national gas transmission

SIF Project Registration

Date of Submission

Mar 2022

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10020620

Project Registration

Project Title

Gas Networks Interoperable Digital Twin

Project Reference Number

10020620

Project Licensee(s)

National Gas Transmission PLC

Project Start

March 2022

Project Duration

2 Months

Nominated Project Contact(s)

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Project Budget

£79,644.00

Project Summary

Hydrogen is a strategic energy source to decarbonise the UK energy market and as such will place increased technical and operational demands on the existing gas network infrastructure. The development of a digital strategy utilising 'Digital Twins' (DT) will enable National Grid to work with partners such as SGN, NGN & ESO to optimise both the existing network assets and provide improved method of evaluating future systems designs through connected data streams.

Collaboration with these partners will eliminate the risk of each company developing their own standards and protocols for DT's in isolation which would mean that they cannot communicate. Each partner has valuable information and understanding about their assets and processes which will be shared to enable the future whole energy network digital twin. Other GDN networks will also play a part in the project through stakeholder engagement sessions.

RAVMAC are a digital transformation company with over 60yrs industrial experience in manufacturing and engineering systems, they have recently lead the technical development of BSI's Digital Interoperability project funded by Innovate UK the knowledge and technical insights gained into global digital (interoperability) standards will prove invaluable in shaping the Discovery Phase of this project.

It is envisaged at least in the early evolution of the technology development there will be several DT's cooperating and exchanging information to deliver the desired customer expectations within a designated supply chain. The overall ontology will describe and agree where and what DT holds the data and where interoperability is required e.g. in the gas network, each stakeholder (licensee) may either hold their respective DT for their organisational needs or collaborate in a shared DT domain to develop new operating practices and drive innovation. This approach ensures prime authorship, expertise and accountability remains with the appropriate stakeholders and ensures only data and information that meets the functionality and adds value is exported or imported.

An integral part of a DT development is standardisation - a repository of data, processes, and change management, a 'single source of the truth' of how the physical entity should perform and behave. As the DT evolves, more DT interfaces can be realised to improve line of sight and value within the system architecture, eventually building a complete picture of the network. These insights will enable

better system performance through improved information and decision making, resulting in lower operating costs, improved network interventions and lower consumer costs.

VIDEO - https://www.youtube.com/watch?v=FUDJnoPE6aA&list=PLrMOhOrmeR6ktSag0RbT7zPNVn0p1P2f6&index=29

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Problem Being Solved

Ever increasing industrial complexity, environmental challenges, new emerging economic threats, and global market instability in energy supply chains are driving increased demands on business performance, energy security, operating costs and consumer impact. The need to realise improvements in business resilience and efficiency are accelerating the need to explore and create capabilities in new digital solutions and techniques due to National Grid's growing complexity and limited operational insight.

The hydrogen strategy released by the UK government in August 2021 stated that in order to support the net zero targets of 2050, by 2030 there is an ambition to produce 5GWs of low carbon hydrogen. This ambition to provide low carbon hydrogen as a part of a suite of net zero energy sources provides clear guidance to the UK gas networks to progress our hydrogen transportation capability. The national transmission system (NTS) provides a supply of gas to 40 power stations, large industrial users and gas distribution networks from natural gas terminals situated on the coast. The NTS provides a resilient supply of natural gas today and aims to provide the same capability for hydrogen, especially in light of the variability in green hydrogen production.

In turn this variability in hydrogen production and the likelihood of gas blend variation in the transportation assets provides a large challenge in terms of complexity of the system and management. Real time monitoring will be required and we need to begin to understand how digital technologies can assist us, enabling deeper understanding of the combined energy networks and in turn enabling an efficient net zero energy solution. Networks are deploying digital systems through RIIO-2 that we must ensure can work together.

The **Made Smarter Review** conducted in 2017 cited three key enablers in digital transition to succeed, **Leadership** - more ambitious, informed, and focused leadership, **Adoption** - more widespread adoption of IDTs (Industrial Digital Technologies) across supply chains, and **Innovation** - faster innovation and creation of new IDTs. Whilst the energy sector is not specifically cited in the original recommendation of the MS Review, the fact remains that the energy sector is embarking on significant green energy transition through hydrogen to meet global climate impacts and is therefore well placed to collectively exploit and benefit from the use of digital capabilities to further mitigate environmental impact through improving operational efficiency through better democratised methods of real time data acquisition, aggregation, analytics and energy system modelling.

Project Approaches And Desired Outcomes

The Big Idea

This project aims to exploit the very best approaches afforded by digital transformation and the suite of industrial digital technologies emerging across several industrial sectors and providers, known as Industry 4.0. Whilst there remains a host of technologies purported to be available to prospective earlier adopters the fact remains, that any transformative actions require a clear and concise strategy and cohesive roadmap to create real business and customer value. The ability to capture existing operational interfaces and interoperability developed over many decades within an already complex and transitioning industry energy sector will necessitate a new and novel technology approach to meet the challenge. To achieve this, this project seeks to explore the value and benefits of developing 'Digital Twin' capabilities within the existing gas National Transmission System in readiness for future energy transitions supporting decarbonisation.

'A digital twin is a virtual representation of physical assets, processes, data exchanges within business systems enabling users to understand and model their performance, optimise operations, test scenarios, and manage maintenance regimes of physical assets, systems, and business processes -a digital knowledge repository' (RAVMAC)

The future existence of a digital twin(s) aspirational through an open source network and scalable products is seen to provide the platform to; enable better means of communicating within the gas network between operating businesses, highlighting the necessary connected assets through remote sensing through to providing seamless secure data exchange, with the ability to promote collaborative innovation and operational efficiency gains. This transparency of data will provide a future structured architecture to streamline data, remove redundancy and encourage standardisation. This is seen as an essential ingredient in transitioning the gas network to hydrogen energy in a more cost-effective and efficient way for vulnerable consumers.

Bringing the right expertise into the project will be key to forming the approach, the extent of the project ambition and emerging nature of digital twin interoperability should realise capabilities and technology breakthroughs for the whole energy sector. It is proposed that generated foreground IP will be shared amongst funded partners to further encourage collective innovation.

Innovation Justification

A preliminary literature search and consultation with technology providers and universities has revealed a great deal of research into Digital Twins, from academic research papers, proprietary software toolset development by technology providers, with several small scale locally developed projects, such as the Drinks industry and Construction Industry. Whilst the research covered relatively unrelated industrial applications it has provided valuable insight into how to shape the direction of this project.

As described in previous sections, embarking on an ambitious plan to develop a digital twin of existing operations need to be proven to an appropriate size, capable of being scaled and developed in future stages of the project evolution, namely the Alpha and Beta phase. The variety of available data around digital twin programmes researched varies dramatically, some have developed small scale solutions for specific machines, or small operations, very little exists beyond theoretical papers for large scale businesses or systems beyond bespoke laboratory environments, sighting the opportunities and citing specific digital twin subsystem technologies, without executing the theoretical opportunities in real, complex brownfield sites and organisations.

Having considered the available information from the literature search, it has clearly shown the necessity for a more holistic and very structured collaborative approach built on very clear plans formulated in the Discovery Phase. Foremost the need to understand and develop a well-constructed requirements activity aligned with National Grids business challenges in future hydrogen transition, considering the complex nature of the business operations whilst canvassing network stakeholder inputs to define the initial system boundary and map the extent of the systems interoperability requirements. This approach in the Discovery Phase is envisaged to provide a clear cadence of actions, where priorities and data gaps exist, and formulate an approach to demonstrate cohesion and proposed integration of demonstrable assets.

National Grid will be collaborating with ESO to gain learnings from it's 'Virtual Energy System -- Common Framework and Technical Parameters' SIF project and from SGN led 'Common Information Model Development' ; 'Green Hydrogen Digital Twin' and 'Gas Network Digital Twin' SIF projects and will be sharing knowledge from NIA projects such as 'Combined Visual Digital Twin' to ensure an strong interoperable digital twin roadmap can be developed.

Project Plans And Milestones

Project Plan And Milestones

The project will be managed by National Grid and led by RAVMAC with inputs from UK networks and technical leaders from across the UK. The project will be manged through several work packages enabling elements to be run in parallel as appropriate, enabling us to make the most of the 2-month period. As a digitalisation company RAVMAC have experience of agile approaches to delivery and will utilise this approach in the delivery of the work packages, bringing in key stakeholders as appropriate.

The project is split into 5 work packages which will be led by RAVMAC and supported by all gas networks.

Work Package 1 - Requirements and Use Cases

Looks at the requirements and use cases across the different networks and identifies those that have data sharing requirements that require systems to interact. This work package will interface with the electricity networks to develop a wider understanding of how the two energy networks may interact.

Work Package 2 - Optioneering

Takes the requirements and use cases and determines the required output via several concepts. These are then used to undertake technical optioneering with the many digital twin players such as IBM, Siemens etc.

Work Package 3 - Interoperability (Technical and Process)

Looks at the gas network standards that would be required to ensure interoperability of the digital twin systems. This work will not be limited to the technical requirements but also look at the business process alignment between the companies that enable historic and live data to interface robustly.

Work Package 4 - Demonstration Opportunities

Looks at the options for demonstration in the UK, such as the Acorn project and East coast hydrogen and determines the most beneficial option for developing the interoperable systems.

Work Package 5 - Transitional Pathway

Looks at the growing requirements from today's methane network to our net zero future network and the likely growing complexity. As we move towards net zero gases and blends it is likely we will need to understand the pipeline state at increased frequency to that today. This additional sensing capability and complexity needs to be considered as we develop our digital systems for 2050.

Risks and Constraints

Main risks identified are in the business, commercial and technical areas and these have been detailed further in the appendices with mitigation plans. Major constraints have been identified around cross-industry collaboration and security systems which has been factored into work packages.

Route To Market

The digital twin approach is seen as an integral part of National Grids digital transformation journey and can be found in many of the other energy networks digital strategies. The digital twin solutions will form an essential element to deliver and sustain a cost-effective decarbonised energy network for the UK. It is vital that whilst we each commence this journey for our energy network, we consider the part it will play in the wider energy network. As the owners of the national transmission system National Grid are in a complimentary position to bring together a consortium of Gas Distribution Networks that are connected into our system as customers along with power plants that link back into the Electricity network (in the net zero future this connection with Electricity will only grow through the production of green hydrogen). At this stage our consortium partners are limited to enable an agile approach to the feasibility phase bringing in other stakeholders as required through the project period. SGN and ESO are developing parallel activities in this subject area which will contribute to the interoperability strategy. In future phase we will look to expand our consortium in order to demonstrate a whole systems approach to digitalisation of the gas networks in a Net Zero energy future.

A supporting business case will be developed including, the strategic case, to determine the overall approach to digital adoption and relationship with the overall business objective and operational plans, the economic case to evaluate the overall value for money,

including the benefits to overall supply network and where trades exist to ultimately deliver the projected benefits to the consumers, a commercial case to determine partnerships, licenses and digital technology providers (preferably open source) necessary to deliver the required functionality defined and evolved from the Discovery Phase -- this would include in later stages a futures analysis to predict how digital technologies will evolve, and how this will impact the operational and organisational capability model in the existing business (such as skills and infrastructure), the finance case will review the return on investment, affordability and expenditure profile and ongoing commitments (considering the aspects raised in the commercial case) the final aspect will be the management case, to define the delivery mechanisms, mitigate risks, secure resources and develop plans to deliver the established objectives honed through the previous project phases to maximise value and minimise business impact.

Costs

Total Project Costs

79644

SIF Funding

78778

This project has been approved by a senior member of staff

☑ Yes