

SIF Discovery Close Down Report Document

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Jan 2023

Project Reference Number

10024879

Project Progress

Project Title

INCENTIVE - Innovative Control and Energy Storage for Ancillary Services in Offshore Wind

Project Reference Number

10024879

Lead Funding Licensee

SSEN - Scottish Hydro Electric Transmission

Funding Licensee(s)

SSEN-T - Scottish and Southern Electricity Networks
Transmission

Project Start Date

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Project Duration

2

Nominated Project Contact(s)

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Project Summary

Scope

INCENTIVE will:

- address the current and future needs for energy provision - Non-synchronous generation is already causing stability issues, and these issues will become more acute in the future. This project will alleviate these issues. INCENTIVE is particularly relevant for power provision but, as heat and transport come to rely more heavily on power, it will also have relevance to those sectors.
- address future policy, regulatory conditions and market designs - As identified in the BAT-STAT project, these are key barriers for commercial deployment of the innovative technology and novel approaches will be identified, agreed and tested in the project.
- provide a novel approach to infrastructure investment - INCENTIVE will help to maximise the efficiency in large-scale network upgrades by providing a new alternative to business as usual investments. This will be achieved by creating a commercial framework such that private investors are able to invest in the INCENTIVE solutions, and hence improve network resilience and reliability. Further, with its wide range of partners, the project will be able to inform strategic plans for coordinating the location of assets to deliver the most efficient capital investment.

Partners

The BAT-STAT project identified that in order to make the proposed innovative technology a reality, technical, regulatory, commercial and market innovation is required to happen simultaneously. INCENTIVE therefore necessarily entails cooperation between network companies, generators and technical experts. The partnership brings together leading organisations SSEN-T, National Grid ESO, Strathclyde University, and Carbon Trust (representing the nine OWA developers), supported by Fraser-Nash Consultancy, to deliver this coordinated innovation. Through collaboration, the project aims to coordinate the introduction of a novel disruptive technology and to create simple regulatory, commercial and market frameworks for offshore wind to provide stability services, to the benefit of the

whole system and all stakeholders in the energy system. The key outputs of the Discovery phase will be business case justifications, regulatory models and commercial models for INCENTIVE solutions, and a technical scope of work for the Alpha and Beta phases. For partner and sub-contractor details see Appendix Q3-2.

Users

The INCENTIVE solutions will apply to: network owners will use the solutions to facilitate stable connection of offshore wind farms to their networks; System Operators will use the solutions to provide stability services to the onshore grid; and generators (offshore wind farms) will use the assets to reduce curtailment and increase renewable power export to the grid.

Problem Being Solved

INCENTIVE sits within the Whole System SIF Challenge Area. The problem is how to integrate increasing offshore wind capacity onto the GB network, while maintaining system stability and providing value for consumers. The GB electrical system is undergoing a radical change away from synchronous fossil fuel generation towards non-synchronous renewable generation driven by rapid cost reductions of renewables and climate policy targets (UK government target of 40GW of offshore wind by 2030, and only net-zero electrical generation by 2035). Therefore, offshore wind is now attractive economically and environmentally.

Introducing the ever-increasing capacity of offshore wind does not come without problems as exemplified by the GB power blackout in August 2019 that affected 900,000 people, with the lack of system support/inertia from renewables to stabilise the system a feature of the event. Introducing measures that can be readily incorporated into an offshore wind energy project's grid connection that can enhance system stability would be highly beneficial. Without innovation, the rapid roll-out of non-synchronous generation will lead to grid balancing and grid stability challenges at the onshore connection points and in the onshore networks beyond. Without new solutions, the GB grid will become weaker in the coming years, ultimately leading to issues in system operation. These issues will include: increasing the likelihood of severe instability events; increasing the need for imported electricity; and maintaining reliance on synchronous fossil fuel generators on stand-by (which is already proving costly for the System Operator). All of these negative effects will lead to price increases for GB energy consumers and will slow down the energy transition, with adverse impact to the environment.

The opportunity - Through preliminary work ("BAT-STAT" project) conducted within the Offshore Wind Accelerator developer-led R&D programme, an opportunity has been identified to enable offshore wind farms to play a role in stabilising the GB network through the use of innovative technologies that provide voltage, current and frequency control services to the grid. For GB network companies and generators to take this opportunity, simultaneous technical, regulatory, commercial and market innovation will be required. To realise these innovations, collaboration across a wide range of stakeholders is necessary.

INCENTIVE aims to seize this opportunity by studying and demonstrating how these innovative technologies can allow offshore wind farms to provide stability services to the grid. The ultimate aim is to maintain the fast-paced roll-out of offshore wind in GB whilst reducing end consumer cost.

