NIA Project Close Down Report Document

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.
Network Licensees must publish the required Project Progress information on the Smarter Networks Portal by 31st July 2014 and each year thereafter. The Network Licensee(s) must publish Project Progress information for each NIA Project that has developed new learning in the preceding relevant year.

Date of Submission

Jul 2024

Project Reference Number

NIA2_NGESO061

Project Progress

Project Title

VoltaVisor

Project Reference Number

NIA2_NGESO061

Project Start Date

October 2023

Project Duration

0 years and 6 months

Nominated Project Contact(s)

Marian Kantor (ESO)

Scope

Currently, voltage advice for the week ahead is generated using simulations from PowerFactory software (a power systems model of the electricity transmission network), a process that takes approximately a week for Voltage Engineers to produce. In particular, Voltage Engineers spend considerable time manually inputting and adjusting different scenarios and contingencies, a process which is inflexible in adapting for last minute changes (e.g. plant outages).

By examining the relationship between voltage, forecasted national demand, planned outages, and commonly seen patterns of advised voltage support, this project aims to deliver rapid voltage advice under most circumstances utilising AI techniques. The end solution will be used by voltage engineers to rapidly understand the total amount of support required and assess potential combinations of plants and other reactive equipment to mitigate high overnight voltages.

This solution has scope to deliver significant time savings for voltage engineers, providing initial recommendations within minutes, as opposed to hours and days using existing methods. In turn, this can enable the ESO to test a wider set of scenarios than would have been possible before. This not only has benefits for time saved but also acts as an extension of existing capability, further improving system resilience and the quality of advice provided.

Objectives

This project aims to deliver a PoC AI solution to provide rapid voltage advice, namely, a solution that has been trained and tested on historical data but is not yet deployed on ESO infrastructure. The specific objectives of the project are to develop:

- A PoC model that identifies the amount of voltage support (in MVars) required in each region (for the time corresponding to minimum demand, overnight on weekends), and possible combinations of plants and reactive equipment (e.g. SVCs, VCCs, SRs) to deliver it, based on relationships identified from historical data. This will include initial designs of a front-end user interface to represent how the bespoke software would be integrated into decision-making
- A plan for full deployment during a prospective phase based on engineering discovery activities combined with user research (deployment out of scope of this phase).

Success Criteria

The project will be deemed successful if the following criteria are met:

- Voltage advice provided by a PoC solution, validated through acceptance testing with Voltage Engineers and a wider ESO Steering Group.
- Statistical benchmarking of advice provided by the tool relative to prior voltage advice and/or voltage control reports documenting observed actions undertaken by ESO.
- An approved front-end interface facilitating buy-in from end users.
- Clear plan for deployment if successful

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

National Grid Electricity System Operator ("NGESO") has endeavoured to prepare the published report ("Report") in respect of VoltaVisor, NIA2_NGESO061 ("Project") in a manner which is, as far as possible, objective, using information collected and compiled by NG and its Project partners ("Publishers"). Any intellectual property rights developed in the course of the Project and used in the Report shall be owned by the Publishers (as agreed between NG and the Project partners).

The Report provided is for information only and viewers of the Report should not place any reliance on any of the contents of this Report including (without limitation) any data, recommendations or conclusions and should take all appropriate steps to verify this information before acting upon it and rely on their own information. None of the Publishers nor its affiliated companies make any representations nor give any warranties or undertakings in relation to the content of the Report in relation to the quality, accuracy, completeness or fitness for purpose of such content. To the fullest extent permitted by law, the Publishers shall not be liable howsoever arising (including negligence) in respect of or in relation to any reliance on information contained in the Report

Introduction and Project Overview

The VoltaVisor project aimed to revolutionise voltage management advice during periods of low electricity demand. Traditionally, this advice is generated through PowerFactory simulations, a laborious process that takes a significant amount of time for Voltage Engineers to complete, involving manual input and adjustments. This project sought to harness artificial intelligence (AI) to provide rapid, accurate voltage advice, enhancing operational efficiency, flexibility, and system resilience.

Work Package 1: Initial Prototype Development

The first work package was dedicated to the development of an Alpha proof-of-concept (PoC) prototype. This prototype was designed using Python and featured a web-based graphical user interface (GUI). The methodology involved creating a user-friendly platform where Voltage Engineers could input assumptions and instantly receive voltage management advice. The tool incorporated data on outages affecting reactive equipment and generators providing MVAr support, though it did not account for circuit outages.

