technologies, and understanding the asset ownership of such devices.
2) Understanding of the technical performance and specifications, and adjustments to technical markets/ grid codes that could enable INCENTIVE solutions to operate within the inertia market.

Key metrics the Project has developed

- No key metric developed

Objectives of the SIF challenge met by project including references to Project Deliverables

The SIF challenge of the INCENTIVE Beta phase was whole system integration. The INCENTIVE project has built collaboration with a large whole-system consortia, enabling innovation between a large group of generators, transmission networks and OEMs, as well as various teams within NESO and Ofgem. This whole-system approach has enabled new insights on the use of offshore wind to provide ancillary services (inertia) to the wider system, with a view of enabling further offshore wind (and other renewable penetration). The innovations have included insights across a wide range of interdependent areas, such as regulations, grid codes, markets and technical design specification. In terms of whole system integration, the key deliverables which discuss the technical benefits of offshore wind inertia provision and integration all sit within WP3, and the key commercial and regulatory whole system innovations are found within WP2.

Main learning generated by the Project

- Feasible regulatory model for INCENTIVE solutions identified.
- Simulation testing has shown INCENTIVE solutions will meet grid code.
- CBA is positive for INCENTIVE solutions but may need to be improved before

INCENTIVE solutions can be invested in (see bullet point below).

- However, the current market and grid code requirements require an inertia response for 5 seconds, which is detrimental to the business case. This definition of inertia response may need to be updated in future iterations of market requirements and grid code.

Useful links to key project documents

- https://www.carbontrust.com/our-work-and-impact/impact-stories/large-scale-rd-projects-offshore-wind/innovative-control-and-energy-storage-for-ancillary-service-in-offshore-wind-incentive
- https://www.carbontrust.com/our-work-and-impact/guides-reports-and-tools/energy-storage-for-offshore-wind-with-innovative-converter-control

Section 2 -	**Beta Phase – Project Summary**

Please provide a summary of the key findings from your Beta Phase Project.

How your Project is meeting the aims of the relevant SIF Innovation Challenge and the problem and opportunity your project aimed to resolve and how the Project helped solve the issue.

INCENTIVE has addressed the Whole System Integration innovation challenge by investigating and demonstrating how offshore wind farms (OWFs) and their associated grid infrastructure can provide inertia to the onshore networks.
Aligned to the aims of the innovation challenge, INCENTIVE has:

- Improved the coordination between onshore transmission networks and offshore wind developers, with a view of introducing innovative solutions to the GB energy system.
- Reduced complexity and bureaucracy by developing optimal business models that will be applicable not just for the Beta Phase demonstration but for national roll-out following the completion of Beta Phase.
- Avoided duplication by building a common understanding of the INCENTIVE solutions amongst a large consortium with all key stakeholders.
- Reduced barriers to market entry for OWFs to provide inertia.

The fall in inertia in the GB network is inherently a challenge that requires network innovation. INCENTIVE has focused on using OWFs to help stabilise the onshore network. Currently, no OWF is able to provide inertia to onshore networks globally. INCENTIVE will allow a step-change in capability for OWFs across the world, supporting the increase of renewable generation and delivering benefits to consumers.

How the Project has performed relative to its aims and objectives and the approach it trialled

The INCENTIVE Beta Phase itself delivered according to its original aims and objectives, delivering all results originally planned. However, the INCENTIVE Beta Phase intended to be followed by a further final phase where a physical demonstration would take place. At the time of writing this report, a route to demonstration has not been identified. SIF Round 2 funding has not been applied for due to a decision from SSEN not to proceed. The consortium will continue to consider alternative approaches to financing the next phase.

Project's outputs and outcomes including the innovative aspects of the work including any new findings or techniques.

Please see Section 7 below.

Improvements this innovation has made to new processes, products, or services.

- New Products: The INCENTIVE project has proved the case for these novel technologies being brought to market and is derisking investment.
- Services: The INCENTIVE project has proved the use of these novel technologies in conjunction with participating in the stability services market

Any difficulties or delays encountered during the Project and how these challenges informed future thinking on undertaking innovation Projects effectively.

Some delays experienced in receiving technical models from OEMs due to time taken to agree necessary NDAs and for model tuning. While this has not affected the overall project timeline, we have shared this experience with UKRI to help enable other projects to mitigate for similar challenges.

How learning developed over the course of the Project.

The progress that has been made within the INCENTIVE project can be divided into 3 main areas:

1) **OEM model validation**
   Working with OEMs on validating their novel technology models has provided Offshore Wind (OSW) developers and TOs with assurance in the technologies; while also ensuring all parties understand the offerings these technologies could provide in terms of inertia markets and how best to specify these technologies.

2) **Regulatory model**
   The progress that has been made with DESNZ, Ofgem, NESO and OFTOs has enabled viable regulatory models to be developed and a clear path for progression to market to form.

3) **CBA**
   Significant work has been undertaken on the cost benefit analysis of these solutions. The CBA is now significantly more detailed than in Alpha Phase, and the additional analysis undertaken on this has uncovered an issue regarding inertia definition, which is leading to asset oversizing, and hence a damaging business case.

Section 3 -	Beta Phase – Knowledge creation and dissemination

What lessons were learned from the approach and the project's innovation for the relevant period? Provide insights gained from the project innovation and the approach employed.

Several lessons have been learnt in the process of delivering INCENTIVE Beta Phase, namely:

Contracting: Contracting a large consortium such as that of the INCENTIVE Beta Phase, takes a large effort and can be difficult to align across such a broad spectrum of organisations.

Lesson learnt: Start early and allow time Although we got contracts signed in good time it was a big effort. In any future phase, we would plan to have an opening procurement phase to ensure procurement and contracting time is factored in.

