

Ofgem Strategic Innovation Fund Discovery End of Phase Report Template

Completion Information

In accordance with the SIF Governance Document, the end of phase reporting is designed to facilitate learning and knowledge dissemination. It will also inform Ofgem's decisions whether a Project satisfies the SIF Eligibility Criteria and whether a Project can move onto the Alpha Phase (subject to a successful Alpha Phase application).

The Project must submit an End of Phase Report to the Monitoring Officer by email or link to file sharing site. In addition, the Project must present findings at a public Show and Tell webinar scheduled for the end of May 2022.

In addition to concluding the Discovery Phase of SIF, should the Project be intending to progress to the Alpha Phase, this report will also form part of the application assessment process. The Show and Tell webinar will also be attended by the expert assessor panel responsible for Alpha Phase assessments.

The Monitoring Officer will review this End of Phase Report and assess the performance of the Project against the SIF Eligibility Criteria.

Your answer to each section can be up to 400 words. The Project may include diagrams to support responses but no hyperlinks unless we have explicitly requested. Up to 5 pages of appendices may be provided to support the report, including the finalised Project finance spreadsheet and risk register to support your responses to sections 4 & 6. Projects are encouraged to use appendices only where necessary, with the intention that the information provided in the End of Phase report focusses on the key elements of the Project, in a manner that is easily reviewed and accessible to a range of stakeholders.

10024879	INCENTIVE
12/05/2022	Written By David Plunkett and Robert Keast, Carbon Trust)

Section 1 -	Discovery Phase – Project Summary
Please provide a summary of the key findings from your Discovery Phase Project. Describe the innovative aspects of the work including any new findings or techniques. Please provide a short factual summary of the most significant outcomes of your work.	
You should describe: <ul style="list-style-type: none"> • How your Project has met the aims of the specific SIF Innovation Challenge. • How your perception of the problem and opportunity evolved. • Why the problem relates to energy network functions, and the potential role of energy networks to realise future opportunities. The innovative, novel and/ or risky aspects of the work, including any new findings or techniques. 	
INCENTIVE builds on knowledge created in the BAT-STAT project, an Offshore Wind Accelerator study, which identified several technology solutions ("INCENTIVE solutions") that allow offshore wind farms (OWFs) to provide stability services to the grid. However, it was found that market and technology barriers as well as unclear regulation currently hinder deployment into the UK system.	
The Discovery Phase has evolved our understanding of the problem and opportunity of integrating these solutions. Regarding key tasks and findings: <ul style="list-style-type: none"> • The business case could be confirmed. A detailed cost-benefit analysis (CBA) found positive Net Present Value (NPV) compared to the counterfactual for all INCENTIVE solutions, indicating value to the consumer. However, uncertainty remains in the results due to estimations in some data inputs and with regard to how NPV varies depending on ownership models. Further work is required to gain more commercial confidence. 	

- A regulatory analysis in feasible ownership models for INCENTIVE solutions revealed complexities and uncertainties which need to be addressed. Currently, it is unclear for each INCENTIVE solution who should be the most appropriate owner to receive revenues from providing different types of services. Further work is required to evaluate the most appropriate owner for INCENTIVE solutions, and hence advise future regulation, build commercial confidence, and maximise consumer benefit.
- INCENTIVE solutions supplier engagement identified additional, emerging technologies. Their feasibility and impact on the network still need to be tested and verified. We have determined simulation and demonstration requirements to test these 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 commercialisation. To bring the technologies to market, there is need for continued 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 solutions, with a view of developing a path to commercialisation.
- The large consortium (including nine OWF developers and the networks) allowed a coordinated approach that fostered alignment and avoided duplication.
- Technology testing requirements have been developed that cover a wide range of possible technology options that will reduce excessive variation in the INCENTIVE solutions' capabilities.
- Complexity and bureaucracy for the INCENTIVE solutions have been reduced by studying regulation, whilst barriers to entry have been reduced by studying their value to the consumer and technical capabilities.

Section 2 - Discovery Phase – User Needs

Please summarise your understanding of user needs including how you are translating these into requirements?

