SIF Project Registration

Date of Submission

Mar 2022

Project Reference Number

10026595

Project Registration

Project Title

Virtual Energy System

Project Reference Number

10026595

Project Licensee(s)

National Energy System Operator

Project Start

April 2022

Project Duration

2 Months

Nominated Project Contact(s)

Jonathan Barcroft

Project Budget

£149,929.00

Project Summary

The ESO proposes to lead an industry-wide initiative to develop a digital twin of the entire GB energy system -- the VirtualES. This will be an enduring programme over a number of years, consisting of three interacting workstreams:

- Workstream 1 -- Stakeholder Engagement
- Workstream 2 -- Common Framework
- Workstream 3 -- Use Cases

This Discovery phase project supports the common framework workstream and will be used to understand what standards should be set out with participants to facilitate collaboration and compatibility. The common framework will provide a 'blueprint' so multiple parties can develop a wide range of digital twins which are interoperable and can interact using open data.

This project will explore with our partners key areas such as, but not limited to, cyber security, data quality, metadata, data ownership/storage, common attributes of digital twins, interoperability, technology, legal and regulatory issues, risks and potential use cases. We seek to understand the most challenging and high-risk elements so that these can be explored first in the 'alpha' phase, and then solutions refined further in the 'beta' stage, including testing use cases.

We envisage that VirtualES users will include network companies (Transmission Owners, Distribution Network Owners/Distribution System Operators, Gas Distribution Networks); generation asset owners and operators (wind farms, solar parks, thermal generators, batteries, interconnectors); retail companies; traders; aggregators and ultimately GB consumers. The VirtualES will provide these users with access to data and integrated modelling capabilities, to improve data-driven decision making for investments and

operations. The VirtualES should also prove useful to government departments, regulators, academics and think tanks to inform whole-system strategies, policies and regulatory decisions for the net zero transition.

The ESO will lead the project but since the VirtualES is whole-system, we have engaged project partners who bring the perspectives of electricity network asset owners (NGET, SPEN, SSEN Transmission, SSEN Distribution, WPD) and gas network participants (NGGT, NGN). To deliver the project we have also partnered with a technical consortium (Arup, Energy Systems Catapult, Icebreaker One) who bring considerable expertise in digital twins, systems-thinking and energy data.

The proposed project aligns strongly with the spirit of the SIF Innovation Challenges issued for 2021. The VirtualES, underpinned by a common framework, supports an integrated whole energy system transition and explores the role of the energy sector within the wider economy.

Third Party Collaborators

Arup

ScottishPower

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Problem Being Solved

National Grid ESO (ESO) is committed to driving the digitalisation of the GB energy system as innovation will play a crucial role in accelerating the net zero transition. This project addresses two key interrelated problems: that the energy landscape is becoming increasingly complex and interconnected, but that currently digital models are disconnected from one another and that data is often siloed.

Presently, there are numerous individual models of different parts of the energy sector -- using disparate data sources and largely running in isolation, leading to duplicated effort, inconsistent assumptions, and missed opportunities.

The GB energy landscape is becoming increasingly complex as we move toward achieving net zero. The energy system will need to have greater flexibility than today, and greater levels of integration; not only within the energy sector but also extending to other sectors (e.g. heat, transport).

This project aims to seize the opportunity for developing an integrated digital representation of the GB energy sector -- a 'Virtual Energy System'. This will be delivered by defining an underpinning common framework and identifying use cases through stakeholder collaboration. The vision is that multiple digital twins, developed by a wide range of participants, will join together for specific use cases to share data, analysis and learnings. In this way, individual models capturing the expertise of a participant in their own domain will form small parts of a much bigger whole.

The models will share data and interact with one another to better simulate scenarios and inform real-world decisions -- from investment timescales to realtime operations, leading to a more robust, resilient and efficient net zero energy system. Models of the energy sector will be integrated with digital models of other sectors of the economy -- so that wider impacts and implications can be understood, mitigated and optimised. This will serve the whole energy sector and beyond, resulting in benefits for GB consumers.

