

## NIA Project Registration and PEA Document

### Date of Submission

Dec 2023

### Project Reference Number

NIA2\_NGESO065

## Project Registration

### Project Title

Virtual Energy System: Common Socio-technical Framework Development

### Project Reference Number

NIA2\_NGESO065

### Project Licensee(s)

National Energy System Operator

### Project Start

November 2023

### Project Duration

0 years and 4 months

### Nominated Project Contact(s)

Jonathan Barcroft

### Project Budget

£575,000.00

## Summary

Digitalisation and data sharing are critical enablers to the achievement of net zero. If an ecosystem of connected digital twins is to be delivered for the energy system, a common framework is required. No framework for interoperable data exchanges in energy exists or has reached this stage of development. The proposed design developed to date through desk-based research and interviews requires validation through a proof of concept aligned to related programmes National Digital Twin Programme and Digital Spine.

This project continues the development of the tangible demonstrator for the common framework, with the aim to develop a simplified proof of concept and detailed design of the technical architecture required, bringing together the related programmes.

### Nominated Contact Email Address(es)

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## Problem Being Solved

Achieving net zero requires the development and operation of an integrated whole energy system across many vectors including electricity, gas, heat and hydrogen.

Operating this integrated energy system, where many thousands of assets are responding to variable and dynamic signals, requires modelling of a wide range of scenarios. Defining and modelling these scenarios requires visibility of system behaviour whether that be network assets, generation, storage or consumption.

To achieve this visibility in a decentralised system, operated by many different organisations, will require data sharing. This data sharing needs to be supported by a common socio-technical framework to facilitate interoperability.

Through a previous NIA project ([NIA2\\_NGESO0014 A Common Framework for a Virtual Energy System](#)) a framework of 14 socio-technical key factors has been established. These include the people, process, data and technology capabilities that are required to support this energy data ecosystem. Each of these factors is at a different stage of maturity. Through the most recent related NIA project ([NIA2\\_NGESO028 Common Framework Demonstrator](#)) – the initial 6 priority key factors have been investigated. The result of this is a high-level design for the data sharing infrastructure and a proposed governance model.

This high-level design requires validation alongside the proposals for the digital spine led by Department for Energy Security and Net Zero (DESNZ) and the National Digital Twin Programme led by the Department for Business and Trade. An assessment of security sensitivities and requirements also needs to be undertaken. This will help to inform the scope of development required and where collaboration with other sectors could support acceleration.

## Method(s)

This project will be primarily desk-based research with functional evaluation of required components where required. The project will not consider any internal data from ESO systems though may make use of open data published by industry to develop an improved understanding of requirements.

Proposals will be validated with industry through targeted interviews and workshops with subject matter experts and shared with our programme Advisory Groups for review and feedback. Anonymised summaries of the information gathered through these interviews and workshops as well as the briefing materials shared will be included in project reports.

At the end of the project all reports and outputs developed will be published on the [Smarter Networks Portal](#). With the architecture and security review there may come requirements to redact sensitive information. This will be proportionate to the risks and with the aim of publishing openly as much as possible.

The project will include the following packages of work, which are structured as a progression from the previous project NIA2\_NGESO028.

### Work package 2: Demonstrator

WP2.5 – Electricity use case preparation: Prepare and document the data requirements for the outage planning use case. Outline necessary considerations for data licensing, security controls, and organisational data preparation node. Research and evaluate mechanisms for connecting neighbouring models including a focus on any resulting requirements for the data sharing infrastructure.

### Work package 5: Technology

WP5.1 – Technology architecture: Detailed technology architecture for the Minimum Viable Product (MVP) of the VirtualES, and associated functional requirements, which have been tested and validated with key users, stakeholders, and the priority use cases. This would enable the low-level design in future phase that will follow this project.

WP5.2 – Integration with the data sharing infrastructure: Scoping studies into the integration with both National Digital Twin Programme and Trust Framework Architecture, which includes identification of functional overlaps and gaps, and an outline integration development roadmap. These will each be developed through stakeholder engagement and workshops.

### Work package 6: Commons

WP6.1 – Security scoping: Conduct a security and Critical National Infrastructure (CNI) overview of the VirtualES and proposed technology architecture, outlining the security attributes, risks, and impacts. Provide a summary of activities for future investigation.

WP6.2 – Operating environment: Explore and assess the potential operating model for the VirtualES, considering possible policy requirements, regulatory implications, revenue streams, cost implications, future partners, and operating team roles and responsibilities.

WP6.3 – Stakeholder engagement: Support for stakeholder engagement activities throughout the project, including show & tells and Advisory Group briefs.

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

TRL Steps = 1 (2 TRL steps)

Cost = 2 (>£500k)  
Suppliers = 1 (1 supplier)  
Data Assumptions = 1  
Total = 5 (Low)

## Scope

This project will build on the high-level design, governance model and key factors delivered in previous project phases (NIA2\_NGESO0014 and NIA2\_NGESO0028). There remains no existing socio-technical framework for data sharing in energy, delivery of this would accelerate the journey to net zero. This project and its predecessors have progressed the development of this framework including defining its scope through the key factors and assessing potential solutions.

