NIA Project Registration and PEA Document

Date of Submission:

*Notes on Completion: Please refer to the NIA Governance Document to assist in the completion of this form. Please use the default font (Calibri font size 10) in your submission. Please ensure all content is contained within the boundaries of the text areas. The full-completed submission should not exceed 10/12 pages in total.*

1. Project Registration

|  |  |  |
| --- | --- | --- |
| Project Title (*This cannot be changed once registered*) |  | Project Reference |
| Hydrogen Production for Thermal Electricity Constraints Management |  | NIA2\_NGESO036 |
| Funding Licensee(s) |  | Project Start Date |
| National Grid Electricity System Operator |  | Jan 2023 |
| Nominated Project Contact(s) |  | Project Duration |
| Louis Priday |  | 18 Months |
| Contact Email Address |  | Project Budget |
| Innovation@nationalgrideso.com |  | £520,000 |

**Project Summary (125 words limit)**

Thermal constraints are forecast to cost consumers between £500m and £3b a year between now and 2030, owing to an increase in renewable generation and a lack of capacity on the transmission system to transfer power from where it generated to where it is used.

Hydrogen electrolysis has the potential to mitigate some of these constraints by acting to store excess generation at times of high renewable generation. However, this will only be realised if the facilities are located in the right place and can operate in a way which provides a benefit to the electricity system. This project aims to investigate the potential for such facilities to provide constraint management services and suggest the right market signals to encourage investment in the right areas.

**Lead Sector**

|  |  |
| --- | --- |
| Electricity Distribution | Gas Distribution |
| Electricity Transmission  X | Gas Transmission |

**Other Sectors**

|  |  |
| --- | --- |
| Electricity Distribution | Gas Distribution |
| Electricity Transmission | Gas Transmission  X |

**Research Area**

|  |  |
| --- | --- |
| Net zero and the energy system transition  X | Optimised assets and practices  X  X |
| Flexibility and Commercial Evolution  X | Whole Energy System |
| Consumer Vulnerability | Energy System Transition |

**Development steps**

|  |  |
| --- | --- |
| Technology Readiness Level (TRL) at Start  2 | TRL at Completion  5 |

1. Project Details
   1. Problem(s)

This should outline the Problem(s) which is/are being addressed by the Project. This cannot be changed once registered.

Transmission constraints are already increasing due to clustering of renewable generation connections. Constraints can be addressed through network reinforcement. However, this is costly and can be a lengthy process given consenting and construction timescales. The majority of current constraint management actions involve the redispatch or curtailment of generation, leading to cost and carbon system operability impacts. This increase is driven by significant growth in renewable generation in Scotland, northern England and offshore, and further growth in continental interconnectors in the south. By 2030 some areas of the network are expected to see peak power flows which are 400% greater than current boundary capability. This is expected to lead to GB thermal constraint costs forecasted to be between £500m to £3bn annually out to 2030.

* 1. Method(s)

This section should set out the Method or Methods that will be used in order to provide a Solution to the Problem. The type of Method should be identified where possible, eg technical or commercial.

For RIIO-2 projects, apart from projects involving specific novel commercial arrangement(s), this section should also include a Measurement Quality Statement and Data Quality Statement.

This project consists of six work packages**:**

**WP1: Digital site locator**

To develop a model that depicts multiple factors related to energy constraints and Hydrogen Production Facility (HPF) construction and operations which enables the NGESO to interrogate, weigh, and visualise the location of these factors.

To create a scoring system for site criteria enabling potential HPF site locations to be selected and ranked.

Deliverables:

1. A UK wide mapping of variables for HPFs siting on energy constrained areas with cumulative ranking assessed to 1 km hexagon grid cells. Variables may include distance to water sources, distance to electricity substations, gas infrastructure, etc.
2. A tool for the client to interrogate the mapped variables by hexagon grid cell and apply bespoke weighting for each variable.
3. A short list of potential HPF site locations ranked in order of preference, according to pre agreed site criteria.
4. Dedicated section included in the overall report that presents methodology and key findings/ conclusions of the site location and selection work package.

**WP2: Commercial Model**

To develop a commercial model that supports the investigation into the high-level feasibility of operating hydrogen plants as a method of balancing thermal grid constraints.

Deliverables:

1. Excel-based commercial model that summarise the key inputs and outputs for each of the scenarios outlined. Key outputs are expected to be cost forecasts and the levelised cost of hydrogen for each scenario as well as system operability benefits.
2. Dedicated section included in the overall report that presents methodology and key findings/ conclusions of the commercial model work package.
3. The model will include a dashboard to make it more approachable in case it will be rerun in future by National Grid with different inputs or for checking further scenarios than those defined and agreed in the workshop.