The ESO believes a Virtual replica of the energy system will accelerate innovation. It will provide third parties with (selective) access to the energy system representation, allowing for more ideas and solutions to be developed by the wider ecosystem.

The first step in making this vision a reality is to develop a common framework which enables all the models to interact with one another. This is the focus of this Discovery phase SIF application -- but we hope this will only be the start of the journey.

Project Approaches And Desired Outcomes

The Big Idea

This project addresses the wider competition aims of supporting whole system integration and, in particular, data and digitalisation. We will develop a common framework which enables organisations across the energy sector to integrate their digital twins, with the aim of delivering a coordinated net zero transition and increasing consumer benefits. The VirtualES addresses two of the Challengespecific requirements: (i) by providing enterprise and business processes which facilitate the flow of data within and between organisations; and (ii) by improving technical the interoperability of software platforms and data with other infrastructure sectors. Users can harness these capabilities to improve their network planning and operation approaches and facilitate the integration of electric heat and transport technologies.

The VirtualES will bring together multiple digital twins from stakeholders across transmission and distribution; as well as generators, suppliers, innovators, and local and national government. This is enabled by a common framework that will be open access for stakeholders to use as a blueprint to collaborate and integrate their own digital twins. Stakeholders will develop use cases that scope out a problem they cannot solve alone; then use the common framework to develop a solution on a foundation of interoperability and open access principles.

The project is at an early stage of development, which is appropriate for the SIF discovery phase. The ESO has mapped out the overall VirtualES programme scope and identified 3 workstreams to deliver it; with the common framework as a priority workstream that underpins the others. Initial research and engagement has been undertaken to identify:

- existing digital twins and best practice, for lessons learned and successful approaches;
- the overall scope of what the common framework is expected to cover;
- possible use cases for testing applications of the VirtualES.

In terms of IP arrangements, the VirtualES is made up of multiple individual digital twins, so following Chapter 9 of the SIF Governance document, we expect background IP will be retained by the owner with access and data sharing agreements facilitated by the common framework guidance. The common framework documentation itself will need to be available for dissemination and utilisation, this foreground IP will be licenced to different parties according to the individual terms in Chapter 9 of the SIF Governance document.

Innovation Justification

There are numerous examples of cross-sector digital collaboration initiatives, but our initial horizon scanning (see annex) has not shown up any examples of the scale and scope planned for the VirtualES.

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.

Within the UK energy sector there are many individual digital twins/models, but serving different purposes such as networks, markets, weather, behaviour etc. International engagement with AEMO (the Australian System Operator) revealed a similar situation: development of discrete models without an integrating framework and an ambition to develop a single Digital Twin that fits them all together.

Alongside specific projects, there are existing precedents that encourage collaboration that are relevant to the VirtualES. The Centre for Digital Built Britain has developed the Gemini Principles, which provide high-level guidance for digital twin development. The Energy Data and Digitalisation Taskforces have identified best practice considerations in key areas for energy system data and digital infrastructure. The Data Taskforce recommended the creation of a unified Digital System Map and common data standards, which the VirtualES and common framework could partially deliver. This common framework project will follow the best practice guidance, however, as the guidance is only high-level, we will 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. This presents development risks; the common framework content is unknown and cross-sector coordination is challenging. Therefore, innovation is needed to create new knowledge and develop new collaboration tools.

This is a cross-sector project, not a BAU activity required to deliver the ESO role. As such it is not a named project with allocated business plan funding. The current ESO business plan only contains very limited funding for innovation to enhance business activities, so smaller project elements of the VirtualES may draw upon NIA funding in parallel with this SIF project activity. However, the considerable scale and urgent need for cross-sector collaboration will mean that SIF funding and support is ultimately required to realise the end goal of the VirtualES.

