Electricity/Gas Network Innovation Competition Screening Submission Pro forma

Notes on completion		
Before completing this form, please refer to the relevant Network Innovation Competition (NIC) Governance Document(s).[1] Please use the default font (Verdana size 10) in your submission. We will only accept the text visible in the text entry areas. The text entry areas are predetermined and should **not** be changed. The full-completed submission should not exceed 10 pages in total. Ofgem will publish all the information contained within this Screening Submission.		
Is the application for the Gas or Electricity NIC?	Gas NIC ☐	Electricity NIC ☒
Cross Industry Project	YES ☐ *If yes, please fill out Cross Industry Projects section*	NO ☒
Funding Licensee(s)		
National Grid Electricity Transmission		
Network Licensee Project Partners		
Vattenfall Wind Power Limited		
Funding Licensee area(s)		
England and Wales		
Project Title		
H-Awel		
Project Summary		
H-Awel will pilot a cross-sector solution for decarbonisation across the electricity, transport and heavy industry sectors. This project will see the coupling of the 228MW Pen y Cymoedd onshore wind farm, the biggest in England and Wales, with a large-scale, 50MW hydrogen electrolyser. The green hydrogen resulting from this project would have several local uses, including the decarbonisation of local steelworks and the displacement of diesel on local train lines, whilst trialling innovative transport solutions for uses across England and Wales. H-Awel will use direct power from wind to create green hydrogen through the electrolysis of water at a scale five times larger than existing systems. An innovative control system will manage both the wind farm and electrolyser, using market and grid load signals to direct power between different end uses. The project will also demonstrate the capability of hydrogen energy storage for electricity transmission network constraint management and providing ancillary services (e.g. frequency response). The produced hydrogen will be used to drive the decarbonisation of local steelworks and transport, especially railways. This is a truly holistic, first-of-a-kind attempt at integrating multiple emerging technologies to drive forward system-wide change and decarbonisation. A large-scale demonstrator sign-posting the way forward for our future energy system and hydrogen economy.		
Estimated Start Date	**Estimated End Date**	
Q1 2020	Q1 2023	
Estimated Project funding		

[1] https://www.ofgem.gov.uk/publications-and-updates/version-30-network-innovation-competition-governance-documents All capitalised terms used in this document have the meaning given to them in the respective NIC Governance Document.

The Licensee must provide an approximate figure of the total cost of the project and the amount of NIC funding for which it is applying.

Total Cost of Project **(If Cross Industry Project provide cost split in Cross Industry section)**	£51 million	**NIC funding requested**	£45.9 million
Is the Technology Readiness Level (TRL) of the Project at start date between 4 and 8?	YES ☒	NO ☐	

What is the Problem?

The Licensee must provide a narrative that explains the Problem(s) that the Project is seeking to address.

In next few years, the UK must make important decisions about its energy infrastructure which will shape how we use energy for electricity, heat and transport to meet the emission targets for 2050 and beyond. However, without holistic thinking, decisions taken independently in one energy sector cannot provide the best value to society overall.

The Committee on Climate Change (CCC) has advised Government clearly that whilst progress in decarbonising electricity is on track, great strides need to be taken in industry and transport. Only 4.5% of the heat in buildings is from low-carbon sources and the CCC's advice is that natural gas is incompatible with long-term decarbonisation. In industry, responsible for almost a quarter of UK emissions, the sector needs to aim for 80MtCO2e by 2030 compared to around 105MtCO2e in 2017. Iron and steel, responsible for around 17% of industrial emissions in 2015 has seen major emissions reductions recently but largely linked to the closure of steelworks at Redcar. In transport, now the largest emitting UK sector, emissions have either been flat or rising in recent years. Although there is much excitement about the scope for electric vehicles to drive emissions reductions, the way forward for heavy freight and rail is less clear.

Whilst the national decarbonisation challenges are well-understood, local issues tend not to get the same level of attention. The South Wales area, home to the Pen y Cymoedd wind farm, has a number of emissions and public health challenges. Local train lines are not suitable for overhead electrical lines and the nearby city of Port Talbot has been identified by the WHO as having the most polluted air in the UK measured by particulates. Fossil fuel to hydrogen switching therefore clearly has local and national benefits.

