Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form. The full completed submission should not exceed 6 pages in total.

NIA Project Registration and PEA Document

Date of Submission

Mar 2018

Project Reference Number

NIA_NGSO0006

Project Registration

Project Title

System Impacts of Embedded Storage (SIES)

Project Reference Number

NIA_NGSO0006

Project Licensee(s)

National Energy System Operator

Project Start

March 2018

Project Duration

0 years and 8 months

Nominated Project Contact(s)

Elizabeth Warnock

Project Budget

£220,000.00

Summary

As the GB Transmission System Operator, National Grid has visibility of transmission connected assets in terms of their presence, size and behaviour. In most cases National Grid also has mechanisms through which to influence the behaviour of these assets. However, this visibility does not extend into the distribution networks. As the GB electricity system becomes more distributed National Grid's visibility of an increasing proportion of assets decreases. This is particularly true for electricity storage, a significant proportion of which is likely to be deployed within the distribution networks and operate under business models that do not exist, and so are poorly understood, today. As a result of the above, this project will focus on storage assets that are embedded within the distribution networks and with a time horizon of five to eight years to prioritise any potential risks.

Third Party Collaborators

Carbon Trust

Nominated Contact Email Address(es)

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Problem Being Solved

The battery storage market has developed significantly over recent years and evidence suggests that this growth could continue to accelerate. This is due to a number of factors, including:

- the SO's launch of the Enhanced Frequency Response product and availability of long term Capacity Market contracts;
- the simplification of SO balancing services, which will likely make these services more accessible to batteries;
- rapidly falling technology costs coupled with increasing sophistication of the market in terms of supply chain, customer awareness, investor understanding and demonstration viable business models;
- removal of policy barriers e.g. regulatory definition
- government support and investment into technology research and demonstration
- the continuing maturity of viable storage business cases that are not driven by balancing services

Most analyses into the potential for batteries have focussed on benefits, where batteries contribute to alleviating system challenges by performing services such as renewables integration, constraint management and balancing services.
There is limited understanding of how embedded storage may work to the detriment of system operation rather than in support of it, e.g. how storage assets could be driven by price signals to act such that the System Operator must take balancing actions to mitigate their behaviour, rather than using such assets to perform balancing more cost effectively as is often assumed.

As such, while the focus has been on the potential benefits that storage may provide, it is important to consider the potential risks to system operation through the deployment of innovative technologies and emerging business models.

Method(s)

This study will be delivered across six work packages using predominantly desk based research.

WP1: Establish baseline of system operation. This work package will consolidate information on current system operation and establish a baseline that will help form the basis for assessing the impact of new assets like embedded storage.

WP2: Design framework to identify system risks and impacts. This work package will develop a framework building from models such as the Smart Grid Architecture Model (SGAM) to help assess the impact of embedded storage use cases. The framework will be developed as a spreadsheet-based qualitative tool that will include key parameters across the system along with acceptable excursion levels. Once the storage use cases are analysed and decomposed into the services they will carry out and the parameters they will affect (and how), the framework can then be used to help better understand where potential conflicts or issues might occur.

WP3: Identify and map relevant storage use cases. This work package will focus on mapping different use cases of storage and detailed operational models within these to serve as the inputs for the next work package, which is for assessing the risks. In addition to the mapping all the current use cases, the analysis will also be forward looking i.e. what are the likely use cases that could develop in the next 5-8 years.

WP4: Employ framework to assess risks. The framework developed in WP2 will be utilised here to assess the potential risks to the System Operator from the scale up of use cases identified in WP3.

WP5: Prioritise use cases and risks. This work package will focus on analysing the outputs that will come out of WP4 using the framework to prioritise those use cases that could potentially create material risks for the System Operator.

WP6: Recommend next steps for further exploration and mitigation of identified risks. A key aim of the project is to recommend next steps that could be carried out as further NIA projects or conducted under existing activities within the System Operator (as appropriate). The recommendations will be categorised based on the particular risk they are seeking to mitigate, e.g. improving visibility, reducing uncertainty. These recommendations will also address details such as type of partner organisations required, potential scale, objectives etc.

