

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

Sep 2018

### Project Reference Number

NIA\_NGTO023

## Project Registration

### Project Title

Increasing Transmission Boundary Power Flows using an Active Power Control Unit

### Project Reference Number

NIA\_NGTO023

### Project Licensee(s)

National Grid Electricity Transmission

### Project Start

December 2018

### Project Duration

1 year and 5 months

### Nominated Project Contact(s)

Xiaolin Ding

### Project Budget

£8,470.00

## Summary

This project proposes to assess the performance of a novel power electronic asset called the Active Power Control Unit (APCU). The APCU is a technology based on power electronics that can control active and reactive power flows in power lines both at transmission or distribution. The ability to control active and reactive power, provide the APCU with the ability to utilise existing capacity within the network.

The first stage is to provide a technical and commercial assessment (including Cost Benefit Analysis (CBA)) which will inform the feasibility of further deployment. This method was selected in order to greater explore a potentially significant opportunity at relatively low risk and investment levels.

### Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

## Problem Being Solved

The electricity network in the UK is facing some big changes. The changing generation mix, subsequent system dynamics and efficient use of existing assets, challenges how networks are and will be operated. The way assets operate sometimes results in some circuits under greater use than others. This can lead to constraints in some parts of the network. The main problem to be addressed is to develop solutions that increase the amount of power that flows across transmission boundaries, but exploiting the underutilised assets.

## Method(s)

This project proposes to assess the performance of a novel power electronic asset called the Active Power Control Unit (APCU). The APCU is a technology based on power electronics that can control active and reactive power flows in power lines both at transmission or distribution. The ability to control active and reactive power, provide the APCU with the ability to utilise existing capacity within the network.

The APCU is based on multi-level, voltage sourced converter technology that provides a wide range of active and reactive power control. The system is able to control load flow and mitigate power oscillations, sub-synchronous oscillations and other dynamic events with high efficiency. With the exception of HVDC, there is currently no other system available that provides such a wide range of

functionality and performance.

However, by virtue of design and application, the APCU is potentially has a smaller hardware footprint and cheaper than a HVDC solution.

The first stage is to provide a technical and commercial assessment (including Cost Benefit Analysis (CBA)) which will inform the feasibility of further deployment. This method was selected in order to greater explore a potentially significant opportunity at relatively low risk and investment levels.

## Scope

The following activities will be part of the scope of the project:

1. Identification of target circuits: Identify the line criteria where an APCU would have the most beneficial effect and then work with National Grid to identify a suitable line to study
2. Technical Modelling: Model the technical parameters of the system to identify performance, losses and begin to identify technical requirements (this involves building a model of the APCU and the line to be studied and performing load flow studies to establish a base case line performance and a performance with the APCU in service).
3. Economic and Business model arrangement Modelling: Establish the economics and value the solution generates. Investigate potential business models for deployment, operation and maintenance.
4. Create Cost Benefit Analysis : Produce & Present CBA of solution to allow an informed decision to be made regarding progression to stage 2.
5. Establish requirements and scope for stage 2: Define technical requirements, control functions and interfaces with NG to build stage 2 proposals which would be deployment of technology and validation of CBA.

## Objective(s)

Provide networks with the capability to model the value of APCU technology to drive efficiencies in the way power is driven across transmission boundaries. If the CBA and this feasibility study are positive, then stage 2 of the project will look to deploy the technology – this will be a separate project.

## Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

## Success Criteria

Development of a CBA that leads to an informed decision regarding stage 2 investment and key learning and recommendations to identify necessary conditions/replacements for future deployments

## Project Partners and External Funding

None

## Potential for New Learning

Transmission and Distribution networks are all under pressure to maximise the full potential of existing assets, so the learning generated could provide benefits to other licensees. The proposed modelling, business model development, learning and technology would be relevant for all T&D licence holders.

## Scale of Project

The feasibility study was chosen to be this scale as it is a suitable length of time to assess the potential benefits offered by this technology and answer key questions about APCU performance (technically and economically). A larger project is not presently required, and a smaller project would leave key questions unanswered or answers under developed.

## Technology Readiness at Start

TRL4 Bench Scale Research

## Technology Readiness at End

TRL4 Bench Scale Research

## Geographical Area

This will be a desk based project

## Revenue Allowed for the RIIO Settlement

None

## Indicative Total NIA Project Expenditure

£8470.00

## 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)

If the APCU is seen as a viable transmission system upgrade technology, this could potentially save £10s of millions during large infrastructure projects. This may also prevent additional overhead lines being constructed, which would reduce visual impact.

#### Please provide a calculation of the expected benefits the Solution

This is a research project, so a cost benefit analysis is not presently required.

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

As this technology could be used at any voltage level, this could be applied across the whole GB network. Any TO or DNO could directly use this technology, and other licensees may benefit from using the APCU to support the network.

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

In order to develop infrastructure projects that incorporate the APCU, each Licensee would need to have models and processes in place to assess the potential boundary power flow increases that where possible. This would cost approximately £2million for all licensees. The cost of deploying the APCU as part of a specific scheme is very hard to estimate, but would be in the £10s to £100s of millions per scheme.

### 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

The project would determine the technical and commercial effectiveness and feasibility of a new technology which could then be assessed for consideration on other networks. The same models could be used by other licensees and the report could be used to inform the development of new infrastructure projects.

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

This project fits within the (chosed from below) value area of the Electricity Innovation Strategy:

Service Delivery - Developing new service-based propositions and business models

- 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.

No duplication project has been found. The two most similar projects have looked at different technical solutions to the same problem:

[http://www.smarternetworks.org/project/nia\\_ukpn0027](http://www.smarternetworks.org/project/nia_ukpn0027)

[http://www.smarternetworks.org/protect/nia\\_nget0211](http://www.smarternetworks.org/protect/nia_nget0211)

This project is assessing a different technology to utilise more of the existing transmission capacity, and is therefore not a duplication of research.

### 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

The project will aim to evaluate the option of APCU for addressing the transmission boundary constraints. This technology has the potential to provide value to the consumer, subject to a positive business case. The similar project has not been tried before because of the associated cost and uncertainty about business case.

### Relevant Foreground IPR

n/a

### Data Access Details

n/a

**Please identify why the Network Licensees will not fund the project as part of its business and usual activities**

There is an uncertainty about the business case for the concept of using APCU for addressing the transmission boundary constraints.

**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**

There is a commercial risk as there is no proven business case for addressing the transmission boundary constraint using APCU. The NIA funding offers the most appropriate route for NGET to evaluate techno economic aspects of this solution.

**This project has been approved by a senior member of staff**

Yes