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

Dec 2021

Project Reference Number

NIA2_NGESO0014

Project Registration

Project Title

A Common Framework for a Virtual Energy System

Project Reference Number

NIA2_NGESO0014

Project Licensee(s)

National Energy System Operator

Project Start

December 2021

Project Duration

0 years and 10 months

Nominated Project Contact(s)

Rhiannon Calado

Project Budget

£350,000.00

Summary

The ESO is developing the Virtual Energy System (VirtualES) Project to improve data driven decision making in an increasingly complex low-carbon energy system. The VirtualES project will create a digital twin of the GB energy system by integrating currently disparate models and data from stakeholders across the energy landscape.

A Common Framework is an essential underpinning for the VirtualES project. It will set out the technical standards and engagement principles which stakeholders can follow to collaborate and build an interoperable VirtualES. This integration will deliver new insights to improve investments, operation and participation, ultimately driving customer benefits.

This feasibility study explores the scope and content for a Common Framework, investigates how it can be informed by current best practice, and recommends possible delivery approaches.

Third Party Collaborators

Arup

Nominated Contact Email Address(es)

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Problem Being Solved

Traditionally, the energy system had a relatively small number of inputs, there were relatively few variables with a high degree of control, and there was limited consumer participation. The system could be planned and operated effectively using various individual models alongside knowledge from sector experts.

However, the energy system transition has brought the 4 Ds of Decarbonisation, Digitisation, Decentralisation and Democratisation. These factors have created a much more complex and interconnected energy system, which now needs correspondingly sophisticated tools to plan and manage it effectively and support participation.

Currently, many stakeholders have individual models and data sources which are not interoperable or shared openly. Therefore, these models and data cannot be combined to provide a more accurate representation of the whole interconnected system. As a result, investment and operational decisions can be limited by a lack of access to comprehensive system-wide analysis and consumers can't easily access information to support decisions on energy consumption.

To address this problem, a Common Framework is needed. It would set out principles, guidance and standards to enable the combination of currently disparate models and data and to facilitate the agreement of collaborative working arrangements. This would allow stakeholders to integrate their models and data together to create a VirtualES which facilitates better data driven decision making for day-to-day operations and energy transition planning, as well as supporting consumer participation in the energy system.

Method(s)

This project will be a desk-based technical feasibility study delivered with input from a wide range of stakeholders.

The project will:

- research relevant real-world examples of digital twins in order to recommend learnings which the Common Framework should incorporate and to indicate the cost and resource which may be required to develop the VirtualES
- explore and clarify the scope and key elements of the Common Framework, considering technical standards, commercial arrangements, and legal aspects, in order to highlight pertinent issues, outline options and identify gaps
- recommend approaches for delivering aspects of the Common Framework, which may include suitable delivery bodies, activities for stakeholder groups, recommendations for technical content, and roadmaps for further technical development
- Stakeholders will be able to input to this project at various stages through meetings, workshops, and questionnaires. This will include engaging Subject Matter Experts (SMEs) for technical advice and user stakeholders for feedback on the content and approaches proposed.

Risk Assessment

In line with the ENA's ENIP document section 3.2, the risk rating is mostly scored Low (Score 1).

TRL Steps = Score 1 (one TRL step from 2 to 3)
Cost = Score 1 (£350,000)
Suppliers = Score 1 (one supplier contracted)
Data Assumption = Score 2 (scope known but will be refined during the project and appropriate standards and guidance will be identified during the project)

Scope

The overall scope of the project is to clarify the key aspects of a Common Framework and recommend approaches for its further development.

The project will therefore cover:

- relevant digital twin work and best practice guidance from energy and non-energy sectors
- identifying the scope and key elements of a Common Framework, as well as any gaps; this may include technical aspects related to system architectures, modelling approaches and data standards and may also include collaboration aspects related to commercial and legal arrangements
- recommending specific options, approaches and activities for the next steps to deliver a Common Framework, including identifying delivery bodies, any gap filing work required and stakeholder engagement priorities

The ESO can directly deliver financial benefits from the VirtualES by feeding the new insights into the control centre, markets, networks, and strategy teams. Supporting operational decisions to improve day-to-day economic efficiency as well as strategic planning and market development to deliver value over the long term.

