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NIA Project Close Down Report Document

Date of Submission

Jul 2025

Project Reference Number

NIA2_NGESO077

Project Progress

Project Title

FastPress

Project Reference Number

NIA2_NGESO077

Project Start Date

March 2024

Project Duration

0 years and 6 months

Nominated Project Contact(s)

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Scope

Develop a Proof of Concept (PoC) solution by following the below steps. Note, PoC refers to an AI solution that is trained and tested, accompanied by user-tested front-end infrastructure, but is not yet fully deployed.

- Conduct user research with identified domain experts and end users to better understand requirements:
  -Work with the Gas Network Planning team to understand user needs and refine solution requirements.
  -Gather users UX requirements and key success metrics.
  -Understand the process of running static versus transient scenarios.
- Collect, assess, and examine available data, including:
  -Understand data access, availability of actuals, existing assumptions set and SIMONE configurations.
  -Understand the implications on network configurations caused by maintenance or outages.

- Develop PoC models that can analyse and categorise different scenarios in bulk, and inform the analysts of the prioritisation of different network scenarios, as well as
  -Develop a methodology for rapidly assessing (or scoring) outputs from SIMONE for different scenarios.
  -Create a similarity metric to compare two scenarios.
  -Develop a method to evaluate success of scenario and to estimate the best configuration.
  -Develop benchmarking of performance to assess quality of advice.
- Explore strategies for assessing the feasibility of future NTS configurations as the role of hydrogen grows.
  -Explore automated network configuration optimisation strategies that can assess scenarios with new NTS configurations for situations where there are limited historic simulations to base recommendations on
- Develop a plan for the Beta phase to optimise and refine model performance and deploy the live solution.

-Plan solution architecture for full deployment of solution.
-Develop a front-end tool/dashboard that can be tested with the end users.
-Set out an approach as to how AI could be explored optimise transient scenarios.

Objectives

- Develop a proof-of-concept solution to improve day-to-day decision-making on the NTS, by rapidly assessing past inputs / outputs on similar observed days.
- Improve operational decision-making by leveraging AI solutions to enhance modelling capability and maximise the value of expertise held within ESO.

Success Criteria

- The PoC demonstrates an ability to identify close to final network configurations in ‘sufficient’ cases (with ‘sufficient’ defined and agreed with end-users)
- The PoC demonstrates an ability to calculate the acceptability of a given network configuration for a scenario, using SIMONE in an automated manner such that analysts can quickly identify which scenarios require further assessment.
- There is agreement from ESO end-users that the PoC tool demonstrates potential to result in ‘material’ improvements to existing ways of working once fully tested and deployed in future phases (e.g. through time savings).

Performance Compared to the Original Project Aims, Objectives and Success Criteria

Project Overview

The project aimed to develop a proof-of-concept solution to improve decision making on the National Transmission System (NTS), by utilising AI solutions to support the expertise within NESO. The main differences between the planned project scope and project delivery to date have arisen due to the need to reconcile the innovative approaches of the project work with the existing modelling framework used operationally.

The work focussed on supporting static end of day gas network analysis, with transient analysis outside of the project scope. The project delivered a major step towards delivering multi-scenario modelling, increasing the speed by which network scenarios can be analysed and creating a larger library of solved scenarios, allowing for improved understanding of the capability of the NTS. Several cutting-edge AI and mathematical modelling techniques were used, and some beneficial interim steps have been delivered.

Project Outputs

Discovery Phase – this involved extensive user research through interviews with members of the NESO Gas Network Planning team, to understand the roles of the network analysts and where AI-enabled tools would have potential to improve their workflow. Exploratory data analysis was undertaken on datasets of both solved and unsolved static scenarios, given as outputs of the SIMONE software, covering base, entry, and exit capability analysis. This allowed an understanding of the similarities and differences between scenarios in terms of supply and offtake flows, and compressor settings. Finally, various AI features were identified which had potential to address some of the challenges discovered.

The findings of the Discovery Phase were summarised in a final report. This phase successfully delivered on the project scope of working with the Gas Network Planning team to understand user needs and requirements, understand the process of running static and transient scenarios, and understanding data access and the configurations used to run the SIMONE (external modelling software). The work led to a focus on supporting a specific part of network analysis, namely automating the process of solving static gas scenarios, and a mapping as to how the various potential proof-of-concept tools may link together towards this overall goal, as well as bring value individually.

Alpha Phase – this involved development of several tools to proof-of-concept level.

The Base Scenario Solver (BSS) is a tool which will automatically solve static base scenarios, to a level that would pass Standard Operating Procedure audits, and be deemed acceptable by network analysts. Several complex procedures are undertaken by network analysts when solving static scenarios, and accordingly several component PoC tools have been developed to mimic this workflow.