Lastly, the need to deliver renewables at the scale needed to help meeting decarbonisation objectives in a low- or no-subsidy environment and to integrate this generation into the system at lowest cost to the consumer is an emerging challenge for the 2020s. Finding a valuable application for excess renewable generation is critical to realising grid-wide benefits such as reduced costs of grid constraint, new sources of ancillary network services, and potential sources of secure supply through reusing hydrogen for electricity generation, as well as providing a commercial route-to-market for new renewable generators through demand assurance.

Decarbonisation has been insufficient outside the power sector arguably because we have lacked a revolutionary technological change which allows low-cost fuel substitution and mass renewables deployment has posed its problems. By knitting sectors together we believe we can solve multiple issues at once with hydrogen as the key.

Hydrogen has huge potential to address the decarbonisation need across the energy sector. There has already been a significant effort in research and development of various technologies related to hydrogen. Nevertheless, the commercial adaptation and faster deployment of these technologies require practical demonstrations.

What Method(s) will be used?

The Licensee must describe the Method(s) that are being demonstrated or developed. It must also outline how the Method(s) could solve the Problem. The type of Method should be identified where possible eg technical, commercial etc.

H-Awel would be the first project to test Polymer Electrolyte Membrane (PME) electrolysers at this large (50MW) scale. The design is based on a 10MW system due to be installed at a German refinery (Refhyne) in 2020. At potentially five times the size, H-Awel would be the biggest installation of a PEM electrolyser system in the world.

A new integrated Renewable Energy System Controller will be developed and trialled in this project. The electrolyser will be connected via a cable to the Pen y Cymoedd onshore wind farm. The controller will control the wind farm, direct power to the electrolyser as well as steering actions in various ancillary services markets (e.g. primary frequency control). Using this controller, the electrolyser will become a flexible demand load in the system, thereby mitigating the impact of the windfarm in the system.

The costs and practical limitations of transporting hydrogen from a centralised production facility to its end source could be overcome via the use of liquid organic hydrogen carriers (LOHC). LOHC technology is the perfect solution for high volumes of industrial and transportation processes as it is a non-toxic carrier material and not classified as hazardous, allowing for safe shipping at ambient conditions in normal road tankers, ships and trains.

To balance heat supply between the summer and winter demand, loads will require very large scale inter-seasonal storage of energy. Hydrogen storage injected in to deeply porous rock could meet this need. Sites within 10-20km of Pen Y Cymoedd will be identified as candidate sites for storage using techniques that have already been established and published. H-Awel will closely collaborate and engage with key stakeholders across the sector to support local decarbonisation in heavy industry and transport in Wales. A commercial arrangement of supplying green hydrogen to facilitate local decarbonisation will be developed as part of this project to drive maximum value to consumers.

Method(s) continued

The overall process would therefore be:

A cable will be connected from Pen Y Cymoedd windfarm will be installed directly to an industrial site in Port Talbot. Renewable energy would then be used to power the electrolyser – with the electrolyser being controlled to be a flexible demand load – running when the demand on the system is lowest, and wind generation is at its highest. This hydrogen would then be primarily used for:

1) Industrial off takers in Port Talbot to decarbonise their processes
2) Transportation uses in the region, including for use in local railway systems which are otherwise unsuitable for electrification
3) Potential other local uses, such as bus franchises in Bath and Bristol
4) Transportation of excess hydrogen using the innovative LOHC technology to much further demand consumers than currently available to be serviced by such a project. This could be used to fuel buses in London, Brighton, Birmingham, Manchester and Liverpool.
5) Storage and transportation of excess hydrogen in porous rock underground to assist with load balancing.
6) There is further scope to investigate gas grid injection, though this has not yet been fully developed.

