SIF Discovery Round 2 Project Registration

Date of Submission

Aug 2023

Project Reference Number

NGN_9021_SIF_R2_Discovery (UKRI_10058442)

Project Registration

Project Title

HyCoRe - Hydrogen Cost Reduction

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NGN_9021_SIF_R2_Discovery (UKRI_10058442)

Project Licensee(s)

Northern Gas Networks

Project Start

Apr 2023

Project Duration

2 Months

Nominated Project Contact(s)

David Lynch - DLynch@northerngas.co.uk

Project Budget

£171,670.00

Funding Mechanism

SIF Discovery - Round 2

SIF Funding

£137,257.00

Strategy Theme

Net zero and the energy system transition

Challenge Area

Improving energy system resilience and robustness

Lead Sector

Gas Distribution

Other Related Sectors

Electricity Distribution

Funding Licensees

NGT - National Gas Transmission PLC

Lead Funding Licensee

NGN - North East

Collaborating Networks

National Gas Transmission PLC, Northern Gas Networks, UK Power Networks

Technology Areas

Energy Storage, Gas Distribution Networks, Gas Transmission Networks, Hydrogen, Modelling, Offshore Transmission, Resilience

Equality, Diversity And InclusionSurvey

Yes

Project Summary

Renewable hydrogen and energy storage options are widely regarded as critical toachieving the UK's 2050 net-zero target. For project developers planning offshore-wind/hydrogen production facilities, an abundance of design choices andconfigurations exist, each of which has advantages and disadvantages, andquestions remain about how to integrate electrolysers/energy storage devices intothe existing energy system. These include (i) where best to locate these systems,(ii) what enabling technologies are required to deploy them efficiently, (iii) how tovalidate/demonstrate novel enabling technologies, and (iv) how to efficiently incorporate the resultant hydrogen into the existing gas network while minimising the costs of a secure, resilient, multi-vector energy system.

Answering these questions requires a whole system approach, which the projectseeks to take via three primary work streams:
1) Defining the optimal methods of exporting energy from an offshore-wind farm inthe context of value for money for customers.
2) Defining the energy carrying characteristics of electricity vs hydrogen toestablish the cost drivers and identify opportunities for cost reduction.
3) Understanding the impact on the gas/electricity networks of the imminentincrease in renewable generation into the network and how strategic deploymentof electrolysers, energy storage devices, and novel enabling technologies canreduce energy network investment requirements.

The projects longer-term aim is to support Kinewell to build on their expertise andexisting IP to develop a novel, technology-agnostic planning tool to helpdevelopers establish the optimal configuration and additional technologyrequirements on a case-by-case basis. This will significantly reduce costsassociated with offshore-wind/hydrogen production and its integration into the gas network, strengthening the UK's energy system robustness to support efficient roll out of new infrastructure (Theme 2) and accelerating the net-zerotransition.
Discovery phase success will enhance the team's understanding of how green hydrogen can effectively deliver net-zero at the lowest cost to consumers, which will provide focus for subsequent phases that will develop and demonstrate the planning tool and demonstrate/validate novel enabling technologies to maximise the tool's impact.
HyCoRe brings together eight partners with expertise encompassing gas/electricity network distribution operation, offshore-wind technology development/commercialisation, offshore-wind design optimisation, green hydrogen project development, cost modelling and business case development, infrastructure mapping, and supply chain development. The team possess keyskills required to deliver HyCoRe, and to deploy the tool, and any enabling technologies identified, for the benefit of the UK energy system, and ultimately the consumer.

Project Description

Green hydrogen from offshore-wind powered electrolysis has potential to be amajor source of the overall flexibility required to balance a zero-carbon energysystem, and there is huge potential for the UK's existing gas and electricitynetworks to play a critical role in integrating green hydrogen into the energysystem and supporting the UK's transition to net-zero by 2050. Successful integration of hydrogen into the existing energy networks will prevent the current infrastructure assets from becoming stranded, and therefore reduce the capitalexpenditure required to support the net-zero transition, which will ultimately benefitthe consumer. However, achieving this integration will require the adoption ofnovel technologies and new planning approaches.

The literature regarding integrating offshore-wind and electrolysis is limited andthere is currently a poor understanding of, and no consensus on, where tooptimally place electrolysers and energy storage devices to maximise their impacton the energy system. The HyCoRe project seeks to address this by taking awhole system approach, performing a detailed exploration of key questionsincluding where to optimally place electrolysers/grid-scale energy storage devices,and what additional enabling technologies will be required to deploy themeffectively. The purpose is to acquire new knowledge, which will be applied insubsequent phases to develop a software tool to allow offshore-wind/hydrogenproject developers to establish the optimised configuration when accounting forsite-specific conditions. The project is novel in that no such tool currently exists.