The development of the BSS aimed to demonstrate the feasibility of automatically solving static scenarios within a reasonable timeframe. While the model has not yet reached the stage of regularly producing fully solved scenarios, it has shown promising capabilities by consistently improving upon the results provided by the Start Point Finder, which represent the current best approach to 'automatically' solve scenarios. This demonstrates the potential for automated solution discovery using the approaches described. To achieve the objective of generating fully solved results, further enhancements are necessary. These improvements will address aspects such as solution quality and operational consistency, ensuring the BSS reaches its full potential.
From the perspective of running in a reasonable timeframe, the model currently plateaus in solution quality within a timeframe of roughly 2 hours on a VDI without any parallelisation . This is very likely to change, as the BSS has not yet undergone any major re-designs for speed improvements, and the speed could be significantly improved by both general improvement to the model and the other speed improvements discussed. However, the BSS could also require additional time when we build in the required improvements to reliably reach solved scenarios. Given the initial concern that the solution space might be excessively large for any effective exploration (let alone exploration on a timescale that allows for the solver to be helpful as part of gas analyst workflows), the current timescales are encouraging and indicate that the BSS is potentially viable as a tool for analyst workflows.
Thus, while further work is required to refine the BSS and attain fully solved scenarios, the foundation laid by this project suggests promising prospects for future development.

In addition to the Base Scenario Solver, the discovery phase identified potential for the automatic identification of appropriate gas network pipes to be removed from the national transportation system. This was an ambitious and speculative line of research. The exploratory data analysis revealed a rich dataset that was previously unexplored, enabling data-driven planning for pipe removal operations. Using metrics such as edge centrality, distance to offset nodes, and bridge identification, the project narrowed down the candidate pipes from over a thousand to approximately a few hundred - an ~80% reduction in scope. The selection criteria can be easily modified to accommodate different objectives and contexts for pipe removal.
However, some factors limited the approach. For some of the functional analyses, our results would have been more robust with a larger number of sample points, additional valid scenarios, and a broader sampling of potential network configurations. This expanded dataset would allow for a finer determination of the gas flow directions, enabling us to create a more precise directed graph. This, in turn, would enhance our ability to detect if multiple pipes operate in parallel or series, helping to identify pipe co-dependencies (series) and redundancies (parallel). The conclusion from the pipe removal workstream was that it would not be suitable for further work within this or follow-on innovation projects.

The completed work in the Discovery and Alpha phases have been crucial steps to deliver on the project objective of developing a proof-of-concept solution to improve day-to-day decision making on the NTS, by supporting an improved process for static gas network analysis.

Required Modifications to the Planned Approach During the Course of the Project

It was decided not to progress the Pipe Removal Recommender system design into future innovation projects, due to higher priority being given to the Base Scenario Solver, which has greater potential benefit to supporting network analysis. This work exploring adaptability to future NTS configurations was not delivering the benefits hoped for.
Secondly, exploration of potential improvements to the NESO demand, supply, and flow forecasting tool was discontinued, to keep the project focussed on providing tools to support network analysis in SIMONE.

Lessons Learnt for Future Projects

There were challenges in free-platforming the work into Azure, in order to connect external support to a Critical National Infrastructure system. Appropriately strict IT controls meant delays in the project partner being able to access the SIMONE software used to undertake the technical analysis, and so there are lessons to be learned from underestimating the timescale of this challenge.

The project has benefitted from a fail-fast approach, which could be applied to other innovation projects. For example, it was identified quickly that the pipeline removal clustering approach was falling outside the scope of the project, and so resources were diverted to areas of higher benefit.

Note: The following sections are only required for those projects which have been completed since 1st April 2013, or since the previous Project Progress information was reported.

The Outcomes of the Project

Several tools have been developed during the project which have the potential to provide benefit to static end of day gas network analysis.

The following tools using AI models have been developed to PoC stage:

- The Start Point Finder – this tool compares a new scenario with a database of previously solved scenarios. By providing helpful starting points, the time to solve a new scenario can be reduced
- The Solution Scorer - this tool compares the results of a scenario solution to the defined scenario limits and requirements, to assess how close an intermediate solution is to an acceptably solved solution. It also helps to identify scenarios where network assets are close to their limits, highlighting which scenarios may have greater or less resilience.
- The Fixed Pipe Removal Recommender - this recommends which pipes can be removed in response to the potential network changes. Two strategies were explored, one based solely on the topology of the gas network and the other also considering the relevant gas flow dynamics.

Additional undertakings and learnings as part of project development
In addition to developing the proof-of-concept tools, the following activities were undertaken:

User research to understand the gas network, its configurations, assumptions, data requirements, system development requirements, user requirements, and expert support from NESO Gas Network Planning team and National Gas Transmission. This undertaking was deemed successful by the project partner as having received the necessary expert inputs, data, assumptions, and network configurations to develop new AI-based solutions for the innovation project.
Initial data exploration of the available data was performed by the network zones across gas entry and exit scenarios to understand if any biases exist in the datasets. The results outlined significant bias as most of the current analysis were focused on Scotland Entry. The project partner continued to work with stakeholders to obtain more data needed to provide greater balance on the datasets to train the AI models being explored.
Due to the very large quantities of features available in the datasets to train these AI models, early exploration focussed on reducing the dimensionality of the datasets to obtain a lower-dimensional space of data points that preserves the key features in the datasets to enhance the AI model performance. This investigation reviewed entry capability across supply flows alongside compressor station settings providing useful similarity in the obtained outputs.
The similarity metric to compare two scenarios was developed in the phase using Cosine similarity scoring metric which outlined the how close the scenarios were. This assessment proved helpful to better understand the reduced dimensional data, exploring both supply and demand flow patterns across the network.