Energy sector companies, including Licensees, asset owners/operators and innovators, will also benefit from new insights. The

VirtualES can support investment decisions for asset deployment, operational decisions for actions coordination and asset optimisation, and cross-sector insights to enable a coordinated transition to a zero carbon energy system.

Consumers will also benefit, as the VirtualES enables them to be an integral part of the energy transition. VirtualES data can support consumers reducing their energy carbon footprint, enable their participation as prosumers with batteries and PV, and deliver full-chain flexibility from smart EV charging and heatpump operation.

Objective(s)

This project has the following objectives:

- Objective 1: to capture key learnings from relevant digital twin work and apply them as recommendations for the development of a Common Framework for the VirtualES
- Objective 2: to identify the scope and key elements of a Common Framework, considering technical standards and engagement principles, including identifying areas where gaps exist
- Objective 3: to set out delivery options and recommended next steps for developing the Common Framework as a whole and any specific aspects within it where there are gaps

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

This project is at an early stage, so it is not currently possible to quantify the impacts on consumers in vulnerable situations. System wide benefits to all consumers are detailed above, these will also apply to consumers in vulnerable situations. Whilst the VirtualES benefits might sometimes be more accessible to consumers not in vulnerable situations, it is not expected that the VirtualES will negatively impact consumers in vulnerable situations. The ESO will ensure that impacts on consumers in vulnerable situations are considered as the VirtualES programme progresses and will engage with consumer groups at a point when it is appropriate to identify any possible risks to consumers in vulnerable situations.

The VirtualES should provide consumers with better access to information which can support their decisions on energy consumption. However, consumers in vulnerable situations may have less opportunity to access and act on this information than consumers not in vulnerable situations. The VirtualES should reduce technical barriers by providing easier to access information, which should support consumers in vulnerable situations better. The VirtualES has the potential to support reductions in energy bills, if consumers are able to act on price information, which consumers in vulnerable situations may be less able to. The VirtualES has the potential to improve wellbeing as consumers can feel empowered and in control of their energy usage, however consumers in vulnerable situations may have the opportunity to exercise this level of control.

Success Criteria

To build the VirtualES, a Common Framework (covering technical standards and engagement principles) is needed to integrate currently disparate models and data across many stakeholders. By bringing these multiple models and data together, a more accurate view of the whole GB energy system will be available to multiple participants.

The project will be a success if the following learning is delivered:

- Clearly outlined development approaches and key elements of a Common Framework which are aligned with best practice across industry
- Specific options and recommendations for next steps to further define the common framework and fill any current gaps identified

Project Partners and External Funding

There are no Network Licensee project partners.

The project work is to be undertaken by Arup. Arup are leading a consortium which will deliver the project, with Energy Systems Catapult and Icebreaker One as consortium members working alongside Arup.

There are no external funding contributions.

Potential for New Learning

The ESO believes a VirtualES of this scale and scope has not been achieved before, therefore all project outputs are expected to be new learning, specifically:

- best practice guidance for energy sector digital twin development and integration
- what key elements a Common Framework should contain to deliver an interoperable VirtualES and support stakeholder collaboration

- a roadmap of possible activities to deliver a Common Framework

The overall VirtualES programme has the potential for substantial new learning for organisations across the energy sector. Organisations will be able to develop enhanced simulation capabilities by integrating with external models and data; this will give better data-driven decision making providing new learning in the best approaches to energy system investment and operation. The VirtualES will enable coordination across electricity and gas, and consideration of the electrification of heat and transport, to support the net zero transition. There will also be new learning related to future consumer dynamics, with the ability to integrate models of new forms of flexible demand such as electric vehicles and heatpumps.

Learning will be deiminated through stakeholder engagement events and publication of project reports online. In due course, the Common Framework itself will be made available for stakeholders to use when contributing their use cases and digital twins to the VirtualES.

Scale of Project

Arup will be delivering the work, including managing the SME and stakeholder engagement.
This small initial feasibility study is crucial to ensure the future VirtualES programme is underpinned by an appropriate and effective Common Framework. The benefits have the potential to be large as the VirtualES spans the whole GB energy system and can provide new insights to multiple stakeholders from Licensees to end consumers. These insights will enable increased consumer participation, drive more economically efficient decision making, and facilitate the new tools, markets, assets, business models and collaboration necessary for a zero-carbon energy system.