Funding Commentary
The Licensee must provide a commentary on the accuracy of its funding estimate. If the Project has phases, the Licensee must identify the approximate cost of each phase. Non RIIO-Network Licensees should indicate potential bid costs expenses
The total project budget is broken down as follows: £4 million in development expenditure: applicable from commencement of the project until the point of Financial Investment Decision (FID) to conduct a feasibility and front end engineering design (FEED) study. Thereafter, £47 million of capital expenditure: to implement the electrolyser and related chemical plant, comprising: - Detailed engineering, project management and permitting (£3 million) - Civil works, grid connection and infrastructure (£9 million) - Electrolyser (£33 million) - LOHC hydration upstream equipment (£2 million) Additional (and separate) funding would be needed in order to update the railway rolling stock and bus fleets to a fuel cell concept in order for them to use the produced hydrogen as a fuel. It is expected this would be funded through normal transport funding and not Network Innovation Competition funding. It is intended that the operating expenditure (OPEX) would be funded using sales of the hydrogen and related chemicals to industrial/transport consumers. The total cost, based on the partner's experience in this area, has been estimated at approximately £51m with further details included in the full submission. The project budget and work packages are subject to confirmation and further refinement as the project develops prior to full submission. We will also endeavour to identify further sources of external funding and collaboration opportunities to try and reduce the NIC funding requirement and increase the impact.

Which specific requirements does the Project fulfil?(Please tick which of the specific requirements this Project fulfils)

	Electricity	**Gas**
A specific piece of new (ie unproven in GB) equipment (including control and/or communications systems and/or software)	☒	☐
A specific novel arrangement or application of existing electricity/gas transmission and/or distribution equipment (including control and communications systems software)	☒	☐
A specific novel operational practice directly related to the operation of the electricity/gas transmission and/or distribution systems	☒	☐
A specific novel commercial arrangement	☒	☐

How does the Project accelerate the development of a low carbon energy sector and have the potential to deliver net financial benefits to existing and/or future customers in the relevant sector?

The Licensee must demonstrate that the Solution has the potential to accelerate the development of the low carbon energy sector in GB and/or deliver wider environmental benefits to GB customers. The Licensee must demonstrate the potential to deliver net financial benefits to existing and/or future customers.

South Wales is one of the areas with the highest levels of greenhouse gas emissions in the UK. The innovative low-carbon energy solution developed in this project will make a positive contribution to the area by helping decarbonisation heavy industry and transport.

For heavy industry, the project will focus on decarbonisation of the key sources of greenhouse gas emissions in South Wales. The green hydrogen in this project will significantly reduce emissions and allow 'greening' without significant upfront cost to the industrial partner in this first-of-a-kind project. Vattenfall is already experienced in green hydrogen projects for steel manufactures based on the Swedish HYBRIT project, which intends to build a hydrogen based greenfield steel plant. However, even existing steel plants can decarbonise partially by using green hydrogen for various heat treatment and metal processing like annealing, brazing, sintering, hardening, and carburising.

For the transportation sector, the project will focus on decarbonisation of the local rail and bus network. Hydrogen proves to be the cleanest and the most economical low-carbon energy solution for the removal of diesel from local rail and bus networks. The problem faced over much of the UK is the question over which comes first: hydrogen demand or hydrogen supply. By bringing supply forward, this project will make the supply of hydrogen available in large scale and thus enable the rapid transition to hydrogen energy in local transportation.

Furthermore, the project will benefit the effective integration of the renewables. As the grid moves towards a high-level penetration of renewable energy in the system, the cost of integrating renewables to the grid increases, which will be paid by all users of the grid. By creating direct and flexible consumers through hydrogen production, wind farms can reduce their impact on the grid and the associated costs. In addition, this creates a market for stable offtake agreements, creating a long term commercial route-to-market for renewables, which stimulates investment. Also, by creating more investment where electricity is a feedstock, the renewable energy producers can capitalise on the downwards pressure on wholesale prices caused by more renewables (known as the 'merit order effect'), whilst maintaining a rationale for investment.

The technology and experience built up in this project can be shared across GB to accelerate the pace of transitioning to a low-carbon economy. The outcomes of this project will ensure there are no impacts on the environmental eco-systems as well the creation of more jobs to manufacture the electrolyser.

How will the Project deliver value for money for electricity and/or gas customers?

The Licensee must demonstrate that the Method(s) being used can derive benefits. It must also be able to demonstrate that the resulting learning can be attributed or are applicable to the electricity/gas transmission and/or distribution systems.

The following areas are expected to secure value for money for end consumers:

1) The cost to the grid of integrating intermittent renewable power decreases, thereby reducing grid costs to all users of the grid.

2) Flexible demand allows a greater penetration of renewables in general through price stability, improving long-term investment prospects. This lowers the average wholesale price of power, as renewables have a near-zero marginal cost power dispatched into the system. This should lead to a positive impact on consumer bills.