**WP3: Economic and Regulatory Feasibility**

In conjunction with Work Package 1, WP3 will seek to define the most suitable locations (based on pre-defined location criteria) for a HPF, and will model its operation (power supply to electrolyser, injection etc.) to achieve “optimal” commercial and system operability benefits. Finally, it aims to define the regulatory requirements to deliver the right investment signals to hydrogen plants whilst minimising constraint management costs for the NGESO.

Deliverables:

1. Excel based model that will define what will output the facility and system benefits.
2. Dedicated section in the report that will present the results of the model and outline the regulatory framework and market design requirements for hydrogen system constraint management.

**WP4: Modular plant design**

To develop modular HPF design concepts to assist in determining the high-level characteristics and constraints of archetype plant designs. This work will feed into the assessment of electrolysis capacity requirements, water consumption and land area required.

Deliverables:

1. Modular HPF design outlined for up to three HPF archetypes, each archetype design will provide information on:
   1. Peak hydrogen production rate
   2. Raw water demand
   3. Total power demand
   4. Total land area demand
2. Dedicated section in the report summarising HPF modular design concepts and selected designs for identified site locations.
3. Literature Review
4. High level process flows and site layout

**WP5: Hydrogen injection to the gas grid**

To explore the feasibility of hydrogen produced from the HPFs being blended into the gas grid to understand what is the minimum level of hydrogen needed to make blending into the NTS technically and commercially viable.

1. Dedicated section in the report setting out how a HPF may feed hydrogen into the gas grid.
2. Identify preferred locations for blending onto the NTS
3. Understand operational constraints for hydrogen injection (such as hydrogen flow rate variance)
4. The Capex and Opex for injection of hydrogen into the NTS
5. Understand the minimum level of hydrogen production for hydrogen injection into the NTS to become commercially viable.
6. Identification of known unknowns and recommendations for future further work in this area.

**WP6: Synthesis and Recommendations**

To synthesise learning from all work packages and make recommendations for further work.

1. Identification of potential demonstration sites/pilot projects with supporting justification.
2. Detailed scope for demonstration of thermal constraint management by a hydrogen electrolyser plant/s, suitable for use in an innovation funding bid.
3. Dedicated section in the report providing clear recommendations for future further work in this area.

Risk Assessment:

In line with the ENA’s ENIP document, the risk rating is scored Low.

TRL Steps = 2 (TRL change 3)

Cost = 2 (£520k)

Suppliers = 1 (1 Supplier)

Data Assumptions = 1

* 1. Scope

The scope and objectives of the Project should be clearly defined including the net benefits for consumers (eg financial, environmental, etc). This section should also detail the financial benefits which would directly accrue to the GB Gas Transportation System and/or electricity transmission or distribution.

This project will develop models and tools to build a detailed understanding of the potential for hydrogen electrolysis to reduce thermal constraints on the electricity transmission network. The results of work packages on location, commercial models, and the economic and regulatory feasibility will feed into a proof-of-concept design for an electrolysis facility.

The project will also investigate the feasibility (both technical and commercial) of the hydrogen produced to alleviate thermal constraints subsequently being injected into the gas grid.

* 1. Objectives

This cannot be changed once registered.

This project aims to:

• Identify where HPFs need to be located to provide balancing mechanism services to National Grid ESO and to achieve “optimal” commercial and system operability benefits.

• Investigate the high-level feasibility of operating hydrogen plants as a method of balancing thermal grid constraints and other system services.

• Define the regulatory requirements to deliver the right investment signals to hydrogen plants whilst minimising constraint management costs for the ESO.

• Develop modular HPF design concepts to assist in determining the high-level characteristics and constraints of archetype plant designs.

• Explore the feasibility of hydrogen produced from the HPFs being blended into the gas grid.

* 1. Consumer Vulnerability Impact Assessment (RIIO-2 projects only)

Details of the expected effects of the Method(s) and Solution(s) upon consumers in vulnerable situations. This must include an assessment of distributional impacts (technical, financial and wellbeing-related). For RIIO-1 projects please add “Not Applicable”

The ESO does not have a direct connection to consumers, and therefore is unable to differentiate theimpact on consumers and those in vulnerable situations. Benefits to all consumers will be in the form of reducing use of system charges (BSUoS / TNUoS) through reduced spending on constraints in the balancing mechanism and/or reduced spending on transmission reinforcements. These benefits would come as a result of work following on from this project.

This project has been assessed as having a neutral impact on customers in vulnerable situations because it is a transmission project.  

* 1. Success Criteria

Details of how the Funding Licensee will evaluate whether the Project has been successful. This cannot be changed once registered.

The project will be successful if the following questions are answered:

• Can green hydrogen production facilities meet the operational and technical requirements to provide thermal constraint management services for transmission system operation?

• How should commercial terms be structured for green hydrogen production facilities to provide constraint management services?

