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)		
Western Power Distribution		
Network Licensee Project Partners		
Ricardo Energy & Environment, Turbo Power Systems, Vectos, Electricity North West Limited		
Funding Licensee area(s)		
Western Power Distribution - East Midlands		
Project Title		
DC Share		
Project Summary		
DC Share is a network equalisation solution which provides a means of sharing system capacity across AC secondary substations with different load profiles. DC Share will employ power electronics to extract power from existing substations at the 415 V level and distribute this to vehicle charge points via a new high capacity DC cable network. The DC Share approach reduces the amount of traditional AC reinforcement required in areas where it can be difficult and expensive to expand the capacity of existing substations, by releasing unused capacity specifically for EV rapid charging Using a DC mesh to provide the capacity for rapid charging points (50 – 150 kW) leaves spare capacity on existing LV AC cables to customers' premises free for demand growth associated with the existing connections (e.g. off street charging and heat pumps).		
Estimated Start Date	**Estimated End Date**	
6 January 2020	31 December 2022	
Estimated Project funding		
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)	£5.97m	**NIC funding requested** £4.99m
Is the Technology Readiness Level (TRL) of the Project at start date between 4 and 8?	YES ☒	NO ☐

[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.

What is the Problem?

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

The ability of power distribution networks to accommodate new demand to charge electric vehicles is key to enabling the decarbonisation of transport. The Government's Clean Growth Strategy sets out the importance of accelerating the shift to Low Carbon Transport (LCT) with one of its key aims being to "Develop one of the best electric vehicle (EV) charging networks in the world" alongside the policy of ending the sale of new conventional petrol and diesel engine cars and vans by 2040.

Key to user confidence within the uptake of EVs will be the availability of a range of offerings for EV charging: each offering will have an impact on the UK power system. At the moment there is no large-scale availability of EV charging points in the UK. There are a number of possible EV charging scenarios and this proposed project provides an approach to delivering > 50 kW rapid charging facilities in short stay destinations such as town centres, taxi ranks, commercial vehicle and/ or car club charging hubs.

Whilst recent projects (My Electric Avenue and Electric Nation) have demonstrated that slow, 7 kW charging should be largely accommodated by managed charging solutions, the provision of rapid 50 - 150 kW chargers at any scale in urban environments, where users charge for short periods of time rather than hours, is likely to require network reinforcement.

The level of power required for one rapid charger is between 5 and 15% of the rating of a typical secondary transformer and will be more than 20% of the AC cable's rating. Thus, whilst a substation might be able to connect one or two rapid chargers, as soon as they are required at scale reinforcement of the LV AC network is likely to be necessary. At this point consideration should be given to alternative, more cost-effective solutions to provide the required capacity which gives the system more flexibility than a traditional AC reinforcement solution.

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.

The proposed DC Share network will:

- Utilise spare capacity of geographically coincident distribution substations with different load profiles i.e. some with commercial profiles and some domestic profiles;
- Obtain greater utilisation of substation assets through equalisation and load management to provide capacity to support EV rapid charging at > 50 kW load;
- Facilitate the fast and flexible connection of high power charging points for EVs and support future Low Carbon Technology demands;
- Make use of available space in existing substations;
- Provide greater capacity than BAU equivalent solutions.

DC Share is a technical solution that utilises spare capacity in the existing AC infrastructure to support new demand such as EV charging. DC Share will employ power electronics to extract power from existing substations at the 415 V level and distribute this to vehicle charge points via a new high capacity DC cable network.

This DC equalisation solution provides a means of sharing system capacity across AC secondary substations with different load profiles. Using a DC mesh to provide the capacity for the rapid charging points leaves spare capacity on existing LV AC cables to customers' premises free for demand growth associated with the existing connections (e.g. off street charging and heat pumps).

Method(s) continued

The DC Share network would be built from modular components so that it can be readily adapted and extended to address the requirements of different locations and changing needs. The inherent flexibility would include the potential for connection to renewable energy resources such as solar PV installations and to energy storage systems. The DC network will have an inherent capacity to provide flexible support to the wider distribution network.

The system would comprise four principal components:

1. Bi directional power electronic converters connected between the 415 V AC network and ±800 – 900 V DC distribution cable network;

2. A DC cable network with remote sectionalising switches and connection hubs at strategic points and associated communications infrastructure;

3. Rapid 50 – 150 kW EV charging equipment comprising DC hubs with smart chargers to enable managed utilisation of each DC hub whilst the cars are parked;

4. An over-arching monitoring, optimisation, and control system to operate the charging and equalisation system, prioritising efficiency, and enabling services to the local distribution network.

The trial would comprise four secondary substations connected with a DC ring from which in the order of 20 rapid chargers would be connected.

The most appropriate communication solution (optical fibres installed together with the DC cables or radio control) to manage the equalisation and the vehicle charging process will be considered during the project. The specifics of the control system will be agreed in the initial stages of the project, taking account of local decision making, central control system requirements and reliability.