Despite its limitations, this prototype represented a significant advancement in automating voltage advice. Feedback from GB Voltage Engineers highlighted areas for improvement, such as inaccuracies in the advice provided, where the tool suggested an excessive number of synchronous generators compared to what was actually required. This feedback was invaluable, guiding further refinement to align the tool more closely with operational needs.

Work Package 2: Data Source and Quality Assessment

Given the challenges in extracting historical electricity transmission status data, the project pivoted to using daily Voltage Management reports from the Electricity National Control Centre (ENCC) over the past five years. This alternative data source required significant effort to ensure data quality and consistency. The methodology involved meticulous data correction and alignment, as matching data from different sources proved difficult.

Despite these challenges, the project successfully identified and utilised an alternative data source, underscoring the importance of robust data quality assessment and accessibility as foundational steps for any automation project. These efforts laid the groundwork for future improvements in data integration.

Work Package 3: Evaluation of Prototype Performance

The evaluation phase focused on assessing the performance of the Alpha prototype. This involved rigorous testing by GB Voltage Engineers, who provided detailed feedback on the tool's functionality. The methodology included comparing the tool's advice against real-world scenarios, both historical and hypothetical.

The evaluation revealed that the prototype could not include circuit outages as inputs due to limited historical data, restricting its functionality. Additionally, the accuracy of the voltage advice was not at the desired level. However, the user interface was praised for its usability and visual appeal, providing a strong foundation for future iterations. These insights are crucial for guiding the next phases of development.

Work Package 4: Analysis of Rapid Voltage Support Approaches

Faculty AI conducted an in-depth analysis of various approaches for rapidly providing overnight voltage support. This involved examining the relationship between national demand forecasts, outages, and voltage advice patterns. The methodology included

leveraging Integrated Energy Management System (IEMS) data to identify common patterns of generator, circuit, and reactive equipment operations.
The analysis focused initially on nighttime voltage control and aimed to extend to other times. Although the prototype did not fully meet expectations, this phase demonstrated the feasibility of using AI for rapid voltage advice. The foundational work conducted sets the stage for developing more advanced models and refining the tool's accuracy and reliability.
Work Package 5: Recommendations and Future Steps
Based on the project's outcomes, several key recommendations were identified for future initiatives. Ensuring robust data quality assessment and accessibility is critical. The methodology should include close collaboration with network planning and IT teams to ensure successful data integration and tool deployment. The next phase should focus on refining the PoC model, developing a comprehensive solution architecture, and conducting extensive user testing.
Monitoring systems will be essential to detect and address unexpected issues or data drift, ensuring the tool's reliability and accuracy. These recommendations will inform the development of a more robust and responsive voltage management solution.
Conclusion
The VoltaVisor project has made good strides in exploring the potential of AI for voltage management advice. The methodologies followed in each work package provided insights and established a solid foundation for future development. While the Alpha prototype faced challenges, the learnings from this project will guide subsequent efforts, paving the way for more accurate, reliable, and responsive voltage management solutions.

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

Throughout the VoltaVisor project, several key modifications were necessary to address unforeseen challenges and ensure the project's progression. Initially, the project aimed to utilise historical electricity transmission status data, but extraction issues led to the adoption of daily Voltage Management reports from the ENCC. This change required extensive data correction and alignment, highlighting the critical need for flexibility in handling data challenges. Additionally, the tool's functionality was adjusted to focus on outages affecting reactive equipment and generators, as limited historical data on circuit outages prevented their inclusion. Feedback from GB Voltage Engineers revealed inaccuracies in the tool's advice, prompting iterative refinements to improve its accuracy and practicality. Emphasis on developing a user-friendly interface became more pronounced, ensuring the tool's usability despite technical limitations.

These modifications underscored the importance of adaptability, robust data quality assessment, and user engagement in the project's success. Strategic recommendations for future phases included closer collaboration with IT and network planning teams and a focus on addressing foundational data issues, whilst also ensuring deliverables were measurable against an agreed set of criteria. While the Alpha prototype faced challenges, the insights gained from these adjustments laid a solid foundation for future development.