HyCoRe brings together Northern Gas Networks (NGN), Offshore RenewableEnergy Catapult(OREC), Kinewell Energy (Kinewell), Lhyfe UK (Lhyfe), NationalGrid Gas (NGG), Southern Gas Networks (SGN), Ove Arup and Unasys. The team will be further supported by UK Power Networks, who will act as external advisors to the project. The consortium has modelling and practical expertise inelectrical and gas network operation, offshore wind, wind farm design, and thenew field of offshore electrolysis. Together, this group features key supply chain elements required to deliver the proposed project, and to deploy the tool, and anyenabling technologies identified, for the benefit of the UK energy system, andultimately the consumer.

Preceding Projects

REF:10079341 - HyCoRe (Alpha)

Third Party Collaborators

Offshore Renewable Energy Catapult

Nominated Contact Email Address(es)

innovation@northerngas.co.uk

Project Description And Benefits

Applicants Location (not scored)

Lead Applicant: NGN
Partner 1: Offshore Renewable Energy Catapult , Offshore House, Albert Street, Blyth, Northumberland, NE24 1LZ;
Partner 2: Kinewell Energy Limited, 9 Jackson Street, North Shields, Tyne And Wear, NE30 2JA;
Partner 3: Lhyfe UK Limited, 3 More London Riverside, London, United Kingdom, SE1 2AQ;
Partner 4: National Grid Gas plc
Partner 5: SGN
Partner 6: Unasys Limited, 6 Bridge St W, Middlesbrough, TS2 1AE
Partner 7: Ove Arup, 8 Fitzroy Street, London, W1T 4BJ

Project Short Description (not scored)

This HyCoRe Discovery project seeks to acquire new knowledge regarding theoptimal placement of electrolysers and energy storage devices, which will beapplied in subsequent phases to develop a software tool to allow offshore-wind/hydrogen project developers to optimise the planning process, reducingcosts associated with offshore-wind/hydrogen production and its integration intothe gas network, and accelerating the net-zero transition.

Video description

https://youtu.be/VUSPsbPLL6s

Innovation justification

Despite the growing acceptance that green hydrogen from offshore-wind haspotential to be a major source of the overall flexibility required to balance a zero-carbon energy system, literature regarding integrating wind energy andelectrolysis is limited and there is currently a poor understanding of, and noconsensus on, where to optimally place electrolysers and energy storage devicesto maximise their impact on energy system resilience.

This project seeks to address this by taking a whole system approach, performing a detailed exploration of the optimal placement of electrolysers/grid-scale energy storage. The purpose is to acquire new knowledge, which will be applied in subsequent phases to develop an algorithmic planning tool to allow offshore-wind/hydrogen project developers to establish the optimised configuration when accounting for site-specific conditions. The project is novel in that no such toolcurrently exists.

For different potential configurations, the tool will quantify achievable reductions incable/pipeline lengths and compare this against cost implications in other areas ofthe system, to produce an economically optimised design for offshore-wind/hydrogen production facilities, de-risking capital projects and identifying potential cost savings. This builds on software tools previously developed by SME partner Kinewell and will significantly enhance their existing offering to the energy sector.

Wide-scale tool deployment will offer significant economic value to project developers/energy network operators in the form of CAPEX/OPEX reduction, which will ultimately benefit the consumer via reduced energy costs. An alternative scenario, where key project development decisions are taken based on traditional, manual, wind-farm planning approaches, means that cost and efficiency savings achievable by use of an automated digital tool will be lost. A sub-optimal generation facility and network integration strategy will increase CAPEX/OPEX, making offshore-wind/hydrogen production less attractive to developers and investors. Ultimately this will slow/stall the deployment of green hydrogen projects, to the detriment of the energy network sustainability and resilience, the environment, the UK green economy and wider society including future adopters of hydrogen.

As a new-to-market technology development project, HyCoRe is currently deemedtoo risky to be funded by other means. Success will provide confidence in ourapproach, accelerating the development/deployment of the tool, benefiting the consumer in multiple ways. Further, identifying enabling technology gaps, and supporting UK companies to demonstrate/validate promising novel solutions (usingOREC's Blyth facility), will develop/benefit the wider UK supply-chain. This project is well aligned to SIF funding; other funding routes are designed to support a single/small group of technology developers.