You may want to describe:

- How you have defined your scope boundaries and demonstrate why you believe you have got the scope of your project right.
- What would need to happen to make the user journey as a whole work as well as possible (in particular, you are able to talk about other services that are part of the same journey, and the opportunities and challenges involved in making changes to those services).
- How you have tested your own assumptions against the needs of your users
- How the approach you have taken will minimise the burden on your future users and avoid duplication of effort through user journeys.
- How you have considered the wider interactions of your outputs with the energy sector and other sectors. Show how you have looked at the wider user journeys your service might be a part of.

INCENTIVE solutions user needs:

- Consumers need a decarbonised electricity system, at low cost, whilst maintaining stability, reliability, and ensuring energy security – reducing dependency on gas and other energy imports.
- System Operator (ESO) needs 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. The ESO has stressed the importance of planning for lower system inertia for a net-zero system.
- Network owners need to strengthen their networks at low cost, and hence avoid costly network upgrades.
- Generators need to reduce connection costs, reduce curtailment, and increase

deployment speed of OWFs.

- The owners of INCENTIVE solutions must have a commercial rationale for investing in and operating the assets.

When scoping Discovery Phase, these needs were translated into requirements for the INCENTIVE solutions. They must provide value to the consumer, ESO, network owner, generator and INCENTIVE solution asset owner. They must also function adequately to reduce the reliance on traditional gas turbines, and to accelerate the low-cost roll-out of OWFs. To investigate these needs, we focused on three main workstreams: business case development, ownership analysis, and technology performance.

We are 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 stakeholders in regulation, policy and technology development. During these engagements, the stakeholders were supportive of the project and its aims, and no other major avenues of investigation were highlighted, indicating the scope had been correctly devised from the user perspective.

We have considered a wide range of possible INCENTIVE solutions, rather than focusing on any one specific solution. This has allowed the results of Discovery Phase to be widely applicable, and means work need not be repeated.

To improve the user journey for INCENTIVE solutions, further work is required. The three workstreams have all uncovered risks to be addressed in Alpha Phase. Work is required to address user requirements and interactions from initial design through to operation of INCENTIVE solutions. User journey will be at the forefront of the Alpha Phase scope.

Section 3 -

Discovery Phase – Impacts and Benefits

Describe any leading indicators of potential net benefits to consumers as a result of the Project and justify any changes in proposed impacts since the Application stage. Please provide details of any changes that have been made to the Project and why these were necessary.

You may want to describe:

- If the project is still worth pursuing and why is it cost effective to pursue.
- How the Project that progressed towards the benefits outlined in the discovery application.
- An indication on quantitative measurements for associated benefits could be related to the:
 - the end consumer
 - economic benefits resulting from the project to your users and any other

- parts of the supply chain, broader industry, and the UK economy, such as productivity increases and import substitution
- impact on government priorities and any associated benefits with this
- environmental impacts, either positive or negative
- any expected regional or wider energy supply resilience benefits
- impacts on consumers of the whole energy system (both individuals, and collectively), including those with any vulnerabilities or experiencing fuel poverty

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

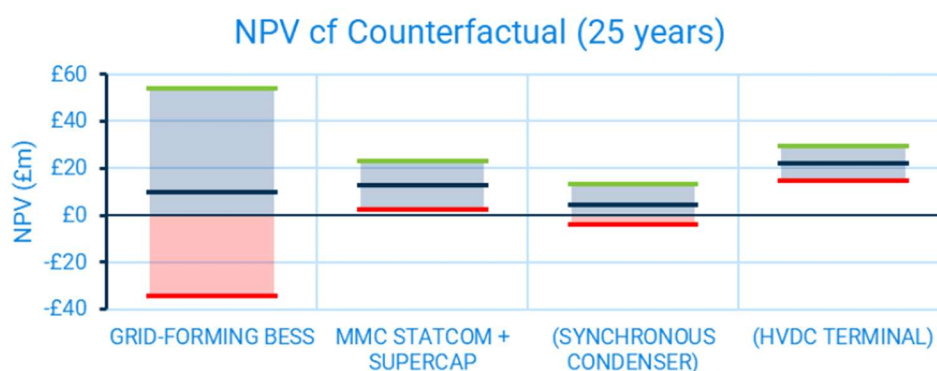


Figure 1: Estimated NPV of INCENTIVE Discovery Phase technology options (based on 50 MW windfarm). Benefits from a reduced reliance on CCGTs to provide grid stability are not included. The BESS and MMC STATCOM + SUPERCAPACITOR options perform the role of a conventional STATCOM at the point of grid connection. Both these options have therefore been evaluated with the saved cost of a STATCOM deducted. The SYNCHRONOUS CONDENSER and HVDC TERMINAL are evaluated on the basis of the cost of modifying a business-as-usual set-up to allow provision of additional grid stabilising services.

