SIF Round 3 Project Registration

Date of Submission

May 2024

Project Reference Number

CAD_SIF0007

Initial Project Details

Project Title

Exploring Geological Hydrogen Storage Opportunities for the East Midlands (EMStor) - Discovery

Project Contact

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Challenge Area

Enabling power-to-gas (P2G) to provide system flexibility and energy network optimisation

Strategy Theme

Net zero and the energy system transition

Lead Sector

Gas Distribution

Other Related Sectors

Gas Distribution

Gas Transmission

Project Start Date

01/04/2024

Project Duration (Months)

3

Lead Funding Licensee

Cadent

Funding Licensee(s)

Cadent

Funding Mechanism

SIF Discovery - Round 3

Collaborating Networks

Cadent

Technology Areas

Gas Distribution Networks

Project Summary

Low carbon hydrogen can be used to decarbonise industrial processes, to provide heat, for transport and for electricity production. Production of hydrogen through electrolysis using renewable energy is a way of using up excess renewable energy and the hydrogen can be stored and used later during periods of peak demand.Cadent is developing a 100% hydrogen pipeline network in the East Midlands and South Yorkshire to connect clusters of potential hydrogen users and producers.This project will investigate options for medium and large-scale storage ofhydrogen to enable the flexible use of hydrogen in the region.

Project Budget

£154,000.00

SIF Funding

£139,000.00

Project Approaches and Desired Outcomes

Problem statement

The UK has a 10GW low-carbon hydrogen production target by 2030. Pipelinenetworks are being developed by Cadent under the East Coast HydrogenProgramme, connecting heavy industrial and power generation customers tohydrogen production sites, thus enabling fuel switching and processdecarbonisation.
In the East Midlands Hydrogen Region (a sub-region of East Coast Hydrogen)there will be 10TWh per year of hydrogen demand from 70 sites. These will beconnected to at least 2 electrolytic hydrogen production sites, at High Marnhamand Ratcliffe-On-Soar, with up to 600MW production capacity by the mid 2030s,utilising excess renewable energy. Cost-effective storage of hydrogen inmedium to large scale would enable:
1) Greater amounts of hydrogen to be produced and stored for when periods ofpeak demand coincide with low renewable electricity availability.
2) A greater number of customers to connect to the new pipeline network morequickly due to increased resilience and capacity to meet their demand.
3) Flexible power generators to connect to the network because their large andinstantaneous variation in demand could be met (line-pack storage is potentiallyinsufficient).
This project will explore how much hydrogen storage is needed over time and theoptions for how it can be stored in the East Midlands taking account of quantitiesneeded (supply and demand), the technical and economic issues. The work willfollow on from regional and local-scale hydrogen storage assessment workundertaken by the University of Edinburgh and British Geological Survey, both ofwhom are project partners. The work will build on the East Coast HydrogenDelivery Plan (Ref:
East Coast Hydrogen Delivery Plan - East Coast Hydrogen
(https://www.eastcoasthydrogen.co.uk/east-coast-hydrogen-delivery-plan/)
).
Through SIF we will assess the options to identify those with the most potential,with a view to developing an active demonstration project that could be connected
to Cadent's hydrogen pipeline network.
Our project meets Innovation Challenge "Enabling power-to-gas (P2G) to providesystem flexibility and energy network optimisation" and specifically Scope 2:"Commercial and technical innovation to secure system benefits from hydrogenstorage deployments". It also supports Scope 1 as it could facilitate hydrogenproduction in the region to be optimally productive if local storage is available.
If successful, the project will support regional decarbonisation and enable asmooth energy transition. It could also allow companies, such as project partnerStar Energy, to develop hydrogen storage services for the network and enhancehydrogen production possibilities in the region.