Summary Key Findings

INCENTIVE builds on an Offshore Wind Accelerator (OWA) project ("BAT-STAT"), which discovered that technology solutions ("INCENTIVE technologies") exist that can allow offshore wind farms (OWFs) to provide stability services to the grid; however, barriers existed in markets, technology, and regulation to allow deployment into the UK system.

The Discovery Phase has evolved our understanding of the problem and opportunity of integrating these technologies. Regarding key tasks and findings:

- Cost-benefit analysis (CBA) was conducted, which found positive Net Present Value (NPV) compared to the counterfactual for all INCENTIVE technologies, indicating value to the consumer. However, some uncertainty remains in the data used, the results, and how NPV varies depending on ownership model. Further refinement of CBA is therefore required to gain commercial confidence.
- Regulatory analysis was conducted, finding feasible ownership models for INCENTIVE technologies. However, there are complexities and uncertainties which need to be addressed. Currently, it is unclear for each INCENTIVE technology who will be the most appropriate owner to receive revenues from providing services. Further work is required to evaluate who is most appropriate to own INCENTIVE solutions, and hence build commercial confidence.
- Technical analysis was conducted, finding a range of INCENTIVE technology solutions, which is wider than the range found in BAT-STAT, are being developed (or have recently been developed) by a range of suppliers. However, their feasibility and impact on the network still needs to be tested. We have determined simulation and demonstration requirements to test INCENTIVE technologies, with a view of de-risking their performance, and hence increasing commercial confidence.

The findings show promise for INCENTIVE solutions, but significant risks remain in developing a pathway to the commercialisation of

INCENTIVE technologies. In order to bring the technologies to market, there is need to continue with network innovation in Alpha Phase.

Regarding the aims of the competition scope, the Discovery Phase has provided:

- Improved coordination between networks, generators, suppliers, policy makers and regulators, by collaboratively investigating INCENTIVE technologies, with a view of developing them a path to commercialisation. The large consortium (including nine OWF developers and the networks) and the wide range of INCENTIVE technologies considered has reduced the need for duplication of this work. Technology testing requirements have been developed that will reduce excessive variation in the INCENTIVE technologies' capabilities.
- Complexity, bureaucracy, and barriers to entry for the INCENTIVE technologies has been reduced by studying their value to the consumer, relevant regulation and technical capabilities.

User needs

INCENTIVE technologies user needs:

- The consumer has the need for a decarbonised electricity system, at low cost, whilst maintaining stability and reliability.
- The system operator (ESO) needs to use INCENTIVE technologies to procure stability services from OWFs, to reduce its reliance on gas turbines, which emit carbon and are becoming increasingly expensive for the provision of stability services.
- Network owners need INCENTIVE solutions to strengthen their networks at low cost, and hence avoid costly network upgrades.
- The owners of INCENTIVE technologies also have needs – they must have a commercial rationale for investing in and owning the assets.

When scoping Discovery Phase, these needs were translated into requirements for the INCENTIVE technologies. They must provide value to the consumer, ESO, network owner and INCENTIVE technology asset owner. They must also function adequately to reduce the reliance on traditional gas turbines, to accelerate the low-cost roll-out of OWFs.

INCENTIVE Discovery Phase was scoped to address these requirements, with a focus on enabling INCENTIVE technologies to be brought to market. To do so, we focused on three main workstreams: business case development, ownership analysis, and technology performance.

We were confident the scope developed was appropriate due to the large consortium of nine OWF developers, one network owner, ESO and one university. All had different views on user needs and technology requirements, and so a comprehensive scope was developed. The work conducted in Discovery Phase proved the scope to be appropriate. We conducted extensive literature reviews and engaged with numerous stakeholders in regulation, policy and technology development (INCENTIVE technology suppliers). During these engagements, the stakeholders were supportive of the project and its aims, and no other major avenues of investigation were highlighted as necessary, indicating the scope had been correctly devised from the user perspective.

To avoid duplication, we have considered a wide range of possible INCENTIVE technologies, rather than focusing on any one specific technology. This has allowed the results of Discovery Phase to be widely applicable, and means the work need not be repeated.

To improve the user journey for INCENTIVE technologies, further work is required. The three workstreams have all uncovered risks to be addressed in Alpha Phase of INCENTIVE. Without this further work, we will not know if INCENTIVE technologies meet the requirements mentioned above, and hence if they address user needs. User needs will be at the forefront of the Alpha Phase scope.

Impacts and benefits

Discovery Phase conducted CBA which demonstrated that there is a positive case for each INCENTIVE technology from the perspective of the GB consumer. A summary of the results for four possible INCENTIVE technologies is set out below.