This project will form the design for an MVP through a technical assessment of the integration and capabilities of the National Digital Twin Programme and Trust Framework.

This project will produce a breakdown of the expected development requirements and assess their technical maturity. It will identify where solutions from other sectors or innovation would be required to support the data sharing infrastructure for a net zero energy system. This will allow future consideration of cost and time to implement an MVP.

Practical development of this MVP would follow completion of this project with the delivery model and funding approach to be confirmed.

A critical element of this design is to ensure it meets security requirements. A deliverable of this project is to perform a security architecture assessment. This will identify the constraints and precautions that need to be applied as well as identifying where there are opportunities for innovative solutions.

## Objective(s)

- Defined functional requirements of the proposed architecture for an MVP
- Clear definition of interfaces with National Digital Twin Programme and assessment of Trust Framework requirements.
- Evaluating the security requirements and identifying potential mitigations in the proposed architecture.

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

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

## Success Criteria

- Functional requirements of the proposed architecture will be clearly articulated.
- Clear definition of interfaces with National Digital Twin Programme and assessment of Trust Framework requirements.
- Security requirements will be defined, and architecture reviewed.
- Reporting on the potential Operating Model, enduring funding and business case.
- At this stage all outputs would be designs based on desktop analysis, to progress to Proof of Concept additional network partners are required as well as formal data sharing agreements.

## Project Partners and External Funding

Arup are the primary project partner supported by Energy Systems Catapult and Icebreaker One. No external funding.

## Potential for New Learning

This project will consider the technical alignment between the VirtualES, National Digital Twin Programme and Open Energy. The output will include requirements definitions and review potential solutions to these.

This understanding of the interactions between programmes and the socio-technical maturity of solutions will directly support the preparation and planning for an MVP for an energy data sharing infrastructure.

The learning will be shared with industry as well as government and regulator to help inform future sector developments. This will be directly with the National Digital Twin Programme through collaborative working and regular meetings with energy digitalisation workstreams in DESNZ and the regulator to help inform their work. The learning will also be shared with the VirtualES programme's industry advisory groups and wider audiences.

All reports and outputs developed will be published on the [Smarter Networks Portal](#). With the architecture and security review there may be some requirements to redact sensitive information. This will be proportionate to the risks and with the aim of publishing openly as much as possible.

### Scale of Project

The project will be delivered following an agile approach over 4 months and will require industry and partner engagement throughout. Arup will be the main delivery partner, supported by Energy Systems Catapult and Icebreaker One.

### Technology Readiness at Start

TRL4 Bench Scale Research

### Technology Readiness at End

TRL6 Large Scale

### Geographical Area

This project is being delivered by UK based suppliers and funded by National Grid ESO, it therefore has a geographical scope of Great Britain.

### Revenue Allowed for the RIIO Settlement

None

### Indicative Total NIA Project Expenditure

£575,000

# 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:

The benefits case of VirtualES follows a series of dependencies:

1. To achieve net zero requires an integrated energy system
2. Operation of an integrated energy system requires modelling of a wide range of scenarios
3. Modelling a wider range of scenarios requires visibility of system behaviour and capability
4. Visibility of behaviour and capability of the system, which is made up of assets owned and operated by different organisations, is dependent on data sharing
5. This data sharing requires the interoperability and capabilities that the VirtualES of connected digital twins can bring

The common framework will create the common language, recommended infrastructure, and processes to connect and federate individual digital twins from across the energy sector.

The framework will consider both social and technical factors including, but not limited to governance, policy, legal, data rights and consent management, ontologies, metadata standards, interoperability approaches, skills, data standards, security protocols, dispute resolution, performance, and codes of practice. It is fully aligned with the recommendations of the National Digital Twin programme and with the Energy Digitalisation Task Force (EDiT) recommendations for a digital spine and data sharing fabric. The Energy Systems Catapult, who delivered EDiT, are part of the team advising the ESO on the development of the common framework.

The VirtualES will not create a singular digital twin of the energy system or single central platform for GB. Instead, it will create a decentralised network where each actor, for example a Generator, Transmission or Distribution Network, could develop their own digital twins and then connect and share their data through the VirtualES. In short it will lay out the requirements, rules, and principles to which all constituent digital twins will need to conform so that they may connect and share data.

### 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)

N/A

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

Given the stage and complexity of the project, it is not possible to quantify precisely the benefits that can be delivered directly by the VirtualES and its enabling common framework. Furthermore, key initiatives across the sector have not quantified overall benefits from data and digitalisation. Albeit they recognise that these are key enablers to unlock wider benefits delivered through system planning, markets, and operations (see RIIO2 decisions, EDiT, FSNR, data best practice).

In a recently completed NIA project NIA2\_NGESO0028 a review of the potential benefit categories of the VirtualES was carried out. Most of the benefits will be realised indirectly through delivery of use cases which utilise the resulting data sharing infrastructure. Direct

benefits will include reduced development costs of bespoke solutions and reduced operational costs through reduction in duplication, collaborative development and data sharing.

At a high-level, benefit categories include reduced consumer bills, improved operability and resilience, reduced carbon emissions and other wider benefits.