Data Access

Details on how network or consumption data arising in the course of NIA funded projects can be requested by interested parties, and the terms on which such data will be made available by NESO can be found in our publicly available “Data sharing policy related to NIA projects (and formerly NIC)” and Innovation | National Energy System Operator.

National Energy System Operator already publishes much of the data arising from our NIA projects at www.smarternetworks.org. You may wish to check this website before making an application under this policy, in case the data which you are seeking has already been published.

Foreground IPR

A report 'Fastpress Project: Alpha Report' dated November 2024 has been produced. The report details the work completed, along with all outputs delivered and proposed next steps.

In summary, the project has delivered proof of concept models which comprise
a) code which resides on a NESO owned Azure platform,
b) conceptual model for the code and associated data (background IP),
c) results from running the proofs of concept,
d) proposed plans for next steps, and
e) knowledge of how to integrate and run the Simone software on NESO's instance on an Azure platform.

The final report is available on ENA Smarter Network Portal - link

Planned Implementation

The following tools were proposed to undergo further development as part of a subsequent (Alpha Plus) innovation project (NIA2_NESO110):
Limit Violation Checker – this thoroughly validates the output of a SIMONE scenario against all network requirements to ensure test compliance (including, but not limited to, the node pressure and temperature, compressor station and unit pressure, multi-junctions matching configurations and linepack balance). This process generates a pass/fail result, effectively replacing the need for manual analyst evaluations.
The Base Scenario Solver – this uses an evolutionary algorithm to automatically find settings that improve the scenario solution. By systematically searching through the range of possible configurations until a sufficiently optimal solution is found, this tool will speed up the process of solving static end of day scenarios.

In addition, the Capability Limit Finder tool was proposed to be explored as part of the AlphaPlus project (NIA2_NESO110). This tool will identify the capability threshold by adjusting pressures based on current and historic data. Currently, pressure increments during a capability test are varied manually and not directly informed by past attempts, so this tool could be beneficial.

Net Benefit Statement

The project aimed to enhance gas network planning at NESO through AI-enabled tools, with vital benefits including automation of manual workflows by significantly reducing the manual effort required by gas network planning analysts. The successful delivery of Proof-of-Concept models and outputs from testing those models completes a necessary step towards being able to run a greater number of gas transmission network analysis models. This will reduce the costs to consumers through better management of capacity constraints on the NTS, and through co-ordination of network planning between natural gas and hydrogen transportation networks.
Further details of benefits are given below:
Previously, solving SIMONE scenarios involved repetitive, time-consuming, and subjective processes. The introduction of Proof-of-Concept tools like the Base Scenario Solver (BSS), Limit Violation Checker (LVC), and Start Point Finder (SPF) automates key steps of the workflow, enabling faster and more consistent scenario resolution. It also provides improved efficiency and analytical capacity by automating scenario solving and validation, so that analysts can now process more scenarios in less time. This increases NESO's capacity to explore a broader range of configurations and future network states, which is critical for strategic planning and resilience testing.
Exploratory work on pipe removal developed a data-driven methodology for identifying redundant or low-utility pipes. This supports NESO's long-term goals of network optimisation and decarbonisation by enabling smarter decommissioning strategies.
The modular design of the FastPress tool, including its roadmap for AlphaPlus project NIA2_NESO110, ensures that it can be scaled and adapted to future needs. These include integration with NESO's cloud infrastructure and the potential to support transient scenario solving, alongside hydrogen network planning. The multiple rounds of user testing and iterative wireframe development ensured that the tool aligns with analyst workflows.
Overall, the project provides enhanced consistency by enforcing standardised methods for scenario evaluation, reducing variability between network analysts, and improving the reliability of outputs. This is particularly important for regulatory compliance and auditability and acts as a foundation for future innovation and development, including a holistic pipe removal pathway planning, resilience testing automation, integration of ML models to predict SIMONE outcomes and enhanced front-end interfaces.

Other Comments

The Project outcomes and results contain confidential information and intellectual property rights that cannot be disclosed in this Report due to their proprietary nature. Should the viewer of this Report ("Viewer") require further details this may be provided on a case by case basis following consultation of all Publishers. In the event such further information is provided each and any Publisher that owns such confidential information or intellectual property rights shall be entitled to request the Viewer enter into terms that govern the sharing of such confidential information and/ or intellectual property rights including where appropriate formal licence terms or confidentiality provisions. Dependent upon the nature of such request the Publishers may be entitled to request a fee from the Viewer in respect of such confidential information or intellectual property rights.

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