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

Nov 2022

Project Reference Number

NIA2_NGESO028

Project Registration

Project Title

Virtual Energy System – Common Framework Demonstrator

Project Reference Number

NIA2_NGESO028

Project Licensee(s)

National Energy System Operator

Project Start

November 2022

Project Duration

0 years and 9 months

Nominated Project Contact(s)

Jonathan Barcroft (ESO), Sabia Sadiya (GT&M)

Project Budget

£535,000.00

Summary

The Virtual Energy System (VirtualES) will provide users across the sector with access to data and integrated modelling capabilities, to improve data-driven decision making for investments and operations. Previous research identified the need for a demonstrator to test the ability of the VirtualES common framework to create an eco-system of digital twins.

This project will provide a greater understanding of the requirements from the common framework to support the overall VirtualES. This will be achieved through a small-scale demonstration of the priority key factors applied to a tangible use case centred on whole-system flexibility, and through development of best practice guidance for building a common framework. To conclude, the project will identify benefits to system operation from developing the use case and interoperability through using the common framework.

Third Party Collaborators

Arup

Energy Systems Catapult

Icebreaker One

Nominated Contact Email Address(es)

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Problem Being Solved

The way we generate, manage, and consume energy is changing rapidly. We have moved from small numbers of large power stations to large numbers of small power stations, expanding the range of participants in the system. The energy system is becoming more interconnected, and behaviour is getting harder to predict as it becomes more market influenced and controlled by automated systems.

The interactions between energy and other sectors are also increasing with electrification of heat and transport. Peak demand on the electricity system can drive rapid changes in gas demand volumes, and gas and electricity interactions are on course to become even more dynamically driven by developments in hydrogen systems and storage.

These changes are essential for achieving net zero and for a cost-effective energy landscape, but they also bring challenges and complexity which necessitates changes in the way we design and operate the energy system.

Multiple individual models and data sources exist across the sector which are not interoperable or openly shared, these models and data cannot be combined to provide a more accurate representation of the whole interconnected system. A common framework is required if a connected ecosystem of digital twins is to be delivered for the energy system.

The previous NIA project, 'A Common Framework for a Virtual Energy System', identified the need for a tangible demonstrator to test the Virtual Energy System (VirtualES) common framework's ability to create an eco-system of digital twins, centred on a whole system flexibility use case. This demonstrator will allow the factors to be developed iteratively and linked to a real-world scenario.

Method(s)

National Grid ESO proposes to lead an industry-wide initiative to enable the creation of an ecosystem of connected digital twins of the entire energy system of Great Britain - the VirtualES. This will unlock the modelling of system interactions across the energy sector. VirtualES will be an enduring programme over several years.

This project will provide a greater understanding of the requirements from the common framework to support the overall VirtualES. This will be achieved through a small-scale demonstration of the priority key factors, including application through a tangible use case.

To minimise risk to the programme, and to act on previous feedback, the use case has been defined to be small in scope. This will allow the project the space to develop the key factors of the framework while providing a narrative and benchmark for how value will be delivered. The use case in the project has an electricity focus though the learning and proposals for the framework are expected to benefit both gas and electricity.

Work Package 1 - Project Management Office
This function will manage the budget, deliverables and reporting throughout the demonstrator through a small dedicated PMO support team.

Work Package 2 – Demonstrating the common framework through the whole-system flexibility use case

WP2.1 – Data assessment and preparation: To establish which key datasets are required to be sharable across the industry with the appropriate detail, frequency and granularity required for it to be able to fill the needs of the use case. Resulting datasets to be cross checked against a parallel use case of Gas Operational Planning.

Deliverables: Data needs & gaps report, and data relationships developed & tested.

WP2.2 – Technology: To determine that it is possible to make energy data visible and accessible to actors across the industry through a secure and scalable solution to store shared data and modelling, verifying the results against a parallel use case of Gas Operational Planning

Deliverables: Technology review report.

WP2.3 – Wireframe the demonstrator: Iteratively show how the demonstrator will be developed.

Deliverables: Interoperability report, data licensing template, and data sharing assessment demonstration.

Work Package 3 – Developing the common framework best practice guidance

WP3.1 – Social (socio) factors: To iterate best practice documents for each of the three priority social (socio) factors, using lessons learnt in demonstrating the use case and from industry.