There is less potential for new learning of the project is smaller, as its key benefits are the integration across multiple stakeholders and the whole-system approach needed for an effective zero carbon transition.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

The VirtualES scope covers the whole GB energy system, although its constituent digital twins may be locational.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

Total: £350,000

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 energy system transition has brought the 4 Ds of Decarbonisation, Digitisation, Decentralisation and Democratisation. These factors have created a much more complex and interconnected energy system, which now needs correspondingly sophisticated tools to plan and manage it effectively and support increased consumer participation.

The VirtualES, underpinned by the Common Framework, is such a tool. By integrating multiple disparate models and data, the VirtualES provides more accurate and comprehensive simulations of a complex, low-carbon energy system. The analysis facilitates day-to-day operation and consumer participation through better data driven decision making, by accounting for sub-system interactions and multi-directional energy flows. The simulation capabilities also support longer-term strategic planning and investment to bring forward the new tools, markets and assets needed for a zero-carbon energy system.

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

Not required

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)

Not applicable.

Please provide a calculation of the expected benefits the Solution

Not required for this phase of work, as this is a research project to define a Common Framework to enable a VirtualES to be built. However, by taking a collaborative approach to defining the Common Framework, this project delivers benefits by avoiding unnecessary duplication of effort.

However, the overall VirtualES programme should provide multiple benefits to organisations across the energy value-chain, such as Generators, Suppliers, Network Owners, System Operators, Aggregators and Innovators. The benefits are realised by an integrated VirtualES which facilitates enhanced simulation capabilities which enable new insights to improve data-driven decision making. These improved investment and operation decisions ultimately deliver efficiency savings which are passed through to end consumers.

For example, if we consider the Electricity System Operator's role alone, the net balancing costs have been increasing, culminating at approximately £1.3bn in 2020. Even a small improvement of 1% due to better integrated data-driven decision making would translate to a saving of £13mn per annum. Many other organisations will be able to deliver their own efficiencies through implementation of the VirtualES and therefore multiply benefits across the economy.

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

The project scope already covers the whole GB energy system; therefore, a Common Framework will be applicable across GB.

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

Costs will be borne by various different stakeholders engaged in the VirtualES project and will depend on how they choose to participate and roll out into Business as Usual (BAU).

Roll out costs are not presently known, but will be investigated as part of this project, and will depend on the development options identified.

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 ESO will use the project learning to progress the development of a Common Framework, including gap filling activities. This process will include engaging relevant stakeholders in specific development activities.

A Common Framework across all networks (both electricity and gas) will enable energy system participants to collaboratively develop interoperable digital twins according to best practice guidance and technical standards. By integrating these individual digital twins into the VirtualES and collaborating with other stakeholders, they will gain new analytical insights which were inaccessible to them working in isolation.

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

Not required.

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 ESO believes a VirtualES of this scale and scope has not been achieved before, as such there should not be direct duplication. Whilst other organisations have developed individual digital twin type capabilities, they are often proprietary, siloed and limited in scope. As such, this coordinating project will create new benefits by joining together individual innovations from across the whole GB energy system under a Common Framework.

As a feasibility study, this project will research relevant real-world examples of digital twins in order to recommend learnings which the Common Framework should incorporate. This will include digital twin frameworks employed in other sectors, such as aerospace and banking, but will adapt these lessons to the new energy sector specific context.

The outputs of this project will be disseminated to industry through engagement events in order to support future compatible digital twin development projects, including development of use case projects for the VirtualES to deliver.

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

The ESO is facilitating an overall VirtualES programme with workstreams running in parallel to this Common Framework project. This wider work includes a stakeholder engagement workstream, to foster knowledge sharing, collaboration and coordination, and also a use cases workstream, to collaboratively develop digital twin capabilities for the VirtualES.

Whilst other organisations have developed individual specific digital twin capabilities, no one is developing a Common Framework for integration across the whole GB energy system down to the end consumer. Therefore, existing organisations are not delivering on the same scope and scale as this VirtualES project.