Video Description

https://youtu.be/qlzoOOq2FJk?si=5AQ2nik4CLWbxPVm

Innovation justification

Until now most work on large-scale hydrogen storage has been focused onsolution-mined caverns and to a lesser extent depleted gas reservoirs and salineaquifers. Approximately 4TWh of hydrogen storage is forecasted to come online insalt cavern storage in the NW and NE, but the pipeline connections to these fromthe Midlands will not be in place until the mid 2030s, which could hamper efforts todevelop a hydrogen network in the Midlands prior to this date.
The core innovation aspect of this project is to undertake a first of its kindfeasibility study into the suitability of the geology of the Midlands to host thesestorage technologies. This will produce a catalogue of the cost-effective mediumand large-scale hydrogen storage options in the Midlands, determining their prosand cons (such as capacity, TRL), and developing an understanding of costs fordifferent options and technical issues. We will then match these against thedetermined hydrogen production, demand and storage needs, in order to identifythe most viable storage options to progress to the next R&D stage.
This work will be the first ever time that depleted UK oil fields have beeninvestigated as potential hydrogen stores.
An alternative approach to addressing the storage requirements would be toconsider above ground storage in carriers such as ammonia or metal hydrides, orstorage in small pressurised vessels. These approaches have been discountedbecause of the high expense and low quantities able to be stored.
As there is no current UK market for hydrogen storage and some of the optionsare at lower TRLs. The project needs innovation

funding to move quickly throughthe TRL process to prepare the information required for a full-scale application tothe upcoming Hydrogen Storage Business Model. SIF is most suitable for thisproject given it is a network innovation.
The assessment and mapping of potential storage areas will be informed using arange of publicly available subsurface and surface datasets (e.g., subsurfaceinterpretations, published datasets detailing relevant rock characteristics). BGSwill apply methods and analytical techniques that have been specially developedto describe potential for hydrogen storage in the subsurface. These methods havebeen published and subjected to peer-review in scientific literature.

Impacts and benefits selection (not scored)

Financial - future reductions in the cost of operating the network

Financial - cost savings per annum on energy bills for consumers

Impacts and benefits description

Benefit 1: Reducing CAPEX costs for Net Zero: Currently there is no intermediate-scale hydrogen storage in the region. Indicative analysis by Cadent has identified three possible counterfactuals to intermediate-scale storage which show a range of possible savings of 6-25% from storage deployment (similar to the estimate 10% saving in the Guidehouse Study referenced in Question 4). As part of the project, the most appropriate counter-factual to storage can be identified and analysis developed to ground the details CAPEX benefit.

Measurement 1: Percentage saving on CAPEX by deploying intermediate-scale hydrogen storage instead of counter-factual solution.

Benefit 2: Use of Curtailed Windpower. Currently there is no hydrogen production in the region and no medium to large scale storage. Annual hydrogen production that has been stored will be produced from renewable energy, a proportion of which would have been otherwise curtailed. This figure will be projected.

Measurement 1:MWh of curtailed windpower used to produce stored hydrogen. Measurement 2: Value of £ saved on avoided curtailment costs.

Benefit 3: Industrial Decarbonisation. Currently there is no pipeline network and no storage. Construction of the hydrogen pipeline network will enable additional industrial customers to be connected and enable flexible power generators to be connected to the network.

Measurement 1: No of sites connected to network with hydrogen storage in the region without additional (non-linepack) storage. Measurement 2: Hydrogen utilised by those customers, with and without additional (non-linepack) storage TWh/year.
Measurement 3: Tonnes of carbon dioxide saved annually with and without additional (non-linepack) storage.

Benefit 4: Creation of new revenue streams: Currently no income is being generated from medium to large scale storage of hydrogen in the region. Income generated from potential hydrogen storage in the Midlands can be estimated based on the shortlisted options that are identified in the Discovery Stage.

Measurment 1: GWh of hydrogen that could potentially be stored in the midlands from identified and feasible options. Measurement 2: £ generated per day by the asset owner if the technology is exploited.

Benefit 5: Market Transformation: There is currently no market for hydrogen storage in the Midlands. New local storage would create new management and operational jobs.

Measurement 1: Estimated number of jobs created/protected in the Midlands if fossil fuels assets transition to hydrogen storage, or if new assets are created.

Teams and resources

- Cadent is the Distribution Network Operator and is the project lead. Cadent have led the East Coast Hydrogen programme and

developing plans for a hydrogen network across the region. They will provide information on pipeline scale and phasing, and latest customer demand and hydrogen production through their relationships with customers and producers.