Benefits Part 1

Environmental - carbon reduction – direct CO_2 savings per annum against a business-as-usual counterfactual
Environmental - carbon reduction – indirect CO_2 savings per annum against a business-as-usual counterfactual
Financial - cost savings per annum for users of network services
Financial - cost savings per annum on energy bills for consumers
Financial - future reductions in the cost of operating the network
New to market – products, processes, and services
Revenues - creation of new revenue streams
Revenues - improved access to revenues for users of network services

Benefits Part 2

How will your project deliver net benefits to consumers?

Expected project benefits described in Q5 will be tracked from a high-level perspective at the discovery stage, as described below. As the project progresses, a strategy for fully quantifying project benefits using the ENA's whole system cost benefit analysis model will be developed.

Financial--future reductions in the cost of operating the networks; cost savings/annum on energy bills for consumers; cost savings/annum for users of network services.

Financial benefits will be tracked during Discovery by costing sub-optimal configurations against the optimal configurations. This will allow us to estimate cost savings associated with planning tool usage. We will link these to relevant aspects of network operation, network service users, and consumers. Using numerical optimisation techniques, Kinewell Energy typically add value of circa 20% of cable system CAPEX reduction through use of their existing KLOC tool. Based on Kinewell's experience of tool development, the value-add at different stages of product development and the proposed analysis of this project, we anticipate cost reduction in the region of 3-6%.

Based on KLOC experience, through digitalisation and automation, a digitalplanning tool can enable productivity gains for planning teams (including engineers and consultants). This weakens constraints on people required todeliver net zero and should reduce future energy infrastructure project planning costs and increase the speed of project progression from feasibility to implementation. Ultimately, this means delivering value to end-consumers through digital tools and automation.

Environmental--carbon reduction: direct CO_2 savings/annum; indirect CO_2savings/annum.

Environmental Benefits will be tracked by estimating the emissions of both optimal and suboptimal configurations and categorising these as direct or in-direct savings.

Revenues--creation of new revenue streams ;improved access to revenuesfor users of network services

During this initial assessment, we will estimate the value of the new revenue streams in an optimal configuration vs a non-optimal configuration, i.e., the delta.

New to market--products, processes, and services

During Discovery, OREC will review technology gaps and/or technology development opportunities to build-out optimised systems and estimate how many additional technology products and services (in addition to the planning tool) couldbe developed, some of which would be validated at their Blyth-based hydrogentest facility as a result of long-term project delivery beyond Discovery. Progression to Alpha will allow identification of potential new products/services that would be taken forward for development and validation, and a target number of new products and services to emerge from Beta will be set.

Project Plans And Milestones

Project Plan and Milestones

This three-month project comprises six work packages.

WP1-Project Management and Coordination
(Lead OREC) £11,062 SIF Funding Requested /18 days: The project will be led and co-ordinated by OREC according to ISO9001 and 14001 accredited procedures.
Key success criteria:
M1.1 - Project complete on time and withinbudget , and delivery of **D.1.1 -** A report summarising project findings and Alphaphase plan.

WP2- Investigating the options for exporting offshore wind power

(Lead: OREC)--£31,692/52days: Technoeconomic modelling and literature review to define the optimal methods ofexporting energy from offshore-wind.
Key success criteria:
M2.1- Optimal wind farm energy generation and exportapproach determined, and delivery of **D2.1-** Report chapter summarising WP2 findings.

WP3-Energy carrier Medium--Interarray and Export
(Lead: Kinewell)--£40,360/66days: Comparing electrical vs hydrogen export systems in terms of cost and risk profile.
Key success criteria:
M3.1- Cost and risk profiles estimated, and delivery of **D3.1**- Report chapter summarising WP3 findings.

WP4-Integrated Analysis & Cost Drivers
(Lead: Kinewell)--£22,680/34days: Identifying cost drivers of hydrogen production form offshore wind.
Key success criteria:
M4.1- Areas of focus for Alpha phase tool development identified, and delivery of **D3.1**- Report chapter summarising WP4 findings.

WP5 - Impact on gas and electricity systems
(Lead: OREC) £21,981/31days: Technoeconomic modelling and literature review to understand how to reduce network infrastructure upgrade requirement costs.
Key success criteria:
M5.1- Alpha phase techno-economic study defined, and delivery of **D5.1** - Report chapter summarising WP5 findings.

WP6-Stakeholder Engagement/dissemination
(Lead: OREC, supported by allpartners) £9,482/12days: Engagement with key stakeholders to promote project activity and garner support for subsequent phases.
Key success criteria:
M6.1- Public webinar delivery, **M6.2** - Alpha phase plan finalised, and delivery of **D6.1**- Report chapter detailing Alpha phase project plan.

The main risk during Discovery is that poor project management will result in failure to deliver on schedule (R2). Mitigation is achieved via a robust project management plan with agreed tolerances. The PM will create a risk matrix to prioritise actions and mitigate those with the highest risk level according to a traffic light system. These will be monitored by the PM and reviewed with the partners on a weekly basis, with corrective or mitigating actions being taken as appropriate.

The major constraint to business-as-usual adoption is the uncertainty around the regulatory frameworks in place for hydrogen. The knowledge and understanding of green hydrogen production, handling and use that will be acquired as a result of HyCoRe will be shared with the aim of informing future regulation.

Regulatory Barriers (not scored)

Regulatory barrier uncertainty that needs further investigation (as it could potentially hinder the project at the Beta phase and beyond) concerns existing/planned regulatory frameworks in place for hydrogen, particularly around hydrogen generation. As examples, clarification on the points below is expected to de-risk long-term planning decisions and therefore improve investor confidence:

- **How do existing frameworks adapt for hydrogen?**
- **What new frameworks need to be developed to support the integration of hydrogen?**
- **At what point in the network do different stakeholder's ownerships start andend?**
- **Confirmation around planning and permit regimes**
- **Regulations and safety around hydrogen blending**
- **Differences in regulations for small-scale pilot projects and large industrial-scale hydrogen systems**
- **Regulations around electrolyser waste products**
- **Regulations around off-grid (electrical) green hydrogen production from onshore and offshore wind**

Furthermore, if through the discovery phase of the project we learn the value of offshore wind production of hydrogen is not directly/exclusively monetary, it would be beneficial to have clarity on the regulatory and policy incentives that could support hydrogen's role in the power sector. This would enable the project team to investigate their impact on decision making and energy system configuration optimisation in the Alpha and Beta phase of the project.
In terms of longer-term regulatory barriers, if in the discovery phase we find that offshore hydrogen production is promising, this could confirm the role of offshore wind in the UK's ambition for a thriving hydrogen economy. This outcome warrants a need to explore industrial scale generation in the Alpha and Beta phases of theproject, which also raises questions around cross-border pipelines and shipping trade and therefore the regulations around importing and, importantly, exporting hydrogen globally.

Learning from the HyCoRe project will be used to create evidence to inform the development of regulatory frameworks and inform future policy where appropriate. At this stage, we do not foresee a need for derogation or exemption for future phases, but this will be monitored as the project progresses.

Commercials

Route To Market

The HyCoRe tool will benefit offshore-wind/green hydrogen project developers (e.g.,Lhyfe), and gas/electricity network operators (e.g. NGN/NGG/SGN/UKPN); these stakeholders are the target customers. Project success will be used to generate/increase customer interest and support reduced time-to-market-acceptance, as described below.

Phase 1--Discovery(April-June 2023): The team will acquire new knowledge re:optimising energy network flexibility/offshore-wind farm configurations and optimising overall system efficiency. The output will be a 'findings' report, including an alpha phase development plan. Target customers (additional to project partners) will be engaged via a dedicated dissemination work package. OREC'senergy sector contacts network will be leveraged to engage stakeholders and promote early buy-in, with the aim of accelerating business as usual adoption post-Beta.
Phase 2---Alpha(Sep.2023-Feb.2024): A prototype tool will be developed/tested to reduce associated risks with further development and provide target customer confidence, garnering their support for full-scale demonstration.
Phase 3-Beta(June2024--Nov.2025): The consortium will expand to include developers (e.g. offshore-wind/additional green hydrogen) with capacity to support full-scale physical demonstrations, undertaken in collaboration with customers, using OREC assets and gas network operators. Foreground IP will be protected in preparation for commercialisation, e.g. patents and/or confidential information restrictions.
Phase 4--Yr1 post-Beta(Dec.2025-Aug.2026): All certification required for commercial tool deployment will be acquired. Trials will be provided a tcommercially advantageous rates to customers who have supported the development, to build case study material. Target customers will benefit from new revenue stream generation, and from CAPEX/OPEX reduction, which will reduce network operating costs and network service costs, ultimately benefiting the consumer via reduced energy costs.Successful development of a UK customer base (including global companies) presents an export opportunity that does not currently exist. Direct/indirect CO2savings will also benefit wider society.
Kinewell have already developed/commercialised several planning optimisation tools, including KLOC. As such, they are well positioned to lead the development and commercialisation of the proposed planning tool and will build on their experience and existing IP to do so, with a focus on third-party client licencing. Similarly, ORE Catapult will use its significant existing expertise to drive forward the accompanying hydrogen technology development, validation and demonstration.