Most EVs available on the market today can charge at 50 kW DC. Numerous models charge at >50 kW including one that can charge at around 100 kW. It is expected that during the trial period more vehicles that are able to charge at 100 kW or higher will come onto the market and hence the trial will provide for both 50 kW and 150 kW charging.

We intend to work closely with a local authority who is actively encouraging the uptake of electric vehicles. The project will undertake collection and analysis of usage data to understand the current requirements for rapid charging and assess the effect of the provision of the charges on users. We will set up an online platform to enable us to conduct focused surveys of the charge point users to provide qualitative data for example considering:

- user profiles – what members of the public are benefitting, how do we ensure equal access,
- journey types and range,
- user satisfaction.

We will also undertake extensive stakeholder engagement before and during the trial to capture user needs and requirements, how these may have changed during the trial and how EV uptake and EV rapid charger usage is likely to scale up in the future.

This will enable us to assist local authorities in gauging future demand for scaling up rapid charger provision and hence the associated network needs.

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 cost is estimated to be £5.97 million. The project partners have agreed to a 10% in kind contribution. WPD and ENWL will contribute 10% as the licensees. This leaves a cost for NIC funding of £4.99 million This is broken down as: Phase 1 Design and development £2.76 million Phase 2 Trial design and installation £1.20 million Phase 3 Trial and analysis £0.65 million Phase 4 Results, dissemination, BaU considerations and close down £0.38 million To enable to demonstration of the equalisation solution it will important to encourage cars to charge, and may be necessary to offer a free charge. Hence, we have allowed for the cost of the provision of electricity to charge cars at 20 charge points. As we further develop the project and identify the EV beneficiaries we will endeavour to engage them in the project by way of covering some of this cost.

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.

The facilitation of EV rapid charging is one part of the GB EV adoption pathway. The consensus is that rapid charging will be especially valuable in areas of poor local air quality and where a borough is promoting EVs For example, Milton Keynes Council are actively encouraging EVs, Coventry launched a "Go Electric" taxi scheme in 2018 and Birmingham City Council are introducing a clean air zone from 2020 which whilst not excluding modern Internal Combustion Engines (ICE) will encourage EVs This means providing more rapid charge points at destinations where vehicles park for short periods of time to encourage the switch to EVs. We anticipate this charging solution being necessary for taxis, commercial vehicles and car clubs wherein low vehicle down time is key to the mobility business solutions as well as for visitors to the local area.

The DC Share approach reduces the amount of traditional AC reinforcement required in areas where it can be difficult and expensive to expand the capacity of existing substations, by releasing unused capacity specifically for EV rapid charging. This reduces costs to customers by making more effective use of existing assets and deferring capital expenditure on substation capacity enhancement. In addition, the DC Share scheme does not compromise the spare capacity available to customers through the existing AC LV cabling to their premises.

The ability of the DC Share system to transfer energy between connected substations allows the distribution companies more options to utilise existing assets, managing supplies to existing customers and to charge points where destination charging is required.

The benefits of this system include:

- Equalisation benefits to the AC network by drawing power from those substations with the most headroom, and injecting power to those requiring support. The amount of accessible capacity will be dependent on the specifics of the trial but could be in the order of 1MW. This provides a benefit to the local authorities in terms of deferred reinforcement and to EV charging providers in terms of lower connection cost. This facilitates central urban areas to provide destination charging at reasonable cost which will benefit all customers.
- Provision of compact rapid EV charging in urban areas which are electrically and physically constrained by optimising the use of existing network capacity. Locating rapid chargers in popular areas should encourage the use of EVs in town centres, assist with the electrification of taxis and commercial vehicles and give all EV users confidence in their ability to charge.
- The greater reach and load diversity of the DC system that can be achieved compared with conventional LV AC systems. The financial benefits of the DC system compared to the AC system increase as the number of rapid chargers increases.
- Capability to connect low carbon technologies directly to the DC equalisation network, enabling the connection and management of electric vehicle charging infrastructure, as well as battery storage and low carbon generation such as solar panels. Incorporating this technology into the managed equalisation network allows it to be monitored and optimised to minimise the impact on, or even provide benefits to, the wider AC network to which it is connected.
- Connecting EV chargers to the DC system leaves LV AC cable capacity for demand growth of the existing connections.
- The DC system can be used to future-proof the network infrastructure to the needs of the customers and society, as it is modular and adaptable, enabling the network solution to be developed over time as rapid charger deployment increases.
- Carbon saving and improved air quality in central urban areas due to encouragement of consumers switching from ICE cars to EV.

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 benefits of this project are associated with meeting the GB decarbonisation targets by encouraging the uptake of EVs, the cost savings in network reinforcement costs, that would otherwise be passed on to the customer and benefits associated with improved air quality.

