NIA Project Annual Progress Report Document

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Date of Submission

Jul 2023

Project Reference Number

NIA2_NGET0002

Project Progress

Project Title

Role and value of electrolysers in low-carbon GB energy system

Project Reference Number

NIA2_NGET0002

Funding Licensee(s)

National Grid - Gas Transmission (GB wide)

Project Start Date

June 2022

Project Duration

1 year and 4 months

Nominated Project Contact(s)

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Scope

Task 1 [M1, M10 and M12]: Review of long-term scenarios for the UK

Subtask 1.1 [M1]: This activity will involve selecting a set of credible future development scenarios used in the analysis considering a range of scenarios from the CCC (including CCC sixth Carbon budget, the climate change risk assessment), BEIS (the climate change report just published), and National Grid FES to achieve net-zero 2050 targets.

Deliverable 1 [M1]: Report on set of decarbonisation scenarios for simulation studies.

Task 2 [M2-M4]: Update of the topology and parameters of the integrated model for electricity transmission planning

The objective of this task is to update the current model's topology and parameters against the selected set of scenarios.

Deliverable 2 [M4]: Report on integrated whole-system model for optimisation studies

Task 3 [M3-M11]: Optimal portfolio and system implications of Power-to-Gas under different scenarios

This task aims to study the system benefits of electrolysers from the whole system perspective with the primary focus on electricity transmission network and system balancing, while also identifying the infrastructure needed to support the transport of hydrogen and the requirement for hydrogen storage.

Subtask 3.1 [M4-M9]: System implications of electrolysers with focus on its impact on electricity transmission operation and development

The benefits and system impact of electrolysers across the whole-energy system will be quantified by comparing the modelling results for a system with and without electrolysers. The analysis will also include assessment of the optimal capacity, technology, and locations of electrolysers under different scenarios developed in Task 1 and using electrolysers for network congestion management to reduce network constraints and associated costs and need for network investment.

Subtask 3.2 [M7-M10]: Role and value of electrolysers in the context of ancillary services

The analysis will be conducted by enhancing the Imperial advanced frequency-secured Stochastic Unit Commitment (SUC) model, considering renewable generation uncertainty while ensuring supply security and frequency stability, taking into account the largest infeed loss and reduction in system inertia. The synergies and conflict between management of transmission network constraints and providing balancing services by electrolysers will be investigated.

Subtask 3.3 [M8-M11]: Transport of hydrogen and need for hydrogen storage

This task will investigate the feasibility of hydrogen transmission infrastructure and existing gas networks at various pressure tiers (i.e. high, medium and low pressure) to transport hydrogen to end user.

Deliverable 3 [M13]: Report on the benefits of optimal portfolio and system implications of electrolysers under different scenarios.

Task 4 [M9-M15]: Sensitivity studies

A range of sensitivity studies will be performed to analyse conditions that can affect the deployment of the electrolysers and, consequently, their system implications.

Deliverable 4 [M14]: Report on the drivers for the deployment of electrolysers and their whole system implications

Deliverable 5 [M15]: Integrated Electricity planning tool and user guide documents and demonstration.

Objectives

The main objective of this work is to identify the optimal locations for large-scale electrolysers to reduce system reinforcement and operational costs and quantify the benefits of multi-vector approach to reduce future network costs.

Success Criteria

The project will be considered successful if the developed model identifies a few optimal locations of large scale electrolysers in each selected decarbonization pathway.

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

NGET (“NG”) has endeavoured to prepare the published report (“Report”) in respect of NIA2_NGET0002 Role and value of electrolysers in low-carbon GB energy system (“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).

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Project Overview

This project aims to analyse the benefits of linking electricity and hydrogen vectors from a whole-system perspective to determine the optimum capacity, location, technologies, and system benefits of electrolysers under different future development scenarios. The impact of power-to-gas on the whole energy system, particularly, integration of renewable generation (provision of system balancing and ancillary services), electricity transmission network operation and development, will be investigated. The project will develop an integrated whole system model to optimise the portfolio and locations of electrolysers considering several factors such as system constraints, end-use application of hydrogen, hydrogen transportation costs to end-use, and water availability to provide cost effective investments to achieve decarbonization of energy networks.