Next Phase: INCENTIVE Beta Phase project was scoped as a shorter Beta Phase project, with the view of an additional follow-on phase to conduct the physical demonstration. Such a physical demonstration of novel technology is a big commitment, and these conversations and commitments take significant time.

Lesson learnt: Start scoping and business case creation early and be clear on resources required for demonstration. Identify key delivery partners, and their resource requirements as early as possible. Ensure all key decision makers in those companies are aware of the need for a decision as early as possible, and support them to make the necessary commitment decision

Model sharing: INCENTIVE Beta Phase has used OEMs' models in the process of the technical work undertaken. This process of procuring these models was slower than anticipated due to additional tuning time requirements and coordination of several organisations.

Lesson Learnt: In the Project Plan, set aside adequate time to procure models (or other inputs) from OEMs. OEMs can require additional time internally to get sign off and to fine tune their models for specific use cases, additionally coordinating multiple OEMs separately and confidentially takes more time than anticipated and it is important to ensure everyone has the time and ability to sign off on each stage.

Section 4 -	Beta Phase – Intellectual Property Rights Generation

Provide a description of any relevant foreground IPR that has been developed from the project and the plans for sharing this across networks.

If the project has generated Intellectual Property Rights (IPR) that Ofgem has specified do not need to be shared, please explain this in detail.

The Relevant Foreground IPR is solely the INCENTIVE deliverables, which can be made available to other networks upon request. No other IPR has been generated.

Deliverables developed:

Deliverable	Title
D1.1	End of Phase Report
D1.2	Meeting minutes and materials
D1.3	Risk register
D1.4	IP register
D1.5	UKRI regular progress reports
D1.6	Annual Report
D2.1	Refined CBA for value chain for Stage 2 demonstration for specific INCENTIVE solution(s) at specific site(s)
D2.2	Business model(s) for Stage 2 demonstration of specific INCENTIVE solution(s) and specific site(s)
D2.3	Impact assessment of INCENTIVE solutions on roll-out of offshore wind
D2.4	Refined CBA for value chain for INCENTIVE solution(s) (non-site-specific)
D2.5	Business model(s) for commercial implementation INCENTIVE solutions (non-site-specific)
D2.6	Review of D2.1, D2.3 and D2.5
D3.1	Testing report on INCENTIVE solutions
D3.2	Testing report on INCENTIVE solutions with offshore wind farms
D3.3	Review of Stage 1 modelling work
D4.1	Qualitative site assessment report
D5.1	Stage 2 Project Plan
D6.1	CBA modelling approach
D6.2	Recommended Further Work

Out with the project consortium, the INCENTIVE project has also collaborated with National Grid Transmission (NGET) and Scottish Power Energy Networks (SPT) during the delivery of the Beta Phase, so all transmission networks in GB are aware of its outcomes.

Section 5 -	Beta Phase – Data Access Details

Provide a description of any data or insights you have produced/published from the Project, and where they may be found or requested.

All insights are contained within the Deliverables listed in Section 4 above. These are confidential to the INCENTIVE project but may be made available to GB licensed networks in accordance with the SIF Governance document. Upon request, non-GB licensees may be granted a licence on terms to be agreed with the INCENTIVE partners, in accordance with the SIF Governance Document.

At the time of writing (Beta Phase close out), INCENTIVE has submitted two papers to IET's ACDC 2025 conference. We are waiting to hear if these submissions are successful. We are also planning a public webinar in December 2024 to disseminate key outcomes.

Section 6 -	Beta Phase – Route to Market / Business as usual

How is your Project working towards integration into business-as-usual practices within your network and across other networks following the successful completion of the Beta Phase? What strategy do your Project Partners have for commercialising the innovation?

If the innovation is not yet ready for implementation, clarify the necessary steps and additional work required before it can be adopted and likelihood that the innovation will be deployed on a large scale in future. A breakdown of actions which are required by the Lead Network, and/or non-network licensee parties outside of policy, regulatory or standard changes.

The innovation is not yet ready for implementation. This is due to nascent, and rapidly evolving, grid code and market definitions for the technology, meaning the technical asset specification is unclear and the revenue streams are uncertain. These present barriers to invest in these solutions, and hence their implementation. Details on the steps that various parties need to take towards implementation are set out in D6.2, which is uploaded to the ENA website alongside this document.

D6.2 denotes the necessary steps and further work to bring these technologies to BAU. This specifically falls into the following 11 areas:

1) Information exchange with German TSOs
2) Improved inertia provision from combination of OWF + INCENTIVE solution
3) Strengthening weak grid connections for OWFs using INCENTIVE solutions
4) Input into new GB grid forming working group
5) Evolving the understanding and definition of inertia in GB
6) Evolving the understanding and definition of strength to connect in GB
7) OWF developer ownership regulatory model
8) TO ownership regulatory model
9) First-of-a-kind deployment of a Grid forming (GFM) STATCOM with supercapacitor storage in GB
10) Guidance for OWF developers
11) Guidance for GB onshore TOs

D6.2 describes the need, aims, scope outputs, costs and duration expected for each of these areas required to bring these technologies to BAU.

Recommendations on how to further exploit the outcomes of the Project.

Recommendations for furthering of the project can be found within D6.2, which is uploaded to the ENA website alongside this document.

The likelihood that the innovation will be deployed on a large scale in future.

INCENTIVE has shown there is great potential in INCENTIVE solutions; but that there are also significant barriers to their deployment. Whether these barriers will be reduced in time for the offshore wind industry to uptake these solutions will depend on the barriers being addressed. There is an element of urgency here. Offshore wind farms are being built very rapidly with huge targets by 2030 and 2035. Opportunities will be lost to install INCENTIVE solutions if the barriers are not addressed quickly. D6.2 describes this in more detail, which is uploaded to the ENA website alongside this document.