To give a quantitative indication of the scale of the indirect opportunities that could be achieved through better use of digitalisation and data sharing, the 2021 Smart Systems and Flexibility Plan (SSFP) estimated that a smart and flexible energy system would deliver benefits of up to £10bn a year by 2050. This £10bn is from reduced generation capex and network costs estimated via a system model. If we consider the System Operator's role alone, even a small improvement of 1% to the current net balancing costs, due to better data-driven decision making, would translate to a saving of over £13m/year.

There is strong stakeholder support for greater openness and sharing of data across the energy industry. The lessons learnt throughout the project will help bring coordination across the various data and digital twin initiatives currently in flight across the energy sector.

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

This project considers scaled common framework demonstrator in a confined geographical area, however the common framework developed will be applicable across GB.

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

At this stage the costs are unknown for rolling out common framework learning into further development. As functional requirements and architecture become known this assessment can be carried out.

### **Requirement 3 / 1**

Involve Research, Development or Demonstration

A RII0-1 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 be delivered with ongoing cross-sector and in-sector collaboration, building on wider initiatives driving change in the energy sector. The technical alignment with the National Digital Twin Programme will help to ensure that the project focusses on the areas that need development specific to the energy sector or where wider solutions are required.

All reports and outputs developed will be published on the [Smarter Networks Portal](#). With the architecture and security review there

may come requirements to redact sensitive information. This will be proportionate to the risks and with the aim of publishing openly as much as possible.

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

N/A

### **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 has been undertaken through the [Smarter Networks Portal](#), Programme Advisory Groups and direct stakeholder engagement and confirmed there is no unnecessary duplication. This project helps to align development with National Digital Twin Programme and other initiatives which will help reduce duplication in future phases.

### **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**

Based on horizon scanning activities, the ESO believes a Virtual Energy System of this scale and scope has not been achieved elsewhere. There is a need to build in a way that is scalable and aligns explicitly to the principles of the National Digital Twin programme.

Entities across the sector need to be supported and incentivised to share models and data extending outside of regulated networks. This presents development risks; the Common Framework content developed in the previous phase needs to be tested and cross-sector coordination is challenging. Therefore, innovation is needed to create new knowledge and develop new collaboration tools.

There are also existing precedents that encourage collaboration that are relevant to the VirtualES. The National Digital Twin programme and Centre for Digital Built Britain developed the Gemini Principles, which provide high-level guidance for digital twin development. The Energy Data and Digitalisation Taskforces have identified best practice in key areas for energy system data and digital infrastructure. The Energy Data Taskforce recommended the creation of a unified Digital System Map and common data standards, the Energy Digitalisation Taskforce recommended a Digital Spine which the VirtualES and common framework could support. This Common Framework project will follow best practice guidance, however, as the guidance is only high-level, it will also develop detailed guidance specific to the VirtualES implementation.

Without a VirtualES and Common Framework, there is a significant risk the energy sector will increase duplication of data and operate with incompatible standards. This will lead to reduced efficiency and increasing data isolation. New equipment, markets and services could be implemented with increasing risk of unexpected interactions.

To manage this risk, the project has been developed as a series of phases delivering knowledge and experience as it progresses. This project proposal forms the next step of these phases, moving from wireframing to a proof of concept of critical components.

### **Relevant Foreground IPR**

The project will primarily develop reports and documentary artefacts that will be published in the course of the project subject to security and commercial sensitivities.

Expected outputs include detailed user journey, detailed architecture, functional requirements for demonstrator use case, outline



security and CNI assessment.

Expected reports include connecting models report, Data Standardisation Mechanism integration report Operational environment report and a report of the Trust Framework integration.

### Data Access Details

Data for this project and all other projects funded under the Network Innovation Allowance (NIA), Network Innovation Competition (NIC) or the new Strategic Innovation Fund (SIF) can be found or requested in a number of ways:

1. A request for information via the Smarter Networks Portal at <https://smarter.energynetworks.org>, to contact select a project and click 'Contact Lead Network'. National Grid ESO already publishes much of the data arising from our innovation projects here so you may wish to check this website before making an application.
2. Via our Innovation website at <https://www.nationalgrideso.com/future-energy/innovation>
3. Via our managed mailbox [innovation@nationalgrideso.com](mailto:innovation@nationalgrideso.com)

Details on the terms on which such data will be made available by National Grid ESO can be found in our publicly available "Data sharing policy relating to NIC/NIA projects" at <https://www.nationalgrideso.com/document/168191/download>.

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

This is a cross-sector project and not a BAU activity to deliver the established ESO role. As such it is not a named project with allocated business plan funding. The project outcomes will be used to define future implementation activities which may be progressed through future business plan proposals.

The considerable scale and urgent need for cross sector collaboration will mean that SIF and/or business plan funding and support is ultimately required to realise the end goal of the VirtualES.

The project outputs may be progressed through the future development of proposals by SIF Beta application, business plan change request or partnership for delivery with other use cases.

### 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

The project is best suited to NIA funding due to the inherent risks: complexity of existing initiatives, standards and regulation, technical viability, data licensing, security, governance, enduring operating model.

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

Yes