[BESS – Battery energy storage system

MMC – modular multi-level converter

HVDC – high voltage direct current

CCGT – combined cycle gas turbine]

The Discovery application highlighted that there are limited stability markets in which offshore wind can participate due to the uncertainty in the technologies required. The application stated that BAT-STAT already found that for two of the chosen technologies, there was a positive CBA. The work completed in Discovery Phase has corroborated this by conducting a CBA that shows the case for integrating INCENTIVE solutions into the network based on benefits to the consumer.

This shows a strong case for continuing to investigate how to commercialise INCENTIVE technologies in Alpha phase.

The Discovery Phase CBA work has found areas where the CBA should be refined in Alpha. Discovery found

- There is limited cost data available, which gives the CBA a degree of uncertainty. In Alpha, more comprehensive cost information (e.g. sourced from technology suppliers) will enable a more accurate CBA to reflect the most up-to-date conditions for INCENTIVE technologies.
- The CBA is impacted by sensitivities. In Alpha, more sensitivity analysis will also be performed to assess which parameters have the greatest uncertainty to the business case of INCENTIVE solutions.
- Market arrangements are likely to change in the future. In Alpha, improved predictions of future market arrangements, and benefits accrued, will be assessed.
- Whilst positive for the consumer, the CBA may differ from user-to-user. In Alpha, different perspectives will be taken in the CBA, for instance to ensure there is positive CBA not just for the consumer, but also for the asset owner or transmission owner, to ensure there is a comprehensive case for commercialisation.
- The CBA depends on specific technology capability to deliver services. For example, some INCENTIVE technologies can provide services outside of stability, which can benefit their overall CBA. More investigation is required in Alpha.
- There may be other non-carbon environmental impacts (positive and negative) of INCENTIVE technologies, which need to be considered.

Risks, Issues and Constraints

Discovery Phase has found no show-stopper constraints that prevent progress to Alpha. However, several constraints exist that require mitigation in Alpha.

- Commercial
 - o Markets for stability services are in their infancy, and many services are not procured through market-based mechanisms. In Alpha, widening the scope of the CBA to encompass other services will provide a challenge in terms of quantifying benefits. Effort will be focused on understanding the effects of price uncertainty and unpicking the benefits of reduced use of CCGTs will be critical to producing a robust assessment of the value of each technology. Inputs on predicted future market arrangements (e.g. from the ESO) will also be sought to ensure the CBA is sufficient to build commercial confidence in INCENTIVE technologies.
 - o There is potential need for data sharing between stakeholders. For instance, there may be integration requirements necessary between INCENTIVE technology controls and OWFs controls. The data exchange required for such integration could be commercially challenging. It is also unclear which parties are required to prove the compliance with the relevant codes.
- Regulatory
 - o The classification of assets as electricity storage or network infrastructure dramatically impacts the licensing regulations, market access method and remuneration they are subject to. This classification (in its current form) was not designed for the technologies being considered in this project, so their treatment is highly uncertain. Further investigation is required to in Alpha to look at the classification of the INCENTIVE technologies.
- Technical
 - o The simulation of INCENTIVE technologies requires models of INCENTIVE technologies, OWFs and the GB grid. Whilst testing using generic models is achievable and provides benefit, the INCENTIVE project (in Alpha or Beta) will benefit from using specific models of INCENTIVE technologies, OWFs and the GB grid. These need to be sourced from technology suppliers, OWF developers and the ESO. Due to the cutting-edge nature of the INCENTIVE technologies, technology suppliers will be very careful about sharing IP outside of their companies. Engagement to secure specific models for testing has commenced on this in Discovery Phase and will continue throughout Alpha. NDAs will be signed if needed to mitigate IP risks.

o As INCENTIVE technologies are novel, there is limited experience in undertaking testing of them in a simulated environment. There is also limited availability of facilities for undertaking these simulated tests. Further engagement is required to ensure buy-in of key stakeholders and capabilities of testing environments.

Working in the open

The project has worked in the open extensively to ensure that all stakeholder views and concerns are considered. This includes:

- Public kick-off webinar, to provide all stakeholders information on the high-level aims and goals of the project, and addressing and overlap between projects which may exist.
- Following this, to avoid duplication, Carbon Trust approached, and set up a call with, Scottish Power Transmission on a potentially related SIF project they are running – FastFlex. The purpose was to explore possible synergies between the projects, to ensure no double-working / overlap was happening, and to explore possible collaboration in the future. The outcomes of this call found that there are some synergies between each project; however, they do not erode each other. It was agreed that both projects would stay informed of each other's progress throughout Alpha and Beta. This agreement provides an opportunity to share outputs and learnings from INCENTIVE with another network and another SIF project.
- Carbon Trust and SSEN-T have begun building relationships with suppliers of INCENTIVE technologies. We have found that there is significant technology development work ongoing and strong interest in the INCENTIVE project. The supplier engagement was conducted through a questionnaire to suppliers that was posted publicly on SSEN-T's website. This was followed up by individual interviews with all suppliers who have shown interest in INCENTIVE. Strong INCENTIVE technology supplier engagement is pivotal to the project, and the levels of input we received in Discovery were excellent. INCENTIVE will continue to build and formalise relationships with suppliers throughout Alpha.
- Carbon Trust hosted a workshop with BEIS and Ofgem to determine the regulatory and policy barriers to the different potential ownership models. This engagement with the key decision makers was important in determining feasible options for ownership.
- The project delivery team consulted with National Grid ESO on their ongoing work; particularly, in their stability market review which aims to reform how the stability pathfinder operates and procures services.
- The project delivery team has had extensive engagement with the OWA developers, which has provided strong OWF developer input into the project. In addition, to ensure openness, the team engaged with EDF – a developer outside of the OWA programme.

Costs and value for money

Discovery Phase provided value for money.

The funds were spent in the delivery of the work as set out in the Discovery Project Plan, and as highlighted below in the final Project Finance spreadsheet. As can be seen from this report and the WP1, WP2, WP3 deliverables, the Discovery Phase has produced impressive level of insight for its budget and timescales. The learnings gained have exceeded the expectations of a "discovery" exercise – it has already gone on to identify initial findings that will assist the commercialisation of INCENTIVE solutions, including views on possible technology ownership models and technology capabilities.

All the work conducted has come in under budget, providing value for money to consumers. The planned budget was £136,001 and the scope expectations were met using just £120,022. Further, Carbon Trust provided £15k in cash to Discovery (from the privately funded Offshore Wind Accelerator programme).

The main way in which Discovery came in under budget was due to the underspend by SSEN (through the National HVDC Centre). This was because the BAT-STAT deliverables (which Carbon Trust and the OWA made available to INCENTIVE as background IP), greatly assisted National HVDC Centre in its understanding of the technical requirements for INCENTIVE solutions. Further, BAT-STAT had already had good levels of supplier engagement, which meant Carbon Trust could efficiently contact, and hence gain the views of, the relevant experts at the various INCENTIVE solution suppliers' companies. At the time of budgeting the Discovery Phase, National HVDC Centre was not able to see the BAT-STAT deliverables (they were released by Carbon Trust after signature of INCENTIVE's Collaboration Agreement shortly after kick-off). National HVDC Centre was therefore not able to know how much work would be saved by the use of the BAT-STAT deliverables in INCENTIVE when SSEN budgeted for the Discovery Phase. In essence, the provision of the BAT-STAT deliverables (which were 100% privately funded by the OWA programme) have provided great value for money to the consumer in the INCENTIVE project.

Special conditions

1. “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.”

Collaboration Agreement was signed by all Project Partners.

2. “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 has occurred to the monitoring officer in line with this condition.

3. “The Funding Party must participate in all meetings related to the Project that they are invited to by Ofgem, UKRI and BEIS during the Discovery Phase.”

Carbon Trust has engaged with BEIS and Ofgem, facilitated by UKRI. This ensured that: the current regulation was being fully considered in Discovery; Ofgem and BEIS knew the preliminary findings of Discovery; possible changes to regulation / policy that may impact INCENTIVE solutions were identified.

As part of Alpha, we will continue this engagement to ensure our findings are shared with Ofgem and BEIS to support relevant policy and regulatory initiatives.

4. “As part of its end of Project Phase report, the Funding Party must set out its views on whether the Project's proposed solutions differ significantly from the current mechanisms and services that the Electricity System Operator (ESO) currently operates.”

Most INCENTIVE solutions being investigated are not currently available to the market and are not currently being deployed on the GB network. Some INCENTIVE solutions are being deployed (BESS and synchronous condenser) in the ESO's Stability Pathfinder. However, the others are not yet being implemented due to their technical, commercial and regulatory uncertainty.

Where INCENTIVE solutions are already present on the GB network, these are still being included in the INCENTIVE study to ensure we are comparing all possible solutions that can allow OWFs to provide stability services. Our investigation goes further by considering controller interactions, and ownership structures of these solutions. Further, there may be technical and commercial issues about locating BESS and synchronous condensers at OWFs, which will require innovation. As such, we believe this goes beyond the current mechanisms and services that the ESO currently operates.

The ESO has provided input into Discovery and the Alpha scoping process. Their role will be clearly defined in the Alpha application.

Documents uploaded where applicable

Yes