• How can the right market signals (investment) be provided to green hydrogen developers given locational, operational and downstream H2 gas usage considerations?

• Are there any regulatory challenges around commercial terms?

* 1. Project Partners and External Funding

Details of actual or potential Project Partners and external funding support as appropriate.

Arup will be delivering this project.

Gas Transmission & Metering will be funding WP5 specifically, the remainder is funded by the ESO.

* 1. Potential for New Learning

Details of what the parties expect to learn and how the learning will be disseminated.

While other projects have looked at the value of hydrogen in other ways, the technical, commercial and economic case for electrolysis facilities responding to a signal from an electricity system operator to provide constraint management services has not been investigated in detail before. With constraints rising sharply to 2030 and beyond, understanding the potential for this technology to reduce costs for consumers is vital if we are to encourage the optimal placement and operation of this technology.

All the above will be published in a final report on the ENAs Smarter Networks Portal, and a webinar summarising the key results will be held. Industry participants will benefit from this work by giving them a basis on which to inform decisions about their own investments into the technology.

* 1. Scale of Project

The Funding Licensee should justify the scale of the Project – including the scale of the investment relative to the potential benefits. In particular, it should explain why there would be less potential for new learning if the Project were of a smaller scale.

This project will span 18 months with ARUP delivering the work. At a project cost of £0.5m against constraint costs in the billions in the latter half of this decade, even small savings resulting from bringing forward an electrolyser project by a year, or by encouraging development in the right areas would lead to savings.

* 1. Geographical Area

Details of where the Project will take place. If the Project is a collaboration, the Funding Licensee area(s) in which the Project will take place should be identified.

This project will cover the whole of the GB network.

* 1. Revenue allowed for in the current RIIO settlement

An indication of the funding provided to the network licensee within the current RIIO settlement that is likely to be surplus to requirements as a result of the Project.

None

* 1. Indicative Total NIA Project Expenditure

An indication of the total Allowable NIA Expenditure that the Funding Licensee expects to reclaim for the whole of the Project (RIIO1).

An indication of the Total NIA Expenditure that the Funding Licensee expects to reclaim for the whole of the Project (RIIO2).

Total: £520k

1. Project Eligibility Assessment

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).

* 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:

* + 1. How the Project has the potential to facilitate the energy system transition:

This project will increase our understanding of how electrolysis technology could help reduce constraint costs, lowering the costs to consumers of integrating renewable energy. It could enable a faster net zero transition through the ability to reduce constraint costs at a quicker rate than building new electricity transmission infrastructure alone. Furthermore, hydrogen produced by these plants could help decarbonise other sectors.

Further work/projects can be developed to take the findings of the project further, rather than increasing the scope of this project e.g. WP4 on plant design could be taken forward into a demonstration project, and/or learnings on how to encourage the best outcomes for the electricity network can be taken forward by the ESO through new or existing processes or markets.

* + 1. How the Project has potential to benefit consumer in vulnerable situations:

N/A

* 1. 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.

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

N/A

* + 1. Please provide a calculation of the expected benefits the Solution

This is for Development or Demonstration Projects, not required for Research Projects. It should be (Base Cost – Method Cost, Against Agreed Baseline) and include a description of the recipients of the benefits.

Not required as this is a research project

* + 1. Please provide an estimate of how replicable the Method is across GB

This must be in terms of the number of sites, the sort of site the Method could be applied to, or the percentage of the Network Licensees system where it could be rolled-out.

This research project will examine the potential for electrolysis to reduce constraint costs across GB. WP1 will deliver an interactive map of GB presenting data on potential across the network – this will help to identify the number of sites/areas suitable for electrolysis plant aimed at managing constraints. The results will be shared with industry and other networks to feed into their own planning.

* + 1. Please provide an outline of the costs of rolling out the Method across GB.

The project will research costs and benefits of using electrolysis to manage thermal constraints, we cannot provide an estimate for costs to roll out solutions at this stage. The work on the commercial model in this project will help facilitate future estimates of the cost to roll out electrolysis for managing constraints, and along with other ESO work will help identify the potential scale of capacity which is cost effective.

* 1. Requirement 3 / 1 – involve Research, Development or Demonstration
     1. RIIO-1 Projects

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 systems and 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 GB electricity transmission or distribution systems |  |
| A specific novel commercial arrangement |  |

* + 1. RIIO-2 Projects

A RIIO-2 Project must involve the Research, Development or Demonstration of at least one of the following:

|  |  |
| --- | --- |
| 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 | X |
| 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 | X |
| A specific novel commercial arrangement | X |

* 1. Requirement 4 / 2a – develop new learning

A Project must develop new learning that can be applied by Gas Transporter and/or Electricity Transmission or Electricity Distribution licensees. For RIIO-1 Network Licensees may wish to address challenges specific to their network.