Any differences between the work undertaken during the Beta Phase and the approach outlined in the Application for the Beta Phase. This should include information on commercial readiness levels (CRL) for your innovation at the end of project.
Work in the INCENTIVE Beta Phase has remained aligned with the Beta Phase application. In line with the Beta Phase application, the Discovery and Alpha Phases raised CRL from 1 to 4. At the end of Beta Phase, CRL is 5. The further work documented in D6.2, which is uploaded to the ENA website alongside this document, sets out how to raise CRL to 8.

Any changes / updates to the plans to enable procurement and utilisation of the innovation across Great Britain and internationally
Procurement of INCENTIVE solutions is one of the key barriers to address that will enable their utilisation. In INCENTIVE Beta Phase, we found that – due to nascent and rapidly evolving grid code and market requirements – it is unclear how to technically specify INCENTIVE solutions to OEMs. There is also uncertainty in terms of INCENTIVE solution revenue streams. This makes procurement difficult at the current time. The key to enabling widespread procurement will be to provide absolute clarity and certainty in terms of grid code definitions and revenue potential. This will enable offshore wind developers to specify requirements to their OEMs and the OEMs to deliver solutions that meet these requirements. D6.2 sets out steps to achieve these goals in more detail.

What considerations have the Project consortium made for the commercialisation of the proposed solution or innovation
Commercialisation has always been at the core of the INCENTIVE project. The key step forward INCENTIVE Beta Phase has made towards commercialisation of INCENTIVE solutions is the development of a workable regulatory models. However, INCENTIVE Beta Phase has also unearthed additional barriers to commercialisation in the form of nascent and rapidly evolving grid code and market requirements, making the commercial investment case for INCENTIVE solutions unclear at the current time. D6.2 sets out the steps to overcome these newly identified barriers in detail.

How the Project is providing support for non-network partners to move towards commercialisation
Working with non-network partners was a key part of INCENTIVE. The project consortium consisted of 11 offshore wind developers and 5 OEMs in addition to networks. As the project progressed through Discovery, Alpha and Beta, the main commercialisation model developed ended up being for offshore wind developers rather than networks. In this regard, a workable regulatory model was devised that enabled offshore wind developers to instal and operate INCENTIVE solutions. The project worked with offshore wind developers and a range of OEMs, using three different offshore wind farms as case studies to work through the various technical and commercial barriers, with a view of commercialising the innovation at those windfarms. This included assisting the offshore wind developers and OEMs in understanding market requirements and translating these into asset specifications, all while providing analysis on the potential revenue streams and therefore business case for the INCENTIVE solutions.

Section 7 -	Beta Phase – Policy, Regulatory and Standard Barriers

Provide a summary of any regulatory, policy, or standards barriers which may require derogations or any proposed changes which would be necessary in deployment of the innovation.

Work Package 2 of the project investigated the regulatory needs to enable the ownership/ operation of an INCENTIVE STATCOM (STATCOM with grid forming converter and supercapacitors). INCENTIVE worked with various teams at Ofgem and NESO, as well as with offshore wind developers and OEMs, to devise novel regulatory arrangements to enable INCENTIVE solutions. A workable model was devised. In order to finalise this regulatory model, it will be necessary for an actual offshore wind project to request to use the regulatory model devised and to work with Ofgem to see it through to implementation. D6.2 describes this in more detail, which is uploaded to the ENA website alongside this document.

In addition to this, the work undertaken in INCENTIVE Beta Phase has uncovered additional barriers to BAU deployment of these technologies, namely the '5 second rule' which is based on the capability to deliver inertia (or Active ROCOF Response Power) for 5 seconds. The design driver for this is a test defined in Grid Code Table PC.A.5.8.2 which requires energy to be provided for a 1Hz/s frequency ramp from 52 Hz to 47 Hz to be quantified. This storage duration also accommodates scenarios where inertia power is provided for successive frequency events without charging or discharging. This onerous requirement reduces the available provision of inertia at a market level. However, the need for this onerous requirement could be disputed and proposed changes to this requirement could enable BAU uptake of INCENTIVE solutions (particularly INCENTIVE STATCOM) and enable them to both provide these services and operate within the inertia market. Examining this definition may be required, as set out in D6.2.

Section 8 -	Beta Phase – User Needs
Summarise who your prioritised users are for your project, outlining their specific needs and how the project is addressing these needs and issues.	

You should describe:

- **what the user journey is for you new product, process or service**
- **how you are translating these user needs into your project design and requirements**

The key users of INCENTIVE solutions include OWF developers, onshore networks and electricity system operators.

All key users of these solutions were represented in the consortium of the INCENTIVE project. At the start of the project, their needs were identified as:

- OWF developers and INCENTIVE solution suppliers need to demonstrate the INCENTIVE solutions before they can be rolled out commercially.
- Networks need to understand their role in the implementation of INCENTIVE solutions, and whether they will be capable of owning and operating these assets in the future.
- NESO needs to understand the technical performance of the INCENTIVE solutions and how they will participate in future markets.
- Consumers need low-cost inertia, and this need will increase in the future as more renewable generation is added to the network.

The scope was designed to address these needs.

Why your understanding of User Needs has been improved as a result of the Project

The project has reduced some of the key barriers preventing OWF developers installing these new technologies, which in turn will enable OWFs to provide necessary inertia to the onshore grid, and therefore widen the pool of potential inertia suppliers to NESO. In particular, a key user need addressed was the development of a workable regulatory model for OWF developers to install and operate INCENTIVE solutions.

However, additional needs were identified during the course of Beta Phase. As described in Section 7, the improved understanding of the '5 second rule' has improved user need understanding and impacted upon all parties. Developers, TOs and OEMs may need this to be clarified or relaxed before some of these technologies become truly attractive. In addition to this, the project has found that local system strength could potentially be more important for developers and TOs when looking to invest in these technologies, rather than just the inertia market value.

These are key new user needs, which can be addressed through the further work identified in D6.2.

How you have tested your own assumptions against the needs of your users

We have ensured that user needs have been at the heart of the project and have shaped the project scope and delivery. This can be seen through our continuous engagement with Ofgem, NESO, offshore wind farm developers and OEMs and our pursuit of cost-beneficial inertia provision for the GB energy user.

How the approach you are taking will minimise the burden on your future users and avoid duplication of effort through user journeys.

We have a large consortium that has been built intentionally to avoid duplication of effort. To build alignment across the industry on the user needs and the solutions to those needs.

Section 9 -	Beta Phase – Impacts and Benefits

Describe your expected net benefits to consumers and justify any changes in proposed impacts since the Application stage.

You may want to describe:
How the Project has progressed towards the benefits outlined in your Beta application and any changes to proposed impacts that were outlined in the Beta Application and why these were necessary.

Progress towards benefits in application:

Benefit identified in application	Beta Phase progress
Improved access to/ creation of new revenues for users of network services	INCENTIVE Beta Phase has significantly de-risked the investment case of novel technologies in nascent inertia markets, therefore making progress towards creating new cost-beneficial market offerings. A key part of this is developing a workable regulatory model to enable offshore wind developer ownership of INCENTIVE solutions.
Cost reductions in operating the networks and wider energy system	INCENTIVE Beta Phase has conducted further CBA, with more detailed data inputs to assess the benefits of INCENTIVE solutions. The results show that INCENTIVE solutions can provide inertia and lower cost, and hence reduce the cost of system operation.
Cost savings for users of network services and Cost savings to consumers	Beta Phase has showed that the deployment of INCENTIVE solutions could reduce the cost of system operation in future, by relying on OWFs to provide inertia rather than stand-alone bespoke assets. This system operation reduction cost can lead onto cost savings for consumers. However, INCENTIVE has found that there is some uncertainty whether INCENTIVE solutions will reduce costs for network users, such as OWF developers. Particularly for the first movers, it is possible that INCENTIVE solutions may increase costs. At a time when future revenues for INCENTIVE solutions are unclear, due to nascent markets and evolving grid code requirements, it is unclear if OWF developers will be able to recover these increased costs. This presents a barrier to deployment. This barrier can be addressed by the further work proposed in D6.2.
Carbon reduction direct or indirect	INCENTIVE Beta Phase has made progress in bringing INCENTIVE solutions to market. It has also shown that, if INCENTIVE solutions can make it to market, they can more cheaply and efficiently support system stability directly from OWFs, thereby enabling further roll out of renewables by maintaining lower carbon system inertia at safe levels at lower cost.

New to market products, processes and services	The derisking of novel technologies both as products through OEM model verification, and also for use in the inertia market for service provision, has accelerated bringing new technologies to BAU and using these to provide ancillary services. The regulatory model devised in Beta Phase is also key to unlocking the deployment of these new products.
UK remains global leader in offshore wind development and integration – Export opportunities	The INCENTIVE Beta Phase project has been a world-leading initiative, investigating inertia provision from offshore wind. INCENTIVE has engaged with stakeholders in a wide variety of countries, and international OWF developers and OEMs are involved in the project and are looking to UK partners (SSEN-T, NHVDCC, ESO, Strathclyde, Carbon Trust and Frazer-Nash) for insights into these novel technologies.

Any developments or events which may affect the benefits gained from the Project and any additional impacts and benefits achieved over and above that predicted at the start of the Project. If the Project discovered significant problems with the approach and technique being trialled.

As mentioned in Section 7, the INCENTIVE Beta Phase has uncovered an additional barrier to BAU deployment of the grid forming STATCOM with supercapacitors namely the '5 second rule' which is based on the capability to deliver inertia (or Active ROCOF Response Power) for 5 seconds. Without change to the market design in relation to this, the business case for the INCENTIVE STATCOM may be reduced. This is one of the key aspects to be addressed in further work, as set out in D6.2.

Should give an estimate of the future value to customers of the approach trialled.

System stability services are critical to supporting increasing volumes of non-synchronous renewable generation. The current provision is through redispatch of synchronous generation, which carries significant financial and environmental costs, and the development of new, standalone assets procured through Stability Pathfinder (SP). Published figures suggest that the £1.3bn contract cost from SP3 could deliver benefits of £14.9bn between 2025 and 2035.

INCENTIVE solutions have the potential to deliver benefits over and above those achievable through SP by developing generation and network assets with in-built stability provision. Benefits include:

- Introducing design alterations to requisite/planned assets to enhance stability service provision for only marginal cost increases.
- Capturing co-development cost savings, e.g. in shared network, access, and planning considerations
- Potential acceleration in connection of renewable assets by proactively addressing stability at the outset.
- Creating a more liquid market for stability services, potentially driving down market prices in the long-term.

The CBA in Beta Phase is based on a 250MVA STATCOM, consistent with a 750MW offshore windfarm. The counterfactual is the cost of procuring similar levels of stability services via a SP tender. The benefits are the system-wide savings that would accrue to both the network

operator and asset owner, with apportionment between these parties dependent on the nature and liquidity of future stability markets.

Section 10 -	Beta Phase – Risks, issues, and constraints

Provide a summary outlining the risks and issues the Project is encountering, including impact, and mitigating actions to address these challenges.

You should describe:

- **any actual or potential constraints in regulation, legislation, commercial contracts, or legacy technology that has/will hinder your ability to implement the findings of this into Business as Usual or delayed progress to roll out which could be relevant to future Projects**
- **the actions taken by the Funding Party to facilitate the removal of any barriers encountered.**
- **how you have adapted the Project outcomes to meet user needs while operating within these constraints.**
- **if you have identified constraints that can be removed in the short or long term, describe how these can be overcome based on the learnings from this project.**

A Risk Register has existed since Discovery Phase of the INCENTIVE project and has been provided to UKRI. This risk register manages, rates, and reviews all identified risks and assumptions, the most notable of which are discussed below.

Key Risks:

1. The risk that INCENTIVE Beta Phase does not deliver a workable business model for an offshore wind farm developer or a transmission owner to own and operate INCENTIVE solutions.
   Mitigation: A workable regulatory model has been defined, with input from NESO and Ofgem. However, it is the stability market (the fact it is nascent and asks for a 5 second duration requirement) that may mean the INCENTIVE STATCOM has a reduced business case. Innovation funding may be required for first mover of this technology. The nascent nature of the market also may inhibit INCENTIVE BESS. To address these residual risks, there is a wide range of further work, which has been specified in D6.2.
2. Risk that Beta Phase finds that market and regulatory changes are required for a workable business model, and these are not agreed by Ofgem and NESO, meaning the business case falls through.
   Mitigation: Continuous engagement with Ofgem and NESO has been achieved. It is likely market changes are required to enable INCENTIVE solutions to participate effectively. It is highly likely regulatory derogations are needed to enable INCENTIVE solutions. Whilst a regulatory model has been devised, it will require a first-mover project / demonstration to apply the regulatory model for the regulatory model to be finally approved. To address these residual risks, there is a wide range of further work, which has been specified in D6.2.
3. Risk that INCENTIVE Beta Phase knowledge not well managed and disseminated, following negative FID for Next Phase. There is a strong need to ensure the work done has legacy. This means the work done must be left in a state such that a third party can pick it up without the support of the INCENTIVE project.
   Mitigation: Additional work package, WP6, was proposed by the INCENTIVE team and agreed upon by UKRI to address this risk. This has been funded through reassigning contingency to this work package, and dissemination and supporting deliverables created to ensure the knowledge gained throughout the project has been managed.

Section 11 -	Beta Phase - Working in the open

How did are you ensuring transparency and stakeholder engagement during the Beta phase?

You should describe:

The methods you are using to communicate publicly about the project.

In INCENTIVE Beta Phase we have developed and executed a dissemination strategy, including public dissemination through a public webinar which will take place at the end of the project and through submitting papers to the IET ACDC Global 2025 conference. The IET ACDC Global conference is an ideal place to present the INCENTIVE project to potential UK stakeholders due to its focus on the latest advancements and technologies in both AC and DC power transmission.

How the Funding Party and Project Partners collaborate with stakeholders to promote and refine the project. The ways in which you invited challenges and external input on your project approach.

The INCENTIVE Beta Phase project has continuously sought project partner input, through regular meetings with all parties involved in the project, and additional meetings with external stakeholders such as NESO, Ofgem, DESNZ, OFTOs, and other TOs (NGET and SPT).

Engagement with consortium members included:

- Three biweekly calls with three OWF developer “Project Champions” who have offered their offshore wind development projects as case studies to the project
- Regular bilateral meetings with all key OEMs
- Quarterly large consortium meetings, where we bridged the gap between this innovation project and the TO community, the OWF developer community (with 11 OWF developers present) and the OEM community (with 5 OEMs present)
- Weekly delivery group meetings to coordinate between all work packages.

How you shared your learnings to avoid duplication of efforts and to accelerate industry progress on related initiative/ Sharing learnings to avoid duplication of efforts and to accelerate industry progress on related initiatives.

The INCENTIVE project has engaged its large industry stakeholder group in order to transparently share learnings. Currently, no additional research projects are investigating these technologies in the UK. The project has made efforts to engage with German TOs to more fully understand projects in Germany looking at similar technologies. See D6.2 for more information on the potential for additional knowledge sharing between INCENTIVE and the German TSOs.

Throughout the project we have also been in contact with other transmission companies in the UK, namely NGET and SPT, to ensure we are not duplicating work and to disseminate learning. The majority of the European offshore wind industry is also present through the 11 developers and 5 OEMs in the INCENTIVE consortium.

Dissemination and collaborative working are at the heart of the INCENTIVE project, which is reflected in its large and broad project consortium. The INCENTIVE project has engaged with 5 OEMs, 11 offshore wind developers, 3 UK TSOs, NESO, Ofgem, and German TSOs to involve all stakeholders in discussions on bringing these technologies into BAU. This engagement ensures effective knowledge sharing, industry upskilling for technology adoption, elimination of redundant efforts, and comprehensive dissemination of project outcomes through the quarterly consortium meetings.

How your team has been working openly and building relationships with organisations and teams responsible for other parts of the user journey, such as infrastructure/data owners, regulators, policymakers, investors, and others.

Throughout the INCENTIVE Beta Phase, we have worked with DESNZ and Ofgem in order to discuss asset ownership and operation models which could exist within current regulations and what adjustments might be required to bring these technologies to market.

Any insights gained from stakeholder engagement that could be relevant for future projects.

We have understood that GB TOs also see a strong value in a physical demonstration of these technologies at onshore locations within their networks, and not just adjacent to offshore wind farms.
German TSOs are due to install a world first STATCOM with grid forming control and energy storage in 2025. There would be benefit from an exchange of information between INCENTIVE, the GB transmission industry, the global offshore wind industry and these German TSOs. See D6.2 for more details on this.

Section 12 -	Beta Phase – Costs and value for money

Provide a detailed account of how the Project funds are being spent, referencing the original forecasted budget.

You should describe:

- **how the project has delivered value for money to consumers.**
- **reasons for any significant variations between the planned and actual spend.**
- **any unspent SIF funding that may be returned to consumers.**
- **any additional funding or contributions beyond those outlined in the Project Direction, noting that these will be considered Disallowed Expenditure.**
- **Any revenues earned related to the Project that will be returned to consumers.**

Include the summary table below with the final project expenditure by each Project Partner.

The budget of this project is managed through budget trackers held by SSEN-T on a joint SharePoint.

The project has demonstrated value for money by delivering its intended work plan and outputs in line with the originally planned budget.

The table below shows spend until end of October 2024.

Project Partner name	SIF funding requested	Total actual project spend	Total project contribution made
SCOTTISH HYDRO ELECTRIC TRANSMISSION PLC	£521,678	£482,641	£0
NATIONAL GRID ELECTRICITY SYSTEM OPERATOR	£37,902	£42,566	£4,664
UNIVERSITY OF STRATHCLYDE	£217,083	£228,508	£11,425
CARBON TRUST	£145,670	£330,670	£185,000

Section 13 -	Beta Phase – Special Conditions

Describe how you have met any requirements of any project specific conditions set out in the Project Direction.

Project Specific Conditions (PSCs) have been met by the following:

PSC1	The Funding Party must not spend any SIF Funding until contracts are signed with the Project Partners named in Table 1 for the purpose of completing the Project.	All contracts signed and no spend was created before this point – Complete
PSC2	The Funding Party must report on the financial contributions made to the Project as set out in its application. Any financial contributions made over and above that stated in its application should also be reported and included within the Project costs template.	Financial reporting – Complete
PSC3	The Funding Party must participate in all meetings related to the Project that they are invited to by Ofgem, UKRI and DESNZ during and after the Beta Phase.	Project has attended all meetings it has been invited to, to date – Complete
PSC4	The Funding Party must, with support from Innovate UK/UKRI and, where applicable Ofgem, scope the requirements and success criteria for each stage gate within a Project at the quarterly reporting meetings ahead of any stage gate. These will be used to determine what criteria a Project must meet in order to pass a stage gate, and whether any additional information, such as a report, must be produced as part of the stage gate.	No stage gates in project – Complete
PSC5	Each of the annual progress reports that the Funding Party publishes in the Beta Phase must, at a minimum, be uploaded to the ENA's Smarter Networks Portal. We also strongly encourage wider dissemination of the annual progress report(s) and support from all Project Partners in ensuring it reaches a wide audience.	One annual report required – Complete
PSC6	As part of the end of Project Phase report, the Funding Party must produce a Project Impact Monitoring and Evaluation Plan. This plan must outline how the Project plans to monitor and evaluate the delivery of benefits outlined in the Beta Phase Application following the end of the Beta Phase. The plan must also include the methodology that will be utilised for quantifying and qualifying benefits realisation and how the Funding Party plans to report this to Ofgem 1, 3, 5 & 10 years post-Beta Phase completion. Further details on how to approach the development of this plan may be provided by Ofgem or IUK.	As Incentive is not continuing beyond Beta Phase 1, a standalone Impact Monitoring and Evaluation Plan has not been produced. The Incentive Beta Phase 1 work has yielded valuable insights which may benefit future projects. SSEN-T will report any benefits identified as related to the project's Beta phase 1 outputs through the Innovation Measurements Framework (IMF). These

		updates will be provided 1, 3, 5, and 10 years after the close out of Beta Phase 1 as per the requirements of Condition 6.
PSC7	The Funding Party and all Project Partners must make reasonable attempts to attend, participate and/or contribute at SIF Community Forum events occurring during the Project delivery. We anticipate there being approximately one event per year.	The project attended the community forum, no other events are planned before project completion - Complete
PSC8	The Funding Party must provide verbal updates at each quarterly meeting on any regulatory, policy and standards barriers and any change requirements which may impact delivery of the Beta Phase activities. The Funding Party must also include as an attachment to each of its annual progress report an update on any regulatory, policy and standards barriers which may require derogations and articulation of any proposed regulatory, policy and standards changes which would be necessary in deployment. The Funding Party must also provide an as an attachment to its end of Project Phase report a summary of the Project's findings on regulatory, policy and standards barriers, including any considerations for future work, and where applicable, where specific regulatory, policy and standards changes would be required for deployment.	Verbal updates provided at each QRM – Complete Summary of project findings – Complete
PSC9	The Funding Party must provide within the first three months of the Project beginning (i.e. by 1 October 2023) an updated 60-second video. If the Project is greater than two years (longer than 24 months) in length, an updated video must also be provided at the Project's mid-point meeting. All Projects must also provide an updated 60-second video as part of their end of Project phase report. Innovate UK can share its guidance for 60-second videos with the Funding Party, if necessary.	Video updated and provided – Complete
PSC10	The Funding Party must provide an update on consumer engagement plans at every second monitoring meeting (i.e. every six months). This must include an update on any activities which involve engagement and interaction with energy consumers, and any impact the Project may have on existing or future energy consumers and their premises.	All updates given - Complete