- The University of Edinburgh (Edinburgh Innovation Limited) runs a globally leading research group on underground hydrogen storage and have over £3M of active funded research with work culminating in the UK Hydrogen Storage Database. Edinburgh Univeristy will apply its expertise in both geological hydrogen storage expertise and GIS infrastructure mapping to evaluate system integration between hydrogen production, demand and storage locations. They have worked extensively with BGS to evaluate regional hydrogen storage options.
- The British Geological Survey runs a multi-disciplinary research programme focussed on Underground Energy Storage, in which hydrogen storage is a central component. Work to date has included development of tools and methods to assess theoretical storage capacities, mapping and quantification of porous rocks, reservoirs and acquifers. BGS will bring geological expertise to help identify and map out potential areas for porous rock storage of hydrogen in the Midlands.
- Star Energy (Island Gas Limited) own oil fields across the East Mids, Lincs, and S.Yorks that could potentially be re-purposed to hydrogen. They will provide asset information to the Discovery phase of the project.
- Net Zero Strategy will undertake project management. Faye McAnulla will user knowledge from her role as Program Director of the HyDEX programme, which brings together over £100m in hydrogen R&D assets and R&D programmes and is focused on developing a hydrogen economy across the Midlands.

Project Plans and Milestones

Project management and delivery

In order to manage this project effectively we will use agile project management for flexibility and responsiveness, adhering to milestones to achieve deliverables and objectives. We will establish weekly calls between the core project team to ensure rapid sharing of information and monitoring of progress and periodic assessment of risks. Whilst there is a dependency between the delivery of WPs 2 & 3 feeding into WP4 and then 5 we have designed the project to minimise the number of interdependencies to allow maximum project impact.

The discovery phase evaluates and maps between the hydrogen storage options, correlating them with proposed hydrogen pipeline and production infrastructure, future hydrogen demand and storage volume scenarios, to evaluate infrastructure requirements for an integrated network within the Midlands. The work is divided into four technical work packages supported by project management work package (WP1) which is detailed in the Project Management Gant appendices.

The short duration of this project is a major risk is deliverly; this is mitigated by the agreement within the project group of a detailed project plan. Other specific risks are detailed in the risk register, and focus on the availability of data to support assessments and also the potential for changes in policy that affect stakeholder engagement. We have proposed mitigation measures to minimise these risks. Furthermore, we will actively manage and keep our risk register up to date throughout the life of the project. Review of risks and mitigation approaches will be a standing item on all project meetings. When risks are realised, alternative actions will be taken to minimise impacts on achieving specific project objectives; these will be detailed in the risk register.

Task leads from core team members are all experienced in the management and delivery of complex, multidisciplinary projects. The project will be tracked using a series of SMART milestones that will be actively managed through weekly project meetings and written reports to the funding body.

The consortium has access to essential data and software resources for project success.

The project will not affect current supply of energy to consumers either during discovery or future phases.

The project will involve engagement particularly with larger users of energy who are part of the East Midlands Hydrogen programme. This will enable us to understand their latest forecasts of hydrogen demand over time.

Key outputs and dissemination

The main outputs from the project are:

Workpackage 1: Management (lead: NZS; supported by all partners):

A record of meeting (including reviews of risks) will be kept as a series of minuted actions.

Formal note for the record of monthly review.

Workpackage 2: Technical (geological) (lead: BGS, supported by Edinburgh):

GIS layers detailing geological domain locations that may be suitable to support:

- Lined rock caverns
- salt cavern data local to the Midlands
- Proximal onshore depleted hydrocarbon reservoirs
- Nearly offshore depleted hydrocarbon fields
- Onshore saline aquifers

Report section detailing different storage technologies relevant to the Midlands

Work Package 3: Technical (hydrogen demand, storage scenarios and Star Energy asset details) (lead: Cadent,

supported by all):

Three spreadsheets containing:

1. Hydrogen demand and production locations and volumes over time.
2. Hydrogen storage quantity scenarios and variation over time.
3. Asset locations and characteristics for Star Energy owned oil fields in the Midlands.

The hydrogen storage quantity scenarios (2) will take account the following factors:

1. Estimates of linepack will be generated by Cadent and fed into the SIF Discovery phase
2. Uniper, (although not an official partner) have committed to pull forward their own storage requirement analysis for their 500W electrolyser project so that it can be fed into this project. Cadent will also engage with other local hydrogen producers including Chinook and HyMarnham to ensure their requirements are accounted for in storage requirment forecasts.

Workpackage 4: Storage integration in the Midlands region (Lead: Edinburgh, support by all)

- Slide pack illustrating system mapping of storage locations, capacities and demand centres and infrastructure.
- Report section: review of logistical and infrastructure requirements for system integration.

