

SIF Project Registration

Date of Submission

Mar 2022

Project Reference Number

10024879

Project Registration

Project Title

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

Project Reference Number

10024879

Project Licensee(s)

Scottish and Southern Electricity Networks Transmission

Project Start

March 2022

Project Duration

2 Months

Nominated Project Contact(s)

simon.stromberg@sse.com

Project Budget

£136,002.00

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 SSN-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.

Nominated Contact Email Address(es)

transmissioninnovation@sse.com

Problem Being Solved

NCENTIVE 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.

Project Approaches And Desired Outcomes

The Big Idea

The proposal is to investigate and demonstrate innovative solutions for voltage, current (fault level and inertia supporting) and frequency control coupled with a short-term energy storage at the onshore substation of existing or new offshore wind farms, with the aim of allowing offshore wind farms to stabilise the grid.

Relating to the aims of the competition scope, the project will:

- accelerate the decarbonisation of the electrical system, by allowing more rapid deployment of offshore wind;
- deliver benefit to consumers through reduced energy bills, by reducing the System Operator's reliance on increasingly expensive fossil fuel synchronous generators as standby capacity;
- improve coordination between networks and generators, by collaboratively developing optimal solutions between the project partners, SSN-T, NGESO and the OWA developers, and other related external stakeholders;
- reduce duplication, by producing a complimentary set of technical, regulatory, market and commercial solutions that can be applied throughout GB, and internationally;
- reduce complexity, by breaking down barriers to entry for the innovative technology in question through clear and simple commercial and regulatory models;
- improve coordination of emerging innovations, by ensuring that the commercial and regulatory models developed are technology agnostic (i.e. are applicable to more than one manufacturer's technical capabilities);
- understand consumers' preferences, by ensuring the innovative market solutions developed in the project properly reflect consumer priorities.

The BAT-STAT project has provided a preliminary review of this concept with a range of options. It has shown that some existing solutions exist (such as 2 or 3-level converter with battery in DC link or MMC STATCOM with ultracapacitor), but more technical innovation is required to develop the solutions (such as moving from grid following to grid forming control). It has also shown that – to make this concept a commercial reality – regulatory, commercial and market innovation is required. The scope of the Discovery Phase will be to review the barriers in more depth and to propose how to overcome them in the Alpha and Beta Phases.

Regarding IP, background IP from the previous studies in the OWA programme (including, but not limited to, BAT-STAT) will be provided to INCENTIVE. Foreground IP developed in INCENTIVE will be handled in accordance with the SIF governance document. Background and Foreground IP will be logged and tracked in an IP register.

Innovation Justification

The OWA commissioned the BAT-STAT study to investigate how offshore wind farms can stabilise the grid. BAT-STAT involved studying innovative devices capable of providing power, current and frequency control at onshore substations of offshore wind farms. The key objective was to produce a technology roadmap to encourage development of this technology. BAT-STAT's three priorities:

- A technology evaluation looked at available technologies and their ability to provide grid services under the guidance of the Network Option Assessment Stability Pathfinder project. This produced a variety of potential design options that are available in today's market. Further analysis was then conducted on these design options and their ability to meet key grid-services, see Figure 1 Appendix Q5. A final study was undertaken to show the advantages and disadvantages of different voltage control approaches ("grid following" vs "grid forming"), and their implication on grid-services.
- A cost-benefit analysis (CBA) was evaluated for a range of sites to develop an investment case for the implementation of technology. The CBA found that, there may be a positive Net Present Value in markets where stability services exist;
- Stakeholder requirements were investigated, and BAT-STAT found that various key stakeholders are required to come together to enable this technology. This includes System Operators, Transmission Owners, regulators, offshore wind farm owners, equipment manufacturers and other key research institutions.

Other research, including NGESO's Demonstration of Virtual Synchronous Machine control of a battery system project (NIA 2019-2020), reinforces this approach.

Conclusions

There are a variety of innovations required to be realised in the INCENTIVE solutions, which include new control technologies to provide a range of new and existing ancillary services, as well as innovative commercial and regulatory arrangements, see Figure 4 Appendix Q5. The SIF is an ideal programme to further the work conducted in BAT-STAT.

Multiple GB and international System Operators have identified the above technologies and process innovations as essential to

connecting more offshore wind. However, there are complex technical, commercial and regulatory barriers to this, see Figure 5 Appendix Q5, resulting in too much uncertainty for this technology to be invested in as BAU or elsewhere in the price control. Currently, the technology simply cannot be procured since technical innovation is required. Innovation funding is therefore required to take a whole system integration approach, by maturing the technology in parallel with commercial and regulatory aspects.

Project Plans And Milestones

Project Plan And Milestones

The Discovery phase will be split into three technical WPs supported by a management WP (WPA), detailed in Appendix Q7-1 Project Plan and Appendix Q7-3 Project Approach.