Lessons Learnt for Future Projects

The VoltaVisor project provided valuable insights that will inform the planning and execution of future initiatives. One of the foremost lessons learned is the critical importance of data quality and accessibility. Initial difficulties in extracting historical electricity transmission status data led to significant project modifications. Future projects should prioritise a comprehensive data assessment phase to ensure the availability and consistency of required data sources. This proactive approach will mitigate risks associated with data integration and enhance the reliability of outcomes.

Another key lesson is the necessity of flexibility and adaptability in project management. The ability to pivot to alternative data sources and adjust project scope based on available information proved essential in maintaining progress. Additionally, iterative testing and incorporating user feedback were crucial for refining the prototype and aligning it with operational needs. Emphasising user engagement from the outset ensures that the developed tools are both functional and user-friendly. Finally, close collaboration with IT and network planning teams is vital for successful data integration and tool deployment, highlighting the need for interdisciplinary cooperation in complex projects. These lessons will guide future efforts in developing innovative and effective solutions.

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

Despite encountering several challenges, the VoltaVisor project yielded outcomes that provide a solid foundation for future advancements in voltage management. The primary achievement was the development of an Alpha proof-of-concept (PoC) prototype designed to deliver rapid voltage advice using AI techniques. This prototype, created in Python with a web-based GUI, enabled Voltage Engineers to input assumptions and receive immediate voltage management advice. Although the tool's functionality was limited to outages affecting reactive equipment and generators, it represented a notable step towards automating the traditionally manual and time-consuming process.

Additionally, the project successfully demonstrated the feasibility of using alternative data sources, such as the ENCC's daily Voltage Management reports, when initial data extraction proved problematic. This adaptation highlighted the project's flexibility and the team's problem-solving capabilities. The user interface of the prototype received positive feedback for its usability and visual appeal, indicating strong potential for user engagement in future iterations. Furthermore, the project underscored the importance of rigorous data quality assessment and iterative refinement based on user feedback, providing crucial insights for subsequent phases. Overall, the VoltaVisor project established a critical understanding of the challenges and potential in developing AI-driven voltage management solutions, paving the way for more advanced and accurate tools in the future.

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 National Grid can be found in our publicly available “Data sharing policy related to NIC/NIA projects” and www.nationalgrideso.com/innovation.

National Grid Electricity System Operator already publishes much of the data arising from our NIC/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

- Source code and documentation has been provided by the developer
- Due to the confidential nature of the information contained in the reports, these will not be uploaded to the Smarter Networks Portal but can be shared with wider network licensees upon request.

Planned Implementation

While the decision has been taken not to progress the VoltaVisor project into subsequent phases through NIA funding, the initial work has laid a foundation that we are now exploring internally. The development of the Alpha proof-of-concept (PoC) prototype and the insights gained have provided valuable lessons and a clear direction for future efforts in voltage management automation.

Internally, we plan to build on the knowledge acquired during the project to explore enhancements to the tool. This will involve addressing the key challenges identified, particularly around data quality and integration. A comprehensive data assessment phase will be prioritised to ensure the reliability and consistency of the information used. Additionally, the focus will be on enhancing the tool's functionality to include circuit outages and other critical factors, aiming for a more accurate and comprehensive voltage management solution.

Net Benefit Statement

Despite its challenges, the VoltaVisor project has generated significant net benefits for the ESO and wider network licensees that will extend beyond the initial phase of development. By exploring AI-driven approaches for rapid voltage management, the project has demonstrated potential efficiencies to streamline operations and reduce response times during low-demand periods. This capability not only supports Voltage Engineers in their decision-making processes but also enhances the overall resilience of the electricity transmission network.

The insights gained from the project highlight the importance of timely and accurate voltage advice, which can ultimately lead to improved operational planning and reduced costs. By enabling more responsive outage management and informed decisions regarding reactive support, the project paves the way for enhanced customer satisfaction among Transmission Operators (TOs) and Distribution Network Operators (DNOs). Additionally, the lessons learned about data quality and integration will inform future projects, ensuring that the ESO and its partners can build on this foundation to develop more advanced, reliable tools that support the evolving needs of the network. Overall, the VoltaVisor project contributes significantly to the ongoing innovation within the electricity sector, positioning the ESO and network licensees for greater efficiency and operational effectiveness in the years to come.

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.

Standards Documents