PSC11	The Funding Party must provide to the monitoring officer within six months of the Project beginning (i.e. by 1 January 2024) a roadmap for activities post-Beta Phase. This can build on the Project's Application question (question 11) and must focus on how and when the proposed solution will become business as usual within your network and across the other GB gas or electricity networks. As part of this, the Funding Party must include consideration for: I. any steps the Project will take to ensure its innovation has suitable business as usual adoption. II. the Funding Party's strategy for adoption of the innovation or proposed solution, giving consideration to potential investment, ongoing costs and third-party involvement and; III. any early indication of interest from other networks in adopting the innovation. The Funding Party must provide an update on all the above at every two quarterly monitoring meetings (i.e. every six months) and must include a final update of this roadmap as attachment to its end of Project Phase report.	This was moved to the end of phase report, please find in appendices below - Complete
PSC12	The Funding Party must provide at every second quarterly monitoring meeting (i.e. every six months) an update on its commercialisation strategy. This can build on the Project's Application question (question 12) and must focus on what considerations have the Project consortium made for the commercialisation of the proposed solution or innovation, and how the Project provides support for non-network partners to move towards commercialisation. As part of this, the Funding Party may wish to include consideration for: I. who the primary customer segment is beyond the Funding Party; the customer value proposition; II. if identified, the outline of the route to market and potential new partnerships; III. any additional Project Partner capital requirements in order to commercialize the innovation and; IV. how this product, process or service could be scaled across the GB network and taken to new markets. The Funding Party must also include a final update of its strategy as an attachment to its end of Project Phase report. Ofgem and/or Innovate UK may issue a template for the final update as part of the end of Project Phase report.	Updates all provided at QRMs. Refer to Section 6. Complete

PSC13	Within the first six months of the Project formally beginning work on the Project, the Funding Party must provide a list of key criteria to the Project's monitoring officer that the offshore wind farm "champions" targeted by the Project would want to see developed from the Project in order for them to commit to hosting and co-funding a future demonstration.	Provided - Complete
PSC14	The Funding Party must, by end of the Project, develop insights around potential interactions between the proposed installations and the wind farms and any implications for the provision of system services. The Funding Party must provide these insights as part of or as an attachment to its end of Project Phase report and must publish these insights on the ENA's Smarter Networks Portal.	Attached to this document - Complete
PSC15	It is essential that the viability or otherwise of regulatory changes and the business models being developed is clear by the end of this Project. The Funding Party must therefore develop an on-going Project engagement strategy with key stakeholders within code bodies, standard institutions, Ofgem and DESNZ with support from Innovate UK and must submit this to the monitoring officer ahead of the Project formally beginning Projects works.	This has been included in the regulatory deliverable, 2.5 ongoing stakeholder engagement has been sought – Complete
PSC16	The Funding Party must include as an attachment to its first annual progress report a report which builds on the Project's regulatory review in Alpha which considers the assessment of the regulatory and code changes that may be required to align with the Project's emerging preferred technical and commercial delivery model. The report must include a plan for securing sectoral support for these changes, identifying the requisite stakeholders and code change groups to influence, and where possible any insights that have been received from Ofgem and code bodies. The Funding Party must also provide an updated version of this report as part of or as an attachment to its end of phase report.	Attached to this document Complete
PSC17	The Funding Party must submit at its second quarterly monitoring meeting (i.e. quarter one) a summary report to the Project's monitoring officer outlining if and how INCENTIVE solutions that are deployed outside wind farms on other parts of the network could benefit from upgrades to provide inertia services. In this report, it must also highlight particular assets and related	Provided - Complete

	stakeholders who would benefit from the learnings emerging from the INCENTIVE Project.	

Section 14 -	**Beta Phase – Material Changes**
Provide a summary of any material changes submitted which has occurred in the relevant reporting period. It should describe why the planned approach proved to be inappropriate and how the alternative approach improved the original approach. No material changes have been submitted.	

Appendices

Appendix 1: Project Specific conditions to be met in end-of-phase report

PSC 8 - *The Funding Party must also provide an as an attachment to its end of Project Phase report a summary of the Project's findings on regulatory, policy and standards barriers, including any considerations for future work, and where applicable, where specific regulatory, policy and standards changes would be required for deployment.*

STATCOMs are typically owned and operated by OFTOs to meet their statutory (STC) requirements for reactive power compensation. Upgrading the asset to provide stability services poses multiple challenges:

- The OFTO regime's cost assessment process does not allow developers to recover the costs of INCENTIVE STATCOM augmentation through divestment to the OFTO. This is due to the asset providing services to the onshore system, above and beyond what is required to facilitate transfer of power from the wind farm to onshore system.
- The licencing arrangements for transmission owners prohibit OFTOs from participating in energy markets, including the NESO Stability Market, which is currently the only means of procuring inertia outside of dispatching assets in the British Market.

The above, means that without significant change to how stability is procured in GB (e.g. making provision of inertia a requirement of the STC) the INCENTIVE STATCOM should be operated by the windfarm generator. To make this work, the following is required:

- If a generator retains ownership of the STATCOM, the OFTO's STC requirements for dynamic reactive compensation at the Transmission Interface Point (TIP) should be replaced by identical generator Grid Code (GC) obligations. This will reduce the need for a complex commercial agreement between the wind farm generator and OFTO, along with providing wind farm developers with an incentive (ORPS payments) to include INCENTIVE STATCOMs in their wind farm designs.
- The removal of OFTO STC requirements (after consultation) can be achieved via condition E13, point 4 in the Electricity Transmission Standard Licence Conditions. The addition of responsibilities on generators for the provision of reactive compensation can be achieved via amendments to Transmission Owner Construction Agreement (TOCA) documents, which form part of the wind farm's bilateral connection agreement.
- Once the above derogation has been granted, Ofgem would take a "minded-to" position to grant an STC derogation to the future OFTO. In the Ofgem-led OFTO tendering process, Ofgem would make it clear to any prospective OFTO what would be divested to the OFTO, what would be retained by the generator and what responsibilities would fall on the OFTO versus the generator. This would ensure any bidder could make an informed decision, based on the information made available to all bidders at the start of the process.