Deliverables: Best practice recommendation on the three priority social (socio) factors – 1) Raising awareness & fostering culture, 2) Engaging stakeholders, and 3) Creating a governance framework

WP3.2 – Technical factors: To iterate best practice documents for each of the three priority technical factors using lessons learnt in demonstrating the use case and from industry

Deliverables: Best practice recommendation on the three priority technical factors – Aligning models and taxonomies, Benefits report on the use case, and Benefits report on the common framework

Work Package 4 – Benefits of the use case & common framework

WP4.1 – Benefits: To commence the identification of the benefits of developing the use case and using the common framework to the system operation and planning, and ultimately the consumer and investors.

Deliverables: Benefits report on the use case and benefits report on the common framework

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

- Identify range of assets to be represented
- Define parameters required for use case
- Use sample data from network partners to determine data availability and quality, available data standards, potential data licences, and relationships between objects.
- Agree a governance process with industry
- Iterate on the principles of the common framework with industry
- Propose technical stack required to share data
- Develop a scaled demonstrator in a confined geographical area
- Present demonstrator with example scenarios to show use and scalability
- Develop cost benefit analysis for the scaled demonstrator, including the benefits that the demonstrator hopes to achieve, and the estimated costs of the demonstrator
- Use experience from demonstrator and results of common framework development to perform a cost benefit analysis of wider system interoperability

Objective(s)

The project has three objectives:

1. Design and wireframe the demonstrator to test core components needed to progress the use case and to show the key elements of the common framework in practice. This will stimulate discussion on future requirements for connected digital twins in the energy industry
2. Use the learning from the demonstrator use case and discussion through advisory groups to formulate and set out the first components of the common framework
3. Perform a cost benefit analysis of the interoperability provided by connected digital twins in energy sector. Present this cost benefit analysis in a way that it can be replicated for future use cases and to support investment in digitalisation

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

- Project is delivered on time, on budget with all milestones met, and clear and timely reporting provided.
- Data assessment and preparation work package (WP2) will result in greater knowledge in:
  - Which datasets are required within the demonstrator to meet the use case
  - The specifications and relationships between datasets which need to be addressed in the demonstrator
  - Any issues around licensing which needs to be addressed during the demonstrator

- Agreement for how data will be best shared
- Suitable technology identified for the demonstrator activity which will enable the collaboration, data sharing and relationship development.
- The wider energy sector will be aware of the common framework demonstrator and it's aims and will have had the opportunity to provide input and feedback following the engagement for this phase and the future of the VirtualES common framework.
- The benefits that the demonstrator hopes to achieve will be further developed and the likely costs of the demonstrator estimated in order to complete the Cost Benefit Analysis (CBA). A more quantitative analysis will have commenced which will have identified key value for each segment involved in the demonstrator allowing the costs and opportunities of connected digital twins in the VirtualES to be estimated.

Project Partners and External Funding

National Grid Electricity System Operator (ESO) and National Grid Gas Transmission & Metering (GT&M) will be jointly funding the project. Arup will carry out the project work supported by Energy Systems Catapult and Icebreaker One

Potential for New Learning

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

This project will be delivered with ongoing cross-sector and in-sector collaboration, building on initiatives driving change in the energy sector and working to ensure that the common framework can be applied across all networks, both electricity and gas.

Learning will be disseminated through the duration of the project using "show and tell" sessions. The project plan includes a stakeholder engagement workstream focused on engagement with industry. Additionally, there will be an Advisory Group established to co-create the outputs.

Scale of Project

The project will be delivered following an agile approach over nine 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

TRL5 Pilot Scale

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

The project will be based upon the GB ESO and GT&M area of operations

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

Total: £534,904

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 deliver EDiT, were 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 attempt to write a Constitution of the Energy Digital Twin, or a Digital Twin Grid Code laying out the requirements, rules, and principles to which all constituent digital twins will have to be conformed 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, scale, and complexity of the project, it is not possible to quantify precisely the benefits that can be delivered 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 ESO RIIO-2, EDiT Report).

For these reasons, the project will undertake a detailed cost benefit assessment (Work Package 4) and will identify the best metrics to

track benefit to be delivered through the project and beyond. To ensure costs are controlled, this project has been proposed as short duration and limited scope designed to provide the evidence to support a CBA before any significant spend on build out.