- The network equalisation benefits will be to the electricity customers requiring an EV charging supply as the DC Share defers the need for reinforcement by making better use of existing assets.
- Customers connected in the areas where the additional capacity is required will benefit as the existing LV AC cable spare capacity supplying their premises is not eroded.
- Local authorities and DNOs will benefit in gauging future demand for scaling up rapid charger provision and the associated network requirements.
- The availability of electric vehicle charging infrastructure is a key customer concern and potential barrier to mass EV uptake. Wide availability of rapid 50 – 150 kW charge electric vehicle points has been identified as necessary for destination charging where low vehicle downtime is key e.g. taxis and commercial vehicles and private cars requiring a mid journey top up. There is an expectation that in the future very high > 350 kW capacity chargers may be required, especially for commercial vehicles, and the solution proposed here can be adapted to accommodate this extra power requirement.
- Encouraging EV uptake by enabling taxis, commercial vehicles, car clubs and those electricity customers who are car drivers and who frequent urban centres to switch to EVs and benefit from the associated financial benefit.
- Local authorities and electricity customers will benefit from the improvements in air quality that results from the reduction in ICE vehicle and the uptake of EV.

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.

The key use case that this project addresses – supporting the connection of electric vehicle charging infrastructure and other low carbon technologies in built up and constrained areas – is one that is relevant all over the UK in towns and cities of all sizes. The project will create knowledge about the technical requirements and commercial viability of DC equalisation networks suppling rapid charging EV demand in urban areas. This learning will be applicable to many locations with short-term parking, particularly areas with clean air and EV uptake ambitions (in particular those involving taxis and commercial vehicles).

In urban areas where land for new substations is difficult to obtain the ability to maximise the use of capacity in the existing secondary transformers and potentially help specific 11 kV networks by providing equalisation will be of value across GB.

The project will be designed with the intention of ensuring the findings are applicable to other network companies and their networks, and that there are clear routes of communication and dissemination of the project methodologies, findings and recommendations. This will include key dissemination events including dedicated workshops, conference presentations, and website development and promotion.

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.

We intend that a declaration of background IP is made in the consortium agreement to clearly define what each partner brings to the projects as already established IP in line with 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 increasing power demands in constrained urban areas means the conventional AC reinforcement solution is not necessarily the most cost effective. For significant power demand a preliminary business case has determined that the use of a DC network equalisation system is cost beneficial. This solution has not been demonstrated and as the converter device is new and as yet, untested NIC funding is required to prove the technical and commercial viability.

The most significant innovation is the concept of the DC meshed equalisation network with multiple low carbon technology connection points.

Equalisation across AC networks has been explored in UK Power Networks NIC project "Active Response for Distribution Network Constraints", and was previously demonstrated in FUN-LV, where the existing network capacity is maximised using power electronics to control flows and WPD's Equilibrium project which considered controlled sharing of power at 33 kV . This system extends these concepts to a DC network such that optimisation is available over a wider area, and the connection of DC loads and other DER is facilitated and managed. The system components are anticipated to be autonomously self-configuring to optimise for network demands, assist with constraint management and minimise losses.

The Solid-State Transformer and AC equalisation network proposed by SPEN in the LV Engine NIC project builds on the FUN LV project learning to demonstrate the benefits of AC equalisation using solid state transformers (SST) and intends to have a radial DC customer connected to the SST. DC Share moves this on with its demonstration of the benefits of a DC meshed equalisation network.

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.*
This project was originated by Ricardo responding to an ENA NIC third party call. WPD will be the Funding Licensee and ENWL will collaborate on this project. Ricardo will take the lead in delivering the project and have the relevant experience. The Energy Practice of Ricardo Energy & Environment has a long and successful track record in delivering innovation projects in the UK power sector. They have a solid understanding of network architectures and a particularly detailed knowledge of the role of power electronics within power networks, non-invasive monitoring systems, communication requirements and effective installation/commissioning procedures. The Sustainable Transport Practice will work with the Energy practice, contributing in their area of expertise in relation to the take up of EVs and charger requirements and locations. Ricardo who will lead, project manage and provide technical expertise to the DC Share project have identified two project partners to ensure successful delivery. Turbo Power Systems (TPS) have a track record of successfully developing innovative power electronic systems. They have experience of the design and manufacture of power electronics directly relevant to smart networks. TPS are currently working with Ricardo on two innovative projects, Active Response NIC, for UK Power Networks and Smart Hubs 1 and 2 with Flexisolar for Innovate UK. TPS have the required technical and practical understanding of delivering application requirements for the substation converters and the DC/DC EV chargers. Vectos is an innovative provider of transport planning and infrastructure design services. They are involved with international research projects looking at innovative and sustainable transport. Vectos have worked with a number of local authorities and together with Ricardo's Sustainable Transport team will assess the provision and use of rapid chargers to ensure the project not only delivers technical learning about the equalisation system, but also learