Energy Networks Innovation Process

Annual Project Progress Form

Notes on Completion: Please refer to the NIA Governance Document to assist in the completion of this form.
Do not use tables

Step 1 - Initial Project Details

Project Title

Hydrogen Economy: Reassessing Approaches to Connecting Large Electrolyser Sites (HERACLES)

Project Reference

WPD_NIA_067

Nominated Project Contact(s)

Nick Devine

Project Start Date

04/22

Project End Date

07/23

Scope (15000 Characters max)

HERACLES's aim was to understand the size of the challenge to ensure that electricity networks were not the barrier to the growth of green hydrogen. It investigated efforts by hydrogen developers, Original Equipment Manufacturers (OEMs), carbon intensive industries and innovators to grow the hydrogen economy in the UK to meet the strategic ambition of the Hydrogen and Energy Security strategies.

Hydrogen electrolysers which will produce the hydrogen are electrically powered, and will require sizeable electrical demand connections in order to function effectively. Furthermore, the Ofgem Significant Code review has shifted the burden for connection reinforcement further towards networks in the ED2 period. It is important therefore to optimise the capacity available on electricity networks for the uptake of electrolysers and reduce reinforcement costs funded by network customers.

The project also aimed to document any new opportunities to provide benefits for customers. For example, new PEM (Proton Exchange Membrane) electrolysers can be dynamically controlled with fast response times and high energy efficiency. There is significant potential for these electrolysers to offer new types of flexibility and interoperability and to embed these in connection agreements.

HERACLES was delivered in three work packages:

WP1. Discovery and criteria development
This work package examined existing DNO knowledge gaps on hydrogen electrolysers and the wider hydrogen economy, existing connection assessment processes and the tools currently used to optimise connections (e.g. capacity maps) and the requisite answers for developing a hydrogen strategy for electricity distribution. It assessed the current UK landscape for the development of the hydrogen economy to understand in detail the problem as described above and develop the criteria for identifying the optimum location for hydrogen electrolyser connections.

Parallel to this, a set of criteria which could be used for site optimisation of future electrolytic hydrogen projects was developed. This was based upon a set of conditions provided by a project developer applying for a connection and included some key with network and non-network considerations. This tool, which has a scoring system, was developed with the objective of streamlining the application process of a project developer for NGED to select and advise on connections and site locations based on the ranking (score) obtained from the tool.

WP2. Network investigation
This work package initially aimed at ~~trialing~~trialling evaluation of hydrogen sites using the criteria developed in WP1. This requires cooperation and engagement from developers. Unfortunately, despite positive initial engagement none committed to provide the case study information required. There is limited value in applying the criteria to these sites as in these scenarios the location of the electrolyser and its limitations are defined by the industrial site. As such, an alternative methodology for assessing the impact of hydrogen on NGED's network was explored through evaluating hydrogen decarbonisation for a selection of industrial sites.

A focused, regional assessment of the implications of electrolyser connection to NGED's network in the South Wales Industrial Cluster (SWIC) was carried out. Without key electrolytic hydrogen projects or case studies to use in this work package, it was decided to focus on the potential demand for hydrogen arising in SWIC as it is the largest

industrial hub within NGED's network area, and the second most emitting industrial hub in the country, accounting for approximately 15% of emissions in the UK.

This assessment was based on potential demand for hydrogen from key manufacturing industries with high emissions that were most likely to switch to hydrogen. Based on the potential demand and potential substation connection points, it looked at any potential network constraints that can impact a developer's decisions to pursue electrolytic hydrogen projects.

WP3. Hydrogen electrolyser connection considerations document
This work package summarised the key findings from WP1 and WP2, with focus on key network challenges for which hydrogen electrolysers might enter the solution marketplace. The main gaps in knowledge and key projects were highlighted. WP3 produced a set of recommendations for key actions and further work needed to fill the gaps to better determine the value of Power-to-X for DNOs, as well as key policy actions that could help realise this value, while ensuring fair access to grid connections.

Objective (15000 Characters max)

1. Understand the current and future development of the hydrogen economy in the UK
2. Understand the technical and operational characteristics of hydrogen electrolysers
3. Develop an understanding of how electrolyser connections to distribution networks may be optimised

Success Criteria (15000 Characters max)

1. The current and future landscape of development of the hydrogen economy, both commercially and technologically, will be captured
2. The operating profile of hydrogen electrolysers will be captured at a high level
3. A set of criteria will be developed and trialled for optimising large hydrogen electrolyser connections to the network

Step 2 - Performance Outcomes

Performance Compared to Original Project Aims, Objectives and Success Criteria
Details of how the Project is investigating/solving the issue described in the NIA Project Registration Pro-forma. Details of how the Project is performing/performed relative to its aims, objectives and success criteria. (15000 Characters max)

Objectives

1. Understanding the current and future development of the hydrogen economy in the UK - **Complete**

   The current and future developments are investigated in Work Package (WP) 1 and the findings documented in the final report.

2. Understand the technical and operational characteristics of hydrogen electrolysers - **Complete**

   An overview of the technical characteristics has been developed in WP1, the operational implications of the green hydrogen funding regime and the status of the electricity supply has also been discussed.

3. Develop an understanding of how electrolyser connections to distribution networks may be optimised - **Complete**

   Engagement within National Grid Electricity Distribution (NGED) and with hydrogen electrolyser developers produced a set of criteria describing the key desirable characteristics of a hydrogen electrolyser connection.

Success Criteria

1. The current and future landscape of development of the hydrogen economy, both commercially and technologically, will be captured - **Complete**

   The current and future development has been investigated in WP1 and the findings documented in the final report.