Project Plans And Milestones

Project Plan And Milestones

The VirtualES will be an enduring challenge that is likely to take a number of years to reach full potential. Throughout this period, ESO will stand ready to drive forward the programme through intensive cooperation with participants to bring the project to fruition. Within the wider programme, we plan three workstreams:

1. Stakeholder Engagement
2. Common Framework
3. Use Cases

The activities within the discovery phase in this application relate to the common framework and identification of potential use cases to be developed in subsequent phases.

A competitive tendering process has resulted in the consortium Arup/ Energy Systems Catapult/Icebreaker One being appointed as our lead technical consultant for the common framework. The main work package to be delivered is fleshing out the best practice standards that we believe will need to be included within a common framework, with the ultimate intention of making sure that a range of digital twins developed by a large number of participants, using open data, can interact with one another. This will require subject matter expertise, hence engaging with our network partners (NGET, NGGT, SPEN, SSEN Distribution, SSEN Transmission, WPD and NGN) for their support and active contribution to the project.

During the discovery phase, we will follow an agile project management approach, consistent with the approach recommended by the Government Digital Service, and that entails five steps: (1) framing; (2) stakeholder, user and data research; (3) synthesis; (4) strategy; (5) document. Further information about each of these activities, the associated milestones, and our project plan, can be found in our annex.

The output of the discovery phase will be a recommendation of the standards that are needed and should be developed further in later stages.

During the discovery phase, we will develop a roadmap for a full package of work to develop the relevant standards; which will be aligned to later Alpha and Beta stages under SIF funding.

We have undertaken risk workshops to identify the main risks for the programme and how to mitigate them (see annex). This ambitious project brings significant commercial challenges (lack of clear vision; lack of short-term commercial incentives for stakeholders; overall project costs), technical risks (cyber security risks; data standards; sector readiness/maturity) and regulatory hurdles (complexity of digital/data regulatory environment; governance of the ongoing VirtualES; national security issues). During the discovery phase, we will mitigate such risks through the appointment of expert technical partners and through widespread industry engagement.

Route To Market

The route to market will be through creation of specific use cases with stakeholders across the energy sector. Upon discovering a problem they cannot optimally solve alone, stakeholders will develop a use case for integration with the VirtualES. Following the common framework approach, they will build standardised interfaces to their digital twins. They can then exchange data and outputs from other models within the VirtualES environment to model better solutions for their use case. These new insights can be used to enhance investment or operational decision making. Our aspiration is that working in accordance to the common framework approach would become business as usual; with the VirtualES evolving with every new use case.

The ESO has multiple models which could benefit from integration. If a common framework were available, existing models would be updated to be compliant; as would any new models. This project is supported by NGGT, NGET, SPEN, SSEN Distribution, SSEN Transmission, WPD and NGN, with whom we will be exploring potential use cases and see the value in developing their digital twins according to a common framework. There will be engagement with institutional bodies, academia, suppliers, aggregators, innovators, and consumer representatives, to bring a wide range of use cases and standardised digital twins into the VirtualES environment.

To deliver such use cases, stakeholders will need access to the common framework documentation and the ability to integrate with the VirtualES environment. A neutral party (possibly a Future System Operator role) will likely be required for governance and administration of the common framework, hosting the documentation and facilitating updates. A neutral party could provide common components and access via standard APIs, managing the coordination of these on a central platform, with necessary data access,

quality control and user support to assist stakeholders. An important component could also be the development of a consumer portal, for enabling secure data sharing with end consumers.

Providing these common services will incur modest operating costs, which could be recouped in various ways. Given the insights will have real commercial value, users could pay for access. However, given the benefits are for the public good, it may be appropriate for some services/access to be free at the point of use. An appropriate commercial model will be considered as part of ongoing project development activities.

By publishing the common framework as an open standard, it could, in time, form the basis of international best practice.

Costs

Total Project Costs

149291

SIF Funding

149291

This project has been approved by a senior member of staff

☑ Yes