Please answer one of the following:

* + 1. Please explain how the learning that will be generated could be used by relevant Network Licenses

Learnings will allow for gas and electricity transmission and distribution licensees to understand locations where there is potential for electrolysis plant built to alleviate constraints on the electricity transmission network. WP5 will provide insight on the potential interactions with gas networks.

* + 1. Or, please describe what specific challenge identified in the Network Licensee’s innovation strategy is being addressed by the Project (RIIO-1 only)

Not applicable

* + 1. Is the default intellectual Property Rights (IPR) position being applied?

This cannot be changed once registered.

|  |  |
| --- | --- |
| Yes  X | No |

If “no”, the following questions must be answered:

* + - 1. Demonstrate how the learning from the Project can be successfully disseminated to Network Licensees and other interested parties:

* + - 1. Describe how any potential constraints or costs caused, or resulting from, the imposed IPR arrangements:

* + - 1. Justify why the proposed IPR arrangements provide value for money for customers:

* 1. Requirement 5 / 2c – be innovative

A Project must be innovative (ie not a business as usual activity) and have an unproven business case entailing a degree of risk warranting a limited Research, Development or Demonstration Project to demonstrate its effectiveness. This could include Projects which are untested at scale, or in relation to which there are risks, which might prevent the widespread deployment of the equipment, technology or methodology.

* + 1. Why is the project innovative?

RIIO-1 projects must include description of why they have not been tried before.

While other projects have looked at the value of hydrogen in other ways, the technical, commercial and economic case for electrolysis facilities responding to a signal from an electricity system operator to provide constraint management services has not been investigated in detail before.

With constraints rising sharply to 2030 and beyond, understanding the potential for this technology to contribute to reducing costs for consumers is vital if we are to encourage the optimal placement and operation of this technology.

* + 1. Why is the Network Licensee not funding the Project as part of its business as usual activities?

Whether there is a viable market for electrolysis facilities to provide services to the ESO is not clear, and this project seeks to demonstrate the potential benefits.

It is not currently clear how the ESO could incentivise the placement of facilities to assist in constraint management. Therefore, it is deemed too high risk for BAU funding to be used at this stage.

* + 1. Why can the Project can only be undertaken with the support of NIA?

This must include a description of the specific risks (e.g. commercial, technical, operational or regulatory) associated with the Project.

It is not yet clear whether there is a viable market for electrolysis facilities to provide services to the ESO. We are not aware of such an approach being considered elsewhere in the world, there are many unknowns due to the hydrogen sector in the UK being in very early stages of development. The project could prove it is too costly or complex to implement.

* 1. Requirement 6 / 2d – 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.

* + 1. Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

**Existing ESO and GT&M Activities:**

ESO:

* Modelling hydrogen for reducing constraints
  + How to assess the benefits from hydrogen electrolysis potentially as an option in NOA (or the future CSNP).
  + The focus is only on assessing electricity network impacts, so unlike this project there is no consideration of wider needs of hydrogen developers or the operating model of electrolysis.

This complements the innovation project as it can help provide data on hydrogen’s effect on constraints.

* Service Provider Capability Mapping (SPCM) NIA2\_NGESO031 – research into flexibility by requesting information from industry on their capabilities and drivers for investment.
  + Phase 1 of the SPCM project could help inform parts of WP2/3 but will not be as in-depth as this project’s scope.
* FES Bridging the Gap
  + Focusing on hydrogen as a source of flexibility.

GT&M:

GT&M Existing Project: Gas Goes Green Hydrogen Blending Infrastructure

Develop a generic functional specification for the infrastructure required to facilitate the injection of hydrogen into the gas grid

**Industry**

This project would also seek to build on relevant GB hydrogen projects such as:

* Flexible Generation Forecasting (NIA\_WWU\_068)
* The Role for Hydrogen as an Electricity System Asset (NIA2\_NGESO010)
  + No consideration of managing thermal constraints, so little overlap here -but did input into the redispatch prices we consider in modelling H2 in our tools.
* Gas and electricity transmission infrastructure outlook (NIA\_NGGT0184)
* Green Hydrogen Injection into the NTS (10023216)
  + The new project would add to this previous project with considering the behaviour of a plant focused on managing electricity constraints (different profile of injection) and if it is an economic proposal for the electrolyser
* Role and value of electrolysers in low-carbon GB energy system (NIA2\_NGET0002)
  + Does not consider specific thermal constraint value
    1. If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

1. PEA approval

The senior person (RIIO-1) or senior network manager (RIIO-2) responsible for implementing RIIO-2 NIA Projects must approve the PEA. It must then be published on the Project Registration page of the Smarter Networks Portal.

|  |  |
| --- | --- |
| **Please confirm this project has been approved by a senior member of staff** |  |