The tool will aim to provide the best possible planning advice to clients regarding which technology choice is most appropriate for their project. The core project team are not incentivised to inappropriately promote hydrogen at the expense of other viable options, or vice versa, and, therefore, will not undermine the development of competitive markets.

Intellectual property rights (not scored)

Background Intellectual Property (IP)
Kinewell bring registered background IP related to KLOC, their existing offshore wind inter-array cable layout optimisation tool.

OREC bring registered background IP, jointly owned with Durham University, relating to a planning tool for offshore wind export system technology choices under severe uncertainty. This tool is being licensed by Kinewell Energy for commercialisation via a SaaS model and developed through their TIGGOR project to include hydrogen export options.

Additional project partners bring informal IP via industry insight and know-howe.g., regulatory considerations, gas/electricity network operation, project developer requirements, etc. and is not subject to (or required to have) any formal agreement put in place.

In line with the SIF governance document (chapter 9), Background IP ownership will remain unchanged. Furthermore, during the project, Background IP will be accessible to partners on a royalty-free basis (as needed) and under fair and reasonable terms post project (as needed) for post project results exploitation.

Project IP Management
The principles of intellectual property management have been discussed within the consortium and will be based on the Lambert Model D collaboration agreement (originating partner owns their own IP with non-exclusive licences available to other partners for use within the project, and an undertaking to negotiate license or assignment post project). An IP register will be used to record background IP used and foreground IP created during the project. The IP register will be reviewed at project meetings to develop plans for protection andexploitation.

Post Project IP Arrangements

Foreground IP generated by partners, e.g., Kinewell and ORE Catapult, will be used to commercialise the planning tool technology and develop the validation and demonstration capability for hydrogen-based technology development and commercial roll-out. There will be a strategic focus on licensing the foreground IP to third-party clients on a commercial basis, whilst paying attention to the SIF governance document (chapter 9, clauses 9.12 to 9.20). Furthermore, project partners will provide access to each other's Foreground IP on an 'As Needed' basis so they can exploit their Foreground IP post-project without unnecessary restrictions in place.
Regarding the third-party client licencing strategy, the intention is to open up the technology and make it accessible to the entire market, thereby maximising commercial and technological reach. For those clients who want to licence the planning tool technology, training and support will be provided as standard.

Costs and value for money

The total project value, including in-kind contributions from project partners, is **£171,670**.
The SIF funding requested is **£137,257**, exclusive of VAT.
The remaining **£34,413 (20%)** will be provided as in-kind contribution fromcommercial project partner private funds.

The balance of costs and SIF funding requested across the partners is as follows:
Lead Partner -- Northern Gas Networks: £4,520
Partner 1 -- ORE Catapult: £72,137
Partner 2 -- Kinewell Energy: £77,000
Partner 3 -- Lhyfe UK: £3,999
Partner 4 -- National Grid Gas: £1,110
Partner 5 -- Southern Gas Networks: £1,304
Partner 6 -- Unasys: £3,600
Partner 7 -- Ove Arup: £8,000

HyCoRe offers value for money in that project success will enhance understanding of how green hydrogen can effectively deliver net-zero, and longer-term, will reduce costs associated with offshore-wind/hydrogen production and its integration into the energy network. This will reduce the gas/electricity network's capital/operational costs, leading to lower consumer bills. Wider project impacts directly benefitting the consumer/taxpayer include:

- Novel IP created/held in UK with export potential;
- CO_2 reduction-contribution to UK 2050 net-zero targets;
- Supporting UK based SME(Kinewell) to increase international competitiveness;
- Improved energy system robustness/resilience i.e., reduced reliance on non UK-based energy suppliers where geopolitical developments may put the energy source at risk.
- Tax/revenue from the above.

Document Upload

Documents Uploaded Where Applicable

Yes

Documents:

HyCoRe - 10058442 - Innovation Funding Service.pdf

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HyCoRE WP2 executive summary.pdf

HyCoRE WP5 Report [final issue].pdf

HyCoRE_WP3_Report_Kinewell (1).pdf

HyCoRE_WP4_Report_final.pdf

Show and Tell HyCoRe (1).pptx

This project has been approved by a senior member of staff

☑ Yes