Scope

As the GB Transmission System Operator, National Grid has visibility of transmission connected assets in terms of their presence, size and behaviour. In most cases National Grid also has mechanisms through which to influence the behaviour of these assets. However, this visibility does not extend into the distribution networks. As the GB electricity system becomes more distributed National Grid's visibility of an increasing proportion of assets decreases.

This is particularly true for electricity storage, a significant proportion of which is likely to be deployed within the distribution networks and operate under business models that do not exist, and so are poorly understood, today.
As a result of the above, this project will focus on storage assets that are embedded within the distribution networks and with a time horizon of five to eight years to prioritise any potential risks.

Objective(s)

At the end of the project, National Grid will receive a report discussing:

- a list of evidence-based and realistic use cases that may require intervention by the System Operator to manage;
- how the impacts of these use cases may be seen by the System Operator and the kinds of management actions required;
- prioritisation of which use cases may present problems in the short to medium term and why;
- what actions may be required to mitigate the risk of these use cases;
- a list of potential innovation projects that could explore specific challenge areas in more detail, for example:
- understanding the influencing interactions and cannibalisation of different sized devices with different objective functions and incentives
- forecasting the aggregate behaviour of assets in order to ensure adequate availability of reserves
- exploring how services could be stacked between SO and non-SO services to optimise asset value while behaving complementarily to system needs
- understanding data sharing requirements between aggregators and the SO in order to anticipate asset behaviour

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project outputs will give National Grid enhanced understanding of the risks of embedded storage to system operation.

Project Partners and External Funding

The research will be conducted by the Carbon Trust alongside relevant National Grid experts. There is no external funding.

Potential for New Learning

As storage has become a more mature industry, there has been research into its deployment potential and the drivers behind its deployment. However, little work has been done to approach this topic from all of the following perspectives that are necessary to understand the problem:

- in the GB context
- from a use case perspective
- with recent analysis
- taking the perspective of the System Operator (rather than e.g. developers or network owners)

As such it is expected that this project will deliver new learning.

Scale of Project

This will be a short desk-based study

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

This project will focus on the entirety of the GB system as covered by the National Grid System Operator.

Revenue Allowed for the RIIO Settlement

None.

Indicative Total NIA Project Expenditure

NIA: £220,000

Project Eligibility Assessment Part 1

There are slightly differing requirements for RIIO-1 and RIIO-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RIIO-2 / RIIO-1).

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations (Please complete sections 3.1.1 and 3.1.2 for RIIO-2 projects only)

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

n/a

How the Project has potential to benefit consumer in vulnerable situations:

n/a

Requirement 2 / 2b

Has the potential to deliver net benefits to consumers

Project must have the potential to deliver a Solution that delivers a net benefit to consumers of the Gas Transporter and/or Electricity Transmission or Electricity Distribution licensee, as the context requires. This could include delivering a Solution at a lower cost than the most efficient Method currently in use on the GB Gas Transportation System, the Gas Transporter's and/or Electricity Transmission or Electricity Distribution licensee's network, or wider benefits, such as social or environmental.

Please provide an estimate of the saving if the Problem is solved (RIIO-1 projects only)

This project is a research study that will provide clarity around a potentially significant risk that the SO faces. If embedded storage use cases and their impacts are not properly evaluated and mitigated then system costs could rise as more balancing actions are taken. This would also represent a missed opportunity to access these assets in order to reduce costs against today.

The project will identify a prioritised list of the most high risk use cases and for these it will describe a series of more detailed innovation projects that we could explore setting up in order to better understand the nature of the risk and possible solutions. While this would not lead to direct financial benefits from this project, the work has the potential to cascade into significant value later.

An analogous example of possible future benefits that could accrue from this research can be seen in experience from solar PV. The System Operator must forecast solar PV output at various timeframes ahead of real time and ensure that there are adequate reserves available to respond in case of forecast error. As the deployment of solar PV is increasing significantly, maintaining an accurate solar forecast is becoming increasingly difficult, and is currently an active area of research under other NIA and existing business activities.

Embedded storage shares many of the same characteristics as solar PV, particularly that it is largely invisible to the System Operator, cannot easily be influenced and its behaviour depends on a complex set of exogenous factors, particularly the use cases of the systems. If this project is able to identify and enable the mitigation of challenging use cases, this could result in substantial savings in e.g. reserve holdings or constraint management costs in future.

Please provide a calculation of the expected benefits the Solution

Not required as a research project.

Please provide an estimate of how replicable the Method is across GB

The method will provide a framework to identify and analyse use cases of embedded storage and how they interact with multiple network parameters. This learning will be relevant to other Network Licensees depending on their role and context.

Further, while this project will focus on embedded storage, the methodology itself can be easily adapted to other emerging technologies of interest such as demand side response.

Please provide an outline of the costs of rolling out the Method across GB.

This project will not result in any new equipment that will be rolled out across GB. The learning resulting from the project itself will be evaluated with a mind to adapt existing and new activities of the System Operator, which has full GB coverage. These routes to value include enhanced modelling as part of the Future Energy Scenarios and System Operability Framework, as well as commercial modeling and forecasting activities or additional NIA projects as necessary.

Requirement 3 / 1

Involve Research, Development or Demonstration

A RIIO-1 NIA Project must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

☐ A specific piece of new (i.e. unproven in GB, or where a method has been trialled outside GB the Network Licensee must justify repeating it as part of a project) equipment (including control and communications system software).

☐ A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)

☑ A specific novel operational practice directly related to the operation of the Network Licensees system

☐ A specific novel commercial arrangement

RIIO-2 Projects

☐ A specific piece of new equipment (including monitoring, control and communications systems and software)

☐ A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven

☐ A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)

☐ A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology

☐ A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution

☐ A specific novel commercial arrangement

Specific Requirements 4 / 2a

Please explain how the learning that will be generated could be used by the relevant Network Licensees

This project will explore use cases of embedded storage that may require additional actions to be taken by the System Operator. In so doing it will seek to understand the behaviour and interaction of these use cases with a range of network parameters. As such it is likely that the outputs of this project will include discussion that will be novel learning for relevant Network Licencees.

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

In early 2018 National Grid published the first ever System Operator Innovation Strategy, which lists 16 strategic priorities. This project addresses the following:

- Developing Distribution System Operators (DSOs) and whole-system operability
- Improving short-term forecasting of generation/supply and demand
- Managing volatility in a low-inertia system
- Supporting voltage and reactive power
- Enhancing visibility of Distributed Energy Resources (DER)
- Unlocking flexibility

☑ Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

Is the default IPR position being applied?

☑ Yes

Project Eligibility Assessment Part 2

Not lead to unnecessary duplication

A Project must not lead to unnecessary duplication of any other Project, including but not limited to IFI, LCNF, NIA, NIC or SIF projects already registered, being carried out or completed.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

A review of existing NIA projects has revealed no similar projects. It is highly unlikely that such projects exist anywhere since no other party has the specific interests of the GB System Operator and so would not design a project to address these specific problems.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

n/a

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

This project is innovative because it is exploring the specific system impacts of an emerging technology class that could behave driven by business cases that are either highly nascent or may not yet exist. As such there is little existing knowledge that could be applied to understanding the risks posed by these technologies and new research from a specific perspective is required. This has not been done before because no other actor in the GB electricity system has an interest in the specific impacts to system operation of embedded storage.

Relevant Foreground IPR

n/a

Data Access Details

n/a

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

There are existing activities that touch upon electricity storage that National Grid is undertaking as part of its role as GB System Operator. These include simplifying and improving our suite of balancing services, facilitating modifications to codes and acting as EMR Delivery Body to calculate capacity requirements and contributions of storage assets of different durations. However, none of these activities include within their scope the focus on behavior of future storage assets embedded in the distribution networks or how use cases that are currently innovative in the market may post a risk to the future system. Currently there are no business as usual activities that could play a role as the problem is currently too poorly or uncertain given the existing market and technological context.

Please identify why the project can only be undertaken with the support of the NIA, including reference to the specific risks(e.g. commercial, technical, operational or regulatory) associated with the project

Conducting the project with the support of NIA will allow the learnings to be widely disseminated among the other network licencees, which will likely themselves be affected by many of the system impacts of embedded storage that are identified by the work. This is particularly important to help identify any technical and regulatory challenges that will arise as we move towards whole system coordination of flexible assets operating under innovative new business models, which may not be appropriately evaluated by conventional business processes.

This project has been approved by a senior member of staff

☑ Yes