

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.

Project Number	INCENTIVE
24/04/2022	Written By (David Plunkett, Associate, 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.	
<p>You should describe:</p> <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. 	
<p>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.</p> <p>The Discovery Phase has evolved our understanding of the problem and opportunity of integrating these technologies. Regarding key tasks and findings:</p> <ul style="list-style-type: none"> • 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.

Section 2 -	Discovery Phase – User Needs
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Please summarise your understanding of user needs including how you are translating these into requirements?
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You may want to describe:

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| <ul style="list-style-type: none"> • 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. |
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INCENTIVE technologies user needs:

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| <ul style="list-style-type: none"> • 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, |
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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.

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: <ul style="list-style-type: none">• 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 technology from the perspective of the GB consumer. A summary of the results for four possible INCENTIVE technologies is set out below.

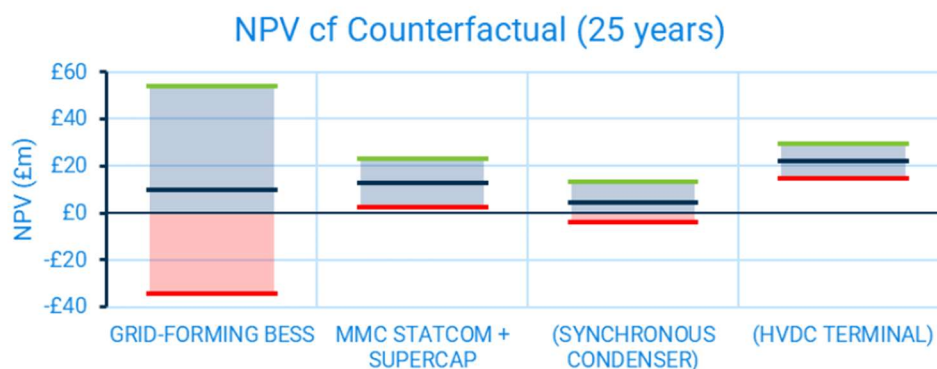


Figure 1: Estimated NPV of INCENTIVE Discovery Phase technology options (based on 50 MW windfarm). Benefits from a reduced reliance on CCGTs to provide grid stability are not included. The BESS and MMC STATCOM + SUPERCAPACITOR options perform the role of a conventional STATCOM at the point of grid connection. 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 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.

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-stopper constraints that prevent progress to Alpha. However, several constraints exist that require mitigation in Alpha.

- Commercial
 - 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

	<p>sufficient to build commercial confidence in INCENTIVE technologies.</p> <ul style="list-style-type: none"> ○ 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. <ul style="list-style-type: none"> • Regulatory <ul style="list-style-type: none"> ○ 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 <ul style="list-style-type: none"> ○ 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. ○ 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.
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Section 5 -	Discovery Phase – Working in the open
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?	
<p>You might want to describe:</p> <ul style="list-style-type: none"> • 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. 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 interested 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.

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.

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Section 7 -	Discovery Phase – Special Conditions
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If applicable, please describe how you have met the requirements of any Project specific conditions set out in the Project Direction.

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 including all of the above.

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."*

In investigating regulatory issues, Carbon Trust has engaged with BEIS and Ofgem, which was facilitated by UKRI. This specific engagement was required to ensure that the current regulation was being fully considered in Discovery, to share with Ofgem and BEIS the preliminary findings of Discovery, and to identify possible future changes to regulation / policy that may impact INCENTIVE technologies.

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."*

The majority of the INCENTIVE technologies being investigated are not currently available to the market and are not currently being deployed on the GB network. Some of the INCENTIVE technologies 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 (which is what INCENTIVE is aiming to resolve).

Where certain INCENTIVE technologies are already present on the GB network (BESS and synchronous condenser), these are still being included in the INCENTIVE study to ensure we are comparing all possible technologies that can allow OWFs to provide stability services. Further, there may be technical and commercial issues about locating BESS and synchronous condensers at OWFs, which will require innovation. Therefore, the implementation of all INCENTIVE technologies go 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.