Project Plan

The project started in June 2022.

- Deliverable 1: Report on set of decarbonisation scenarios for simulation studies. (Month 1)
- Deliverable 2: Report on integrated whole-system model for optimisation studies (Month 4)
- Deliverable 3: Report on the benefits of optimal portfolio and system implications of electrolysers under different scenarios. (Month 10)
- Deliverable 4: Report on the drivers for the deployment of electrolysers and their whole system implications (Month 14)
- Deliverable 5: Integrated Electricity planning tool and user guide documents and demonstration. (Month 15)

Project Progress

Year 2022/2023:

- Deliverable 1: After few months of delay caused by contract negotiations, the project started with a kick-off meeting in June 2022. A report providing a set of decarbonisation scenarios for simulation studies was delivered on time.
- Deliverable 2: A report on integrated whole-system model for optimisation studies was delivered on time.
- Deliverable 3: A report on the benefits of optimal portfolio and system implications of electrolysers under different scenarios was delivered on time.

Next Steps

Year 2023/2024:

- Complete deliverables 4 and 5.

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

Year 2022/2023:

There have been no changes to the scope or costs for this project. The project kick-off was delayed by 3 months due to delays in the contract negotiations phase. Therefore, the completion date has moved three months back.

Lessons Learnt for Future Projects

Year 2022/2023:

- Electrolysers provide flexibility to the system operator as a supplementary approach for system balancing by following the output of renewable energy sources such as wind and PV and to provide ancillary services such as frequency response and network constraint management services. As flexibility providers, electrolysers will compete with other flexibility technologies such as demand response, and/or energy storage.
- High gas prices will shift the hydrogen production from blue to green hydrogen. This will require additional investment in low-carbon generation and other supporting infrastructure such as hydrogen storage and networks. However, shifting to green hydrogen will also reduce the need for carbon storage and offsetting residual emissions from hydrogen production processes.

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

Year 2022/2023:

- A set of decarbonisation scenarios for simulation studies was developed. The scenarios were divided into two categories: core and sensitivity scenarios. The core scenarios use the reference values of key parameters, while sensitivity scenarios alter the value of one or more parameters to identify the impacts of those parameters on the results. The core scenarios' outputs are used as references or counterfactuals when analysing the results from sensitivity studies.
- An integrated whole-system model was developed and the benefits of optimal portfolio and system implications of electrolysers under different scenarios were analysed. The system benefit from power-to-gas (P2G) is significant while there is lower flexibility in the system; it's less significant when flexibility is high because other flexibility sources such as demand flexibility, energy storage can reduce the need for P2G. It was also found that electrolysers facilitate higher penetration of wind and PV. Increased wind especially in the North given its high-capacity factor, will tend to increase the transmission network capacity requirement.

Data Access

Data for this project and all other projects funded under the Network Innovation Allowance (NIA), Network Innovation Competition (NIC) or the new Strategic Innovation Fund (SIF) can be found or requested in a number of ways:

- A request for information via the Smarter Networks Portal at: https://smarter.energynetworks.org, to contact select a project and click 'Contact Lead Network'. National Grid already publishes much of the data arising from our innovation projects here so you may wish to check this website before making an application.
- Via our Innovation website at: https://www.nationalgrid.com/uk/electricity-transmission/innovation
- Via our managed mailbox: box.NG.ETInnovation@nationalgrid.com

Foreground IPR

The foreground IPR will include a developed integrated whole system model for optimization studies, an integrated planning tool with user guide documents, and any publications of journal or conference papers related to the developed method for analysing the system benefits from electrolysers. The default IPR position has been applied to this project.