3) A direct connection from the wind farm to the electrolyser allows constrained power to be used in an application, meaning that no MWh's are wasted through grid or economic constraints.

4) The project will be able to offer ancillary services, creating more competition for those contracts therefore lowering the cost to the grid of procuring those services.

5) The project will contribute to improved air quality at Port Talbot by decarbonising local steel industry and transport using hydrogen. This will bring big environmental and health benefits to consumers in the area.

6) The project will help in reducing the time-to-market of the new technologies vital for hydrogen economy by providing a large-scale demonstration site. The cost saving resulting from this will make these technologies more affordable to the end-users.

How will the Project generate knowledge that can be shared amongst all relevant Network Licensees?

The Licensee must explain the learning that it expects the Method(s) to deliver, and how it will be shared. The Licensee must demonstrate that it has a robust methodology in place to capture the learning and how the learning will be disseminated.

By creating by far the largest integrated wind/electrolysis system, H-Awel will be able to demonstrate the smart link of intermittent generation with flexible demand. This will allow greater penetration of intermittent generation in the overall electricity network.

The application of LOHC logistics in the project will be a very important learning point. This solution enables transporting green hydrogen over longer distances, where high pressurized gaseous transport becomes uneconomic and the gas grid infrastructure does not allow delivery of the quality of fuel-cell grade hydrogen needed in transport applications. The LOHC logistics trial allows H-Awel to demonstrate the development of the hydrogen generation pipeline to be where it makes most sense to deliver in terms of input power, rather than demand.

Vattenfall has proven experience in capturing project knowledge and learning as well as dissemination in various public funded projects (e.g. Hydrogen fuelling station with onsite generation in Hamburg). Vattenfall is broadly active and connected within European hydrogen networks (e.g. Hydrogen Europe) and are regular speakers at hydrogen and renewable energy conferences. In addition, Vattenfall will actively engage scientific research and dissemination partners such as universities and specialised consultancies and its technology both in the UK and Europe.

The learning from this project will be disseminated through various channels including: bi-annual reporting, LCNI/ENA conferences and stakeholder events. The hydrogen projects funded by the Network Innovation Allowance (NIA) will be regularly reviewed and feed in to the development of this project.

Does the Project conform to the default Intellectual Property Rights (IPR) arrangements set out in the NIC Governance Document?	YES ☒	NO ☐

By selecting NO, the Licensee is indicating that it wishes to deviate from the default requirements for IPR. If this is the case, it must demonstrate how the learning will be disseminated to other relevant Licensees and how value for money will be ensured. The Licensee must also outline the proposed alternative arrangements and justify why the arrangements are more suitable than the default IPR arrangements.

The project will confirm to the default IPR arrangements.

How does the project demonstrate it is innovative (ie not business as usual) and has an unproven business case, that the innovation risk warrants a limited Development or Demonstration Project to demonstrate its effectiveness?

Demonstrate why the Licensee has not previously used this Method (including where the Solution involves commercial arrangements) and why NIC funding is required to undertake it. This must include why the Licensee would not run the Project as part of its business as usual and why the Solution is not Research.

The project demonstrates the following innovative characteristics:

1. A genuine cross sector innovation across three sectors (electricity, transport and heavy industry);
2. The first PEM electrolyser system to be deployed at this scale in the world;
3. The first trial and testing of a new integrated control system to manage intermittent electricity production in order to create a product which is commercially viable and responds to market signals.
4. The first time renewable energy has been used in the UK to produce a feedstock for decarbonising industrial processes.

Investment on this scale of hydrogen generation would normally require that the hydrogen demand was secured before the investment was made. As such demand is still in its infancy, this would make it impossible for an electrolyser of this scale and capability to deliver such a high quantity of hydrogen for such a range of end users without innovation funding. Therefore a large-scale bulk production of green hydrogen would be first of its kind in this industrial size. In contrast to business as usual, this site would be built in prospect of expected hydrogen demands and thereby would solve the chicken-egg problem of hydrogen investment. LOHC's are until now still in the demonstration phase. This would be the first application capable of storing and transporting up to 20t of hydrogen per week using LOHC logistics.

This innovation will help decarbonise South Wales industry and transport regionally, as well as across England and Wales. The knowledge and learnings can be shared to the nation to help to accelerate the transition to low carbon energy in the nation.