Subject to further investigation to be completed during the project we believe it is beneficial to proceed with this activity because:

The cost of the wider proposal is low, estimated at around £6m, compared with the potential benefit, estimated at £10bn/year by 2050 onwards. These estimates do not include the additional benefit brought by wider digitalisation and better data interoperability across the energy sector. If we consider the System Operator's role alone, even a small improvement of 1% to the current the net balancing costs, due to better data-driven decision making, would translate to a saving of £13m/year.

There is strong stakeholder support for greater openness and transparency 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 will develop a 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.

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 be delivered with ongoing cross-sector and in-sector collaboration, building on initiatives driving change in the energy sector. Including GT&M as an additional partner on the project will also work to ensure that the common framework can be applied across all networks, both electricity and gas.

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.

The VirtualES programme is externally focussed on the development of an ecosystem of connected digital twins. It is distinct from current programmes for the development of our internal systems and data. These future systems will, in time, become part of the VirtualES by sharing outward from our systems and pulling in external data and models from the VirtualES.

Our users and stakeholders will be from across the energy sector and will include related sectors. It is critical that the programme avoids duplication by learning from and supporting other programmes e.g. EDiT, Networks, ENA Data and Digitalisation Steering Group (DDSG), Open Energy, National Digital Twin programme, Open Data Institute. We will endeavour to ensure these programmes are also represented in our future engagement. Where our interests are aligned, we will collaborate to deliver the requirements of the VirtualES and support their work.

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

There are numerous examples of cross-sector digital collaboration initiatives, but our horizon scanning has not identified any examples of the scale and scope planned for the VirtualES.

The energy system is changing rapidly and there is a critical need for enhanced modelling which can be achieved using interoperable digital twins supported by a common framework.

The volume of data needed to represent the energy system and the increasing number of observations generated in real time require transformational approaches to modelling.
Skywise, the UK BIM Framework, and Open Banking are examples of valuable cross-sector collaborations underpinned by digital infrastructure. Whilst they are outside the energy sector, their best practice in terms of approach, scope, and content can be applied. Particularly relevant learnings relate to data security in Critical National Infrastructure applications, the use of ISO and BS standards, and the need for governance entities and participation guidelines.

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 the best practice guidance, however, as the guidance is only high-level, it will also develop detailed guidance specific to the VirtualES implementation.

Based on the horizon scanning, the ESO believes a VirtualES of this scale and scope has not been achieved before. There is a need to build in a way that is scalable and aligns explicitly to the principles of the National Digital Twin programme and the Information Management Framework (IMF). 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 is to be developed and cross-sector coordination is challenging. Therefore, innovation is needed to create new knowledge and develop new collaboration tools.

The proposed Demonstrator helps to accelerate the development of the Framework. Starting from a defined user need the project will identify required standards and governance processes. The principles identified through the development of the Demonstrator will become parts of the enduring framework.

Without a VirtualES and common framework, the energy sector will increase data duplication 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.

Relevant Foreground IPR

The following Foreground IPR will be generated from the project:

- WP2.1 – Data needs & gaps report
- WP2.2 – Technology review report.
- WP2.3 – Interoperability report, data licensing template, and data sharing assessment demonstration
- WP3/4 – Benefits report on the use case, and Benefits report on the common framework

All relevant reports will be published on the Smarter Networks Portal.

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

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 business as usual (BAU) activity to deliver the ESO role. As such it is does not have allocated business plan funding.

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

Based on the horizon scanning, the ESO believes a VirtualES of this scale and scope has not been achieved before. There is also a need to build in a way that is scalable and aligns explicitly to the principles of the National Digital Twin programme and the Information Management Framework (IMF).

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 is to be developed and cross-sector coordination is challenging. Therefore, innovation and NIA funding is needed to create new knowledge and develop new collaboration tools.

The VirtualES application for SIF Alpha funding was unsuccessful on the basis that the project did not have a clear route to production and would benefit from smaller trials. This feedback has been explicitly addressed in this refined demonstrator project where NIA funding will enable continued development of the VirtualES.

This project has been approved by a senior member of staff

☑ Yes