WP1. Business case development (Frazer-Nash lead)

This WP will advance the existing CBA work from BAT-STAT to capture the whole system benefits and costs associated with INCENTIVE's solutions. An initial shortlisting process will qualitatively filter all potential solutions for provision of stability services. CBA will then be used to compare the solution's NPVs to the electricity consumer against a counterfactual BAU system. The success criteria will be robust, comprehensive and clear CBA results.

Milestone deliverables: CBA model; CBA findings report

WP2. Regulatory and commercial models (Carbon Trust lead)

This WP will appraise a set of ownership models according to benefits and risks. Potential ownership models will initially be shortlisted with reference to the latest position on the seven ownership models evaluated by BEIS' Offshore Transmission Network Review. Workshops will then engage a wide stakeholder group including generation owners, technology manufacturers, transmission operators, NGESO and Ofgem. Success criteria includes comprehensive stakeholder views and producing model recommendations.

Milestone deliverables: workshop documentation; report including model recommendations

WP3. Technical scoping (SSEN-T lead)

This WP will outline the technical demonstration required in the Alpha/Beta phases to advance to a sufficient readiness for rollout following the SIF project. The Alpha phase demonstration is expected to include laboratory-based simulated testing of prototype controllers, covering both HVDC and AC connected offshore wind. The Beta phase is then expected to cover a demonstration at a GB offshore wind site (site identification in Alpha phase). The success criteria will be realistic, targeted and appropriate Alpha/Beta phase scopes.

Milestone deliverables: technical scope of work for Alpha/Beta phase, including modelling specifications

Risks

The key risks:

Suppliers not offering required inputs for Alpha/Beta phase: this will be (and is already being) mitigated through early engagement with technology manufacturers and research institutes.

A viable ownership model not being found that satisfies all stakeholders: this will be mitigated through wide engagement with stakeholders together with a structured appraisal process that considers international approaches.

Constraints

These include legislation that restricts short-term energy reserves ownership, offshore transmission owner asset divestment processes, land sharing arrangements and maturity of technical offerings from suppliers. None of these are major constraints but will be tracked through the WPs.

Route To Market

Procurement and utilisation of the INCENTIVE solutions across the UK and internationally can be achieved by overcoming barriers in four key areas: market, regulatory, commercial, and technical. Whilst primarily focused on GB, INCENTIVE will also consider other jurisdictions to ensure the INCENTIVE solutions can be commercially implemented internationally. Further, whilst primarily focussed on onshore connection points of offshore wind farms, INCENTIVE will also consider transferability of INCENTIVE solutions to other locations on the network, such as at HVDC interconnectors or other onshore locations.

Market barriers - INCENTIVE will work with System Operators in developing clear guidelines for future stability service market arrangements. This should include pricing models, auction approaches, eligibility criteria, volumes, and timelines for implementation.

Developing this market confidence will allow the INCENTIVE solutions to be rolled out commercially.

Regulatory barriers - INCENTIVE will work with regulators to create and implement structured positions on ownership models. This will enable efficient and effective delivery of grid services using INCENTIVE solutions.

Commercial barriers - INCENTIVE will investigate sharing of grid code responsibilities. This will allow offshore wind farms to agree detailed commercial arrangements with System Operators, Transmission Owners and/or OFTOs for taking additional responsibilities. Also, INCENTIVE will investigate land rights. In GB, where the offshore wind developer procures transmission infrastructure, ensuring suitable land rights transfer as part of asset divestment is important. Also, INCENTIVE will develop business cases for INCENTIVE solutions. Addressing these commercial barriers will allow private companies to invest in INCENTIVE solutions, and hence support their uptake as business as usual.

Technical barriers - INCENTIVE will develop technology-neutral specifications with stakeholders to enable INCENTIVE solutions suppliers to understand requirements for their technology. The project will also build System Operator confidence in INCENTIVE solutions by evaluating their performance against the defined specifications requirements. The project will also further mature the existing technology through engagement with technology manufacturers and OEMs. Addressing the technical barriers will ultimately allow the technology to be de-risked, and hence invested in, in GB and internationally, supporting jobs and growth.

The SIF project structure will naturally allow INCENTIVE to scale up to solve these barriers. In Discovery, INCENTIVE will investigate the problem in detail; in Alpha, INCENTIVE will produce market, regulatory and commercial model recommendations, whilst in parallel simulating INCENTIVE solutions' operation in the laboratory environment; in Beta, INCENTIVE will conduct a field trial of the technology and the market, regulatory and commercial models developed in Alpha.

Costs

Total Project Costs

136002

SIF Funding

121002

This project has been approved by a senior member of staff

☒ Yes