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Virtual Energy System

Common framework

Gas network demonstrator use case

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ESO national gas

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Summary

The purpose of the document, the demonstrator, and the importance of electricity and gas network use cases

Purpose of this document

This document provides potential use case options that can be used to demonstrate the common framework of the Virtual Energy System (VirtualES) for the gas networks.

Purpose of the common framework demonstrator

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

The framework considers both social (socio) 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.

When implemented the common framework will be a suite of artifacts, assets, and solutions that are deployable and re-usable by actors across the sector.

Following the example set by the National Digital Twin programme and their Climate Resilience Demonstrator project (CReDo), it was observed that communicating and ultimately implementing a complex and deeply technical concept, such as the VirtualES, is best achieved through a demonstrator that appeals to a wider audience – and rapidly proves that the framework theory can be implemented, that the concept is tangible, and the outcomes beneficial.

The purpose of the demonstrator is to:

- Develop and demonstrate the priority key socio-technology factors which forms the framework
- Develop an initial version of selected high-value components of the suite of artifacts, assets, and solutions
- Provide the first opportunity to test the interoperability and connectivity of energy data within the context of the VirtualES objectives
- Create a foundation for the VirtualES and future common framework development

Electricity and gas network use cases

This NIA-funded Alpha phase is supported by ESO and National Gas. The objective of the VirtualES is to include and consider both electricity and gas networks.

Given ESO's role in the energy system is currently electricity focused, the research and reports published to date have also been focused on the electricity network. This includes the whole electricity system flexibility use case definition proposed for the demonstrator, and the data needs and gaps that have been identified and evaluated in this document.

On scoping the Alpha phase, it had been proposed that a separate use case be understood at a high-level for the gas networks. As the Alpha phase progressed, it has become clear that a separate demonstrator use case should be explicitly developed in detail for either:

- The gas network individually, acknowledging the current demonstrator use case is electricity only.
- A coupled gas and electricity network use case, done in addition to the current demonstrator use case.

Overall, it is considered that in the future the electricity and gas use cases, if developed separately, will converge into a whole energy system demonstrator.

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On-going gas network projects relevant to the VirtualES

An analysis of the energy systems in relation to the gas transmission network

Overview

As part of the Alpha phase, the research team interviewed three National Gas teams: Operational Planning, Data Governance, and Network Planning.

Key insight gained from the interviews:

- High flexibility in operations compared to electricity network.
- On-going activities to bring organisation data into Azure environment.
- On-going work to define data standards related to the gas sector.
- On-going innovative projects to create a digital twin of the gas transmission network.
- Ability to publish data sets on external data portal for external consumption.
- Further studies required to understand data sharing risks with GDNOs, or other external parties. A user trust mechanism is not defined.

Gas System of the Future

Gas System of the Future Digital Twin ("GSOTF") - a project funded through the Strategic Innovation Fund (SIF) and led by Gas Distribution Network (GDN) SGN - sets up use cases for the VirtualES, and the need to support connectivity and collaboration across the sector.

The GSOTF project is the amalgam of two SIF Discovery Phase projects - a low-carbon hydrogen production system digital twin and a gas distribution network digital twin. One of the underlying ambitions of GSOTF has been to create two connected digital twin prototypes connected to different parts of the current and future gas network. Working closely with ESO, the GSOTF project team have produced valid and real-world gas industry use cases for the VirtualES.

The programme demonstrated the need for sector wide collaboration through use cases for gas demand forecasting, dispatching more gas from the National Transmission System (NTS) than forecasted, and hydrogen generation. A future energy system will need to be balanced, comprised of different energy sources (including gas and electricity), reliable, affordable, and sustainable.

This project did not receive SIF Round 1 Beta funding.

NIA National Gas Digital Twin Programme

The collaborative Visual Data Twin (CVDT) programme initiated by National Gas in February 2022 aims to use digital tools to look past the added complexity of system planning and management by advent of Hydrogen, and other decarbonisation initiatives.

One-way National Gas is maximizing the value of data and visibility of data is by making data more widely available to the wider sector. National Grid have been developing tools and techniques to enable this. They have been actively engaging with stakeholders to identify value opportunities for open data, particularly around datasets supporting innovation and decarbonisation and this project supports this ambition.

The programme is based on a Future Grid site at Spadeadam. Future Grid is a transmission hydrogen test facility which is being built to demonstrate how the NTS can transport hydrogen and how this will also interact with a distribution network. The use of this site to demonstrate novel technologies and ways of working when transporting net zero gases is important to enabling the efficient transition of the wider NTS assets. Modelling of assets and networks using combinations of BIM, simulation software and machine learning allows us to understand how an asset is and will behave.