The examples below are illustrative of the multiple discrete models and individual data sets across the energy sector which are not currently integrated:

National Energy Systems Map
https://www.energynetworks.org/newsroom/new-digital-system-map-to-harness-the-power-of-data-to-deliver-net-zero

Geospatial network model

National Grid ESO Data Portal
https://data.nationalgrideso.com/

Network and market data (NG ESO also has various internal models e.g iEMS)

DNO Data Portals
e.g. https://www.westernpower.co.uk/our-network/energy-data-hub
Network and market data (DNOs also have various internal models e.g. DINIS)

Balancing Mechanism Reports
https://www.bmreports.com/
Market data (market optimisation models are available commercially e.g. Plexos, BID3)

Smart Metering
https://www.electralink.co.uk/open-data/
Smart meter asset data

FES Data Workbooks
https://www.nationalgrideso.com/future-energy/future-energy-scenarios
Future scenario modelling

Digest of UK Energy Statistics (DUKES)
https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes
Energy production and use data (Government also has various internal whole-system models)

Whilst there is some published best practice guidance for digital twins and energy sector digitalisation, the guidance is only high-level and is general in scope. This Common Framework project will build on the guidance, supporting the development of further detailed guidance specific to the VirtualES implementation. The VirtualES programme could deliver some of the recommendations to support energy sector digitalisation and will work closely with stakeholders to share learnings.

The examples below are illustrative of the current guidance and recommendations which are high-level:

Centre for Digital Built Britain (CDBB), Gemini Principles and National Digital Twin Programme
https://www.cdbb.cam.ac.uk/DFTG/GeminiPrinciples
https://www.cdbb.cam.ac.uk/what-we-do/national-digital-twin-programme

The Gemini Principles provide high-level guidance for the development of digital twins which can then connect into a wider ecosystem of digital twins across GB. The principles cover three key areas: Purpose (considering the Public Good, Value Creation and Insight), Trust (considering security, openness and quality) and Function (considering federation, curation and evolution).

Energy Data Taskforce & Energy Digitalisation Taskforce
https://es.catapult.org.uk/report/energy-data-taskforce-report/
https://es.catapult.org.uk/news/energy-digitalisation-taskforce-launches/
The Energy Data Taskforce set out high-level recommendations and principles for an integrated approach to energy sector data and digitalisation. The Energy Digitalisation Taskforce is developing these recommendations further, including consideration of digital architectures and governance across the energy system.

Additional Governance And Document Upload

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

The ESO believes a VirtualES of this scale and scope has not been achieved before, as such there is limited research on the content of a Common Framework to underpin it. Therefore, the findings from this project will be novel and innovation will be required to develop the recommendations.

The VirtualES scope is the whole GB energy system, which presents risks in terms of both scale and coordination. Research into a Common Framework is needed to see if viable integration approaches can be created which mitigate these risks.

Relevant Foreground IPR

The following Foreground IPR will be generated from the project:

Reports which include the benchmarking of existing digital twin work and best practice guidance, recommendations on key elements of a Common Framework and recommended options for next steps to deliver a Common Framework.

The reports will be published openly and written to be standalone documents, so no Background IPR will be required to use these results.

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 box.SO.innovation@nationalgrid.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 not an ESO BAU activity required to deliver the System Operator role today, so it is not defined specifically as a project in the RIIO-2 business plan. However, the business plan ringfences NIA funding for innovation projects to be created and undertaken. The VirtualES programme is a new activity, conceived since the business plan was written, it is not funded through the business plan or cost pass through and relies purely on innovation funding. Whilst this research project will build on existing work, it aims to create new solutions, hence it is high risk and innovative as it is not currently known what these solutions are or whether they are possible. The benefits of the ESO undertaking a coordinating role for this project extend beyond the ESO to multiple energy system stakeholders including end consumers, hence it goes beyond BAU activities as a project with much wider stakeholder collaboration.

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

This Common Framework project uses NIA funding, but sits within the wider VirtualES programme which will use funding from multiple sources, including NIA and SIF, as many parties will collaborate to develop different elements.

The large scale and scope of the VirtualES project, which ESO believes has not been achieved before, presents an overall programme delivery risk. Stakeholders from across the whole GB energy system will need to collaborate to resolve technical, commercial and legal differences which have not been considered before.

Delivering the Common Framework presents both technical and commercial risks. Developing a set of common industry standards will be highly complex, requiring new technical specifications and commercial arrangements to be developed and agreed.

This project has been approved by a senior member of staff

- [x] Yes