As OFTO licence conditions prohibit OFTOs from participating in electricity markets, the only viable owner for INCENTIVE BESS assets are Generation Licence holders. As BESS are not typically used by OFTO to meet their STC reactive compensation requirements, and are therefore not divested to the OFTO, there are no issues with the standard business model (ownership and operation by the windfarm developer). If the BESS, or any other asset, was installed by the developer with the intention that it serve as the OFTOs principal reactive compensation device, then the business model developed for the INCENTIVE STATCOM would apply.

PSC11 *The Funding Party must provide to the monitoring officer within six months of the Project beginning (i.e. by 1 January 2024) a roadmap for activities post-Beta Phase. This can build on the Project's Application question (question 11) and must focus on how and when the proposed solution will become business as usual within your network and across the other GB gas or electricity networks. As part of this, the Funding Party must include consideration for:*
I. any steps the Project will take to ensure its innovation has suitable business as usual adoption.
II. the Funding Party's strategy for adoption of the innovation or proposed solution, giving consideration to potential investment, ongoing costs and third-party involvement and.
III. any early indication of interest from other networks in adopting the innovation.
The Funding Party must provide an update on all the above at every two quarterly monitoring meetings (i.e. every six months) and must include a final update of this roadmap as attachment to its end of Project Phase report.

The roadmap for activities post-Beta phase is discussed extensively within D6.2, which describes the additional work required in order to bring these technologies to BAU, and which is uploaded to compliment this End of Phase Report.

However, for completeness please also consider the below:

I. any steps the Project will take to ensure its innovation has suitable business as usual adoption.

D6.2 denotes the necessary steps and further work to bring these technologies to BAU.
This specifically falls into the following 11 areas:

1. Information exchange with German TSOs
2. Improved inertia provision from combination of OWF + INCENTIVE solution
3. Strengthening weak grid connections for OWFs using INCENTIVE solutions
4. Input into new GB grid forming working group
5. Evolving the understanding and definition of inertia in GB
6. Evolving the understanding and definition of strength to connect in GB
7. OWF developer ownership regulatory model
8. TO ownership regulatory model
9. First-of-a-kind deployment of a Grid forming (GFM) STATCOM with supercapacitor storage in GB
10. Guidance for OWF developers
11. Guidance for GB onshore TOs

D6.2 describes the need, aims, scope outputs, costs and duration expected for each of these areas required to bring these technologies to BAU.

II. the Funding Party's strategy for adoption of the innovation or proposed solution, giving consideration to potential investment, ongoing costs and third-party involvement

It should be noted that as a Beta Phase 2 of the INCENTIVE project has not been progressed, no adoption of the proposed technologies will be possible within the UK without a combination of the necessary further work mentioned in I. above.

III. any early indication of interest from other networks in adopting the innovation.
The Funding Party must provide an update on all the above at every two quarterly monitoring meetings (i.e. every six months) and must include a final update of this roadmap as attachment to its end of Project Phase report

All UK transmission networks have been engaged during the Beta Phase of INCENTIVE, through attending meetings and update calls. They will also be invited to the closing public webinar. Further, the outputs of INCENTIVE Beta Phase are highly relevant to the SIF Round 2 Beta Phase

project “BLADE”, which is devising feasible onshore system restoration methodologies using OWFs. There is significant overlap in the consortia of INCENTIVE and BLADE and so the outputs of INCENTIVE will be used in the BLADE project.

PSC 14 *The Funding Party must, by end of the Project, develop insights around potential interactions between the proposed installations and the wind farms and any implications for the provision of system services. The Funding Party must provide these insights as part of or as an attachment to its end of Project Phase report and must publish these insights on the ENA's Smarter Networks Portal.*

Please refer to the attached report titled 'Summary of Small Signal Method Used in INCENTIVE for Interactions Study'. This report will also be published on the ENA's Smarter Networks Portal.

Summary of Small Signal Method Used i

PSC 16 *The Funding Party must include as an attachment to its first annual progress report a report which builds on the Project's regulatory review in Alpha which considers the assessment of the regulatory and code changes that may be required to align with the Project's emerging preferred technical and commercial delivery model. The report must include a plan for securing sectoral support for these changes, identifying the requisite stakeholders and code change groups to influence, and where possible any insights that have been received from Ofgem and code bodies. The Funding Party must also provide an updated version of this report as part of or as an attachment to its end of phase report.*

For an assessment of the regulatory and code changes that may be required to align with the Project's emerging preferred technical and commercial delivery model, please refer to D2.5 or the response to PSC8.

Ofgem:

Ofgem's innovation, licensing and OFTO teams have been engaged in weekly meetings and workshops throughout the beta phase of the INCENTIVE project and have conducted multiple reviews of deliverables.

Statement from Ofgem:

> *"We welcome this detailed report that forms part of the findings of INCENTIVE Beta Stage 1. INCENTIVE has the potential to unlock new sources of inertia, contributing to greater system resilience as well as reducing electricity consumer bills.*
>
> *The INCENTIVE team has made significant headway in understanding how existing regulation applies, and whether and how it would need to change to accommodate this innovative project. We note that any specific development will be subject to regulatory approval and will be evaluated on a case-by-case basis. Ofgem's Innovation Hub is available to support any company looking to explore the INCENTIVE business models further."*
>
> *Ofgem have also included a "process blueprint" for developers looking to implement the INCENTIVE STATCOM business model, which can be found in appendix 3 of D2.5.*

DESNZ:

DESNZ' OFTO policy team was engaged in weekly meetings and workshops throughout the beta phase of the INCENTIVE project. INCENTIVE responded to DESNZ' call for evidence on the OFTO regime, highlighting the barriers it provides to innovation on OFTO networks, including the INCENTIVE STATCOM.