How were project Partners, external resourcing/funding identified, and what are their respective roles in the Project?

The Licensee must provide evidence of how Project Partners were identified and selected, including details of the process that has been followed, and the rationale for selecting partners and ideas for the Project.

The Licensee should provide details of any Project Partners who will be actively involved in the Project and are prepared to devote time, resources and/or funding to the Project. If the Licensee has not identified any specific Project Partners, it should provide details of the type of Project Partners it wishes to attract to the Project.

The initial project proposal was the result of discussions around possible shared areas of innovation collaboration between Vattenfall and National Grid Electricity Transmission.

Vattenfall will be the main project partner in this work; and we will include further project partners as research/dissemination partners and/or technology partners as we develop the full proposal. Potential future project partners could be the supplier of the electrolyser and the supplier of LOHC technology. The final selection of suppliers should be the result of a competitive procurement process to ensure best value for money and a robust solution to deliver the output of the project.

We have also been engaging with other partners involved in the development of industrial clusters around the UK to develop their integration and invited further participation.

Will the Project require any derogations or exemptions?

The Licensee should outline if it considers that the Project will require any derogations, exemptions, or changes to the regulatory arrangements.

The project will be developed in through a stage gate approach with a gate prior to full deployment and energisation. We will may need to discuss with Ofgem E-serve the compatibility of the electrolyser application with the accreditation under the Renewable Obligation scheme of the Pen y Cymoedd wind farm to run a successful trial deployment. This is an area we will consider further as the project develops, and we will provide further information in the full submission document.

No derogations are identified at this stage of the project. This will be further explored during the detailed development of the project.

How will the Project activities impact customers?
The Licensee should outline any planned interaction with customers or customers' premises as part of the Project, and any other direct customer impact (such as amended contractual or charging arrangements, or supply interruptions).
As the nature of this project is a large-scale demonstration a number of stakeholders will be involved but no impact to consumers is envisaged. The project will require close interaction with the industry and transport sectors in South Wales. A customer stakeholder plan will be produced which will list all potential stakeholders and how we intend to communicate with them. Where stakeholders have been identified as having a close involvement in the project a more detailed plan will be produced. Hydrogen is still a very new concept with a lot of research being undertaken. Customers don't necessary know about the gas, its pros and cons and actually how it is going to impact them. This will all be considered when developing the stakeholder engagement plan.
What funding is being requested from each NIC? (Cross Industry Projects only)
The Licensee must outline funding that is being requested from the Electricity and the Gas NICs and include a justification for the funding split.
Click or tap here to enter text.

Are there any further details the Licensee considers would support its submission?
Hydrogen is still a very new concept which is why a number of utilities/companies are carrying out research in this area. As detailed in the proposal this project will integrate the learning from a number of ongoing NIA projects around hydrogen and avoid any duplication. The project aligns with the key principles identified in the Carbon Plan. Domestic transport, industrial sector and the power sector account for the majority of UK emissions. Carrying out the project in South Wales where all these emissions are really high would help the UK meet their future targets. The project also aligns with a number of the themes highlighted in the ENA's Electricity Network Innovation Strategy. The Vattenfall Group is investigating applications for hydrogen produced by renewable energies for more than two decades. In Germany there have been several pilot initiated such as the hybrid power plant Prenzlau. This started in 2009 and looks at combining wind turbines with hydrogen electrolysers and biogas usage via a CHP unit. There is also ongoing collaboration with the Hamburg city bus operator Hochbahn looking at powering their fuel cell buses. Vattenfall is partnering with major industrial companies regarding hydrogen: Emission-free steel production (HYBRIT, Sweden), bio-fuel production (Preem, Sweden), synthesised natural gas production (MAN, Germany), hydrogen fired power plant Magnum (Gasunie & Equinor, Netherlands) and many more. In addition to the technical benefits of hydrogen as an energy carrier, there are also socio-economic benefits that can be expected. The production, assembly and maintenance of the electrolyser could be provided by British manufacturers (e.g. ITM Power Sheffield) and would therefore create additional jobs in the UK. The size of this application would require expansion of production capacities, workforce in engineering, production and maintenance.

Contact Information (*Cross Industry Projects can provide details for up to two contacts)*	
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