[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 more detailed CBA that confirms 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 solutions 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 solutions.

- The CBA is impacted by sensitivities. In Alpha, more sensitivity analysis will be performed to assess the key parameters affecting 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 solutions 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 solutions, which need to be considered.

Section 4 -

Discovery Phase – Risks, issues, and constraints

What constraints (i.e., technical, commercial, regulatory etc.) have you encountered during your Discovery Phase that may hinder your ability to progress the solution into Alpha? How do you propose to navigate these? Please provide a copy of the final updated Project risk register outlining the risks and issues you are currently aware of, including a likelihood and impact estimate, and mitigating actions.

You may want to describe:

- any actual or potential constraints in regulation, legislation, commercial contracts or legacy technology that affect the innovation you are developing
- any barriers for innovations to be delivered into business as usual
- how you will create an innovation that meets user needs while working within these constraints
- if you have identified constraints that can be removed over the short or long term, what your plan is for doing so.

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

- Commercial
 - Markets for stability services provided by renewables 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 solutions.
 - The integration requirements for INCENTIVE solution controls and OWFs controls must be further investigated. Data sharing models must be developed. 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
 - 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 INCENTIVE solutions, so their treatment is highly uncertain. Further investigation is required in Alpha to look at the classification of the INCENTIVE solutions.
- Technical
 - The simulation of INCENTIVE solutions requires models of INCENTIVE solutions, OWFs and the GB grid. Whilst testing by using generic models is achievable and provides benefit, the INCENTIVE project (in Alpha or Beta) will benefit from using specific models of INCENTIVE solutions, 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 solutions, 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. We have received letters of support from four leading suppliers so far.
 - As INCENTIVE solutions 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.

Section 5 -	Discovery Phase – Working in the open
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How have you worked openly during the Discovery Phase, and engaged stakeholders in a transparent and constructive manner? What have you learnt from the approach you have taken?

You might want to describe:

- ways in which you have talked publicly about the Project
- how you have invited challenge and external input of your approach to the Project
- how have you shared learning, to avoid duplication of work by others and accelerate industry progress on related initiatives
- how your team has been working in the open and have started building relationships with organisations and teams responsible for other parts of the user journey. These could include infrastructure/data owners, regulators, policy makers, investors, and others.

The project has worked in the open extensively to ensure that all stakeholder views and concerns are considered. Working in the open has provided the project with extensive learnings, which are detailed below.

- 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 solutions. We have found that there is significant technology development work ongoing and strong interested in the INCENTIVE project.

The supplier engagement was conducted through a questionnaire to suppliers. This was followed up by individual interviews with all suppliers who have shown interest in INCENTIVE. Strong INCENTIVE solution 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.

Section 6 -	Discovery Phase – Costs and value for money
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Please give a description of how funds were spent with reference to the original budget at Project kick-off and explain any significant variations. Explain how the Project has delivered value for money to consumers. Provide a copy of the final Project Finance spreadsheet.

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 SSENT (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 SSENT 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.

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Section 7 -	Discovery Phase – Special Conditions
If applicable, please describe how you have met the requirements of any Project specific conditions set out in the Project Direction.	
<p>1. <i>“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.”</i></p> <p>Collaboration Agreement was signed by all Project Partners.</p> <p>2. <i>“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.”</i></p> <p>Financial reporting has occurred to the monitoring officer in line with this condition.</p> <p>3. <i>“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.”</i></p> <p>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.</p> <p>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.</p> <p>4. <i>“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.”</i></p> <p>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 .</p> <p>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</p>	

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.