Workpackage 5: Way forward/dissemination (Lead: Cadent, supported by all)

- Stakeholder workshop to determine shortlist of storage options for the Midlands and routes to exploitation.
- Final project report of planning for future project phases (Alpha, Beta)
- Delivery dissemination event at hydrogen storage conference run by HyDEX. This will disseminate project findings widely, supporting the development of competitive markets in storage of hydrogen.
- Supporting dissemination activity in partnership with East Midlands Hydrogen via consortium updates (70+ stakeholders), website and social media.
- Dissemination target audience: producers, users, investors, other DNOs, local and national regulatory bodies.

Commercials

Intellectual Property Rights (IPR) (not scored)

Cadent will establish a project consortium agreement, which sets out the responsibilites of partners and the governance of foreground and background intellectual property. Approval of the consortium agreement by project partners will occur whilst the bid is being appraised in order to prevent contracting delays. Work will be arranged within the various work packages to restrict the sharing of any sensitive commerical information between partners. The final project report will be constructed so it does not reveal sensitive commercial information. All agreements and terms-of-reference will be established well in advance of the project start. Finally the agreement will be reviewed and refined within the discovery phase to ensure compliance or if alternative arrangements need to be considered for future SIF phases.

Value for money

The total project size is £154k. £139k is being requested in funding, with Cadent requesting 15k, British Geological Survey 50k, Edinburgh Univeristy £48k, Net Zero Strategy £20k and Star Energy £5k.

There is a project contribution of £15.5k made up of staff time from Cadent (£9.5k), Edinburgh University (£1.5k) and Star Energy (£3k) plus £1.5k from Net Zero Strategy for the dissemination event (from HyDEX).

'In kind' funding of £10k has been moved into the project:

1. BGS will make established methods and GIS tools available to the project. Estimated value of £6.99k (10x£699). Additionally, an understanding of flow process built up from experience at field sites focussing on Sherwood Sandstone storage aquifer will be available to this project.
2. Edinburgh University will provide knowledge, data and software that is worth at least 3k to the project.

In addition, Uniper, a potential storage customer, will conduct a complex piece of work to understand their own projected storage requirements, utilising anonymised customer data from Cadent. This work is valued at £17.5k, will be fed into the storage requirement scenarios work and planning on next steps.

In addition, we have almost £14m worth of projects that have contributed to reaching the current level of knowledge, expertise and experience upon which this project is founded. We are not planning to use any sub-contractors as part of the project.

Supporting documents

File Upload

WP2.6 Summary of Technologies v4.pdf - 2.2 MB
WP2.6 Summary of Technologies v2.pdf - 3.0 MB
WP2.2 Deliverable.pdf - 2.1 MB
Summary of Underground Hydrogen Storage Technologies for Project East Midlands Storage.pdf - 2.2 MB
EMStor_Milestone11_GISmapsofstoragelocations_demandcentres_infrastructure.pdf - 2.5 MB
EMStor_Deliverable5_GIS layers of the geological storage technologies_DRAFT.pdf - 3.3 MB
EMStor_Deliverable 8_GIS layers of production and demand centres.pdf (2) - 2.1 MB
EMStor_Deliverable 8_GIS layers of production and demand centres.pdf (1) - 0.0 bytes
EMStor Show and Tell Webinar Slides_UPDATED (1).pdf (1) - 2.7 MB
EMStor Discovery End of Phase (2).pdf (1) - 2.0 MB
Deliverable 7 Hydrogen storage integration in the East Midlands.pdf (1) - 0.0 bytes
EMStor_Deliverable 8_GIS layers of production and demand centres.pdf - 0.0 bytes
EMStor Show and Tell Webinar Slides_UPDATED (1).pdf - 2.7 MB
EMStor Discovery End of Phase (2).pdf - 2.0 MB
Deliverable 7 Hydrogen storage integration in the East Midlands.pdf - 0.0 bytes
SIF Round 3 Project Registration 2024-05-20 11_12 - 61.2 KB
Summary.pdf - 328.8 KB
SIF Project Agreement Discovery - Exploring Geological Hydrogen Storage Opportunities for the East M.pdf - 609.5 KB

Documents uploaded where applicable?

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