2. The operating profile of hydrogen electrolysers will be captured at a high level - **Complete**

   An overview of the technical characteristics has been developed in WP1, the operational implications of the green hydrogen funding regime and the status of the electricity supply was also discussed.

3. A set of criteria will be developed and trialled for optimising large hydrogen electrolyser connections to the network - **Complete**

   A set of criteria for optimising hydrogen electrolyser connections was captured and developed into a tool for assessing hydrogen electrolyser connections. However, the case study information required to trial the use of the tool could not be obtained as part of the project. An alternative approach has been developed for a techno-economic study of the impact of hydrogen development in a selected region.

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

The Network Licensee should state any changes to its planned methodology and describe why the planned approach proved to be inappropriate. Please confirm if no changes are required. (15000 Characters max)

Taking an alternative approach to applying optimisation criteria

WP2 initially aimed at ~~trialing~~trailing evaluating hydrogen sites using the criteria developed in WP1. This requires cooperation and engagement from developers. Unfortunately, despite positive initial engagement none committed to providing the case study information required. There is limited value in applying the criteria to these sites as in these scenarios the location of the electrolyser and its limitations are defined by the industrial site. As such, an alternative methodology for assessing the impact of hydrogen on NGED's network has been explored through evaluating hydrogen decarbonisation for a selection of industrial sites.

Due to this change in scope, it was necessary to establish a new process for choosing an area of study. South Wales, an industrial cluster with high emissions was chosen and then a sample of companies within that cluster were analysed based on which had the most accessible process information and the need to investigate a spectrum of different sized industries to evaluate different impact scales. This resulted in a detailed network analysis of Rockwool, Solutia, Liberty Steel and the largest Tata Steel plant. Other sites were explored but dismissed due to either lack of information, their current network connections being to the transmission network, or their processes being highly unlikely to use hydrogen in the short to medium term such as power plants. It was found that a simple conversion of emissions to hydrogen demand lacked robustness due to the variety of processes and fuels involved at these sites and the difficulty associated with decarbonising them, particularly steel.

Therefore, it was opted to only study processes that currently use natural gas and so are more easily converted to hydrogen and therefore have the potential to manifest before 2030. The proportion of emissions coming from the processes involving natural gas and working backwards to an energy demand was estimated based on emissions data per kW/h of fuel. From this it was possible to estimate the size of an electrolyser that would be required at a variety of capacity factors with lower capacity factor electrolysers putting significantly more peak strain on energy networks.
The methodology was verified by applying the calculation to gas fired power stations which are known to use 100% natural gas. The value retrieved could then be compared to what the power station would require at 100% capacity factor to estimate the actual capacity factor. Finally, this has been compared against historical capacity factor data for South Wales to verify it is within a reasonable margin of error.

Lessons Learnt ~~For~~for Future Projects

Recommendations on how the learning from the Project could be exploited further. This may include recommendations on what form of trialling will be required to move the Method to the next TRL. The Network Licensee should also state if the Project discovered significant problems with the trialled Methods. The Network Licensee should comment on the likelihood that the Method will be deployed on a large scale in future. The Network Licensee should discuss the effectiveness of any Research, Development or Demonstration undertaken. (15000 Characters max)

HERACLES was a first step towards understanding the challenge of green hydrogen production to Distribution Network Operators (DNOs). As such, implementation of its outcomes would be multidirectional, including integrating the knowledge developed into Business as Usual (BAU) activity, BAU development of new capabilities and potentially follow-on innovation funded projects to address specific challenges which have been identified.

WP3 produced a series of suggested next steps for DNOs to build on HERACLES, which will be found in Section 3 of the final report.

Outcomes of the Project

When available, comprehensive details of the Project's outcomes are to be reported. Where quantitative data is available to describe these outcomes it should be included in the report. Wherever possible, the performance improvement attributable to the Project should be described. If the TRL of the Method has changed as a result of the Project this should be reported. The Network Licensee should highlight any opportunities for future Projects to develop learning further. (15000 Characters max)

- The project has generated a set of reports on learning of the potential impact of the development of green hydrogen production capacity in the UK for DNOs, and the challenges and opportunities herein.
- An electrolyser site selection optimisation tool has been created for potential trial in further Network Innovation Allowance (NIA) or BAU activity.
- A methodology has been developed for forecasting potential hydrogen requirements of carbon intensive industries and the electrical capacity required to produce it.
- The project has highlighted that currently the electricity network does not feature highly in the processes for developing hydrogen electrolyser projects and there is a significant need for networks to become a more prominently featured stakeholder.
- A series of potential next steps within BAU and innovative activities has been identified.

All published reports are available here: National Grid - Hydrogen Economy: Reassessing Approaches to Connecting Large Electrolyser Sites (HERACLES)

Step 3 - Outputs And Implementation

Data Access Level & Quality Details

A description of how any network or consumption data (anonymised where necessary) gathered in the course of the Project can be requested by interested parties. This requirement may be met by including a link to the publicly available data sharing policy. (15000 Characters max)

No new data has been generated for this project, only existing NGED and publicly available data has been used in the analysis. References to these sources are provided in the published documentation.

NGED data can be requested via the National Grid Connected Data Portal (https://connecteddata.nationalgrid.co.uk/).

Foreground IPR

A description of any foreground IPR that have been developed by the project and how this will be owned. (15000 Characters max)

New foreground IPR has been created in the project reports. These are published and freely available on the NGED Innovation website.

Planned Implementation

Please describe the next steps to implement this innovation project. What policies and standards need to be updated or created as part of this implementation. (15000 Characters max)

WP3 produced a series of suggested next steps for DNOs to build on HERACLES, which will be found in Section 3 of the final report.