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Potential gas network only use case options

Three scenarios for gas network use cases to demonstrate the benefits of VirtualES

1) Collaborative Approach to Shrinkage & Leakage

Shrinkage is combusted gas that isn't metered but used in either during routine operations or lost through theft. Includes: Own Use Gas and Theft of Gas.

Leakage is un-combusted gas escaping from the transportation system through leaking or venting equipment. Includes: low pressure and medium pressure mains, AGI leakage and venting and third-party damage.

Each GDNO uses the Leakage Model that was developed by Advantica and approved by Ofgem. GDNOs have a Licence condition to continuously examine ways of improving the accuracy of this model. The model is updated with large volumes of actual asset records and performance data which is reviewed and processed annually in order to provide an accurate Shrinkage RRP assessment.

Use case suggestion

This use case will explore how VirtualES can reduce the time taken to update the model from annually to quarterly bases, and incorporating data across all GDNOs and National Gas to create a holistic view of network shrinkage and leakage.

2) Geospatial Data

In Great Britain, National Gas look after 7,630km of high-pressure underground pipeline. Understanding where pipelines are is critical to providing a safe and reliable network.

National Gas have made a large investments in geospatial systems and data, increasing the granularity of pipeline records and removing legacy systems.

This has enabled National Gas to create a single source of data for pipelines, allowing them to align monetised risk models and pipeline safety risk models with core asset data. The key benefit is the use of consistent pipeline data across all our decision-making processes. Another project, CVDT project, will utilise this geospatial system in a digital twin to enable improved access to data and further insights into the NTS state.

Use case suggestion

This use case will explore how VirtualES can help CVDT project treat their geospatial data as a product, enabling sharing of high-quality, useable data.

3) Hydrogen Ready Area's

The Iron Mains Risk Replacement programme switches ageing iron gas mains with new hydrogen- and biomethane-ready piping, reducing methane natural gas leakage. ENA's research shows that by 2032, if investments plans are approved by Ofgem, the equivalent of 506,993 cars will have been taken off the road as a result of the gas networks-funded Programme.

VirtualES can enable faster decisions on Hydrogen investments by increasing the frequency of sharing between National Gas, GDNO's, and Industry.

Hydrogen Ready Area's are points in UK that have sufficient infrastructure to be a good candidate for hydrogen network conversion, hydrogen consumption, and/or hydrogen production.

Use case suggestion

This use case will explore how NGT network planning team can make investments decisions to future proof NTS based on information provided by GDNOs on hydrogen ready areas.

Next steps

Developing a coupled gas and electricity use case

Overview

This Alpha phase proposed that a separate use case be understood at a high-level for the gas networks.

As detailed on the previous page, three potential use cases were developed through interviews and engagements with National Gas teams.

The need for a gas or coupled gas and electricity use case was a reoccurring need and request that was observed through wider stakeholder engagements conducted for this workstream.

It is therefore recommended that a separate demonstrator use case should be explicitly developed in detail for either:

- The gas network individually, acknowledging the current demonstrator use case is electricity only.
- A coupled gas and electricity network use case, which will be conducted in addition to the current electricity system flexibility use case demonstrator.

Overall, it is considered that in the future the electricity and gas use cases, if developed separately, will converge into a whole energy system demonstrator.

Recommended next steps

As part of the next phase of development of the common framework, it is recommended that a coupled gas and electricity network use case be investigated and developed as a demonstrator. This use case will be conducted in addition to the current electricity system flexibility use case being developed.

The objective will be to develop the coupled gas and electricity use case to the same maturity and level of detail as the electricity network use case. To achieve this, it is proposed that the use case follows a similar three-step sequence of activities that were conducted for the electricity use case.

1. **Use case definition:** Investigate and develop an appropriate coupled gas and electricity network use case. This will require several user interviews with key members of ESO and National Gas to understand the use case. This is equivalent to the ***electricity use case report*** developed as part of the previous phases of the VirtualES.

2. **Data needs assessment:** Establish which key data sets are required to be sharable across the industry with the appropriate detail, frequency and granularity required for it to be used to fulfil the needs of the gas network use case. This is equivalent to the ***WP2.1 data needs and gaps report*** developed for the electricity use case as part of this Alpha.

3. **Interoperability report and wireframe of the demonstrator:** Develop the specific interactions between users, data, and technology through user journeys and process maps that set out the flow of key activities and the user interactions with the VirtualES. Then develop a visual representation of data sharing and complete a data sharing activity to demonstrate the benefit.

   This is equivalent to the ***WP2.3 interoperability report*** and ***data sharing assessment and wireframe*** developed for the electricity use case as part of this Alpha phase.

The methodologies and approaches developed and used for the electricity use case will be applied to the gas use case development to bring efficiencies to this scope.

The technology detailed in ***WP2.2 technology review report*** is applicable to both electricity and gas use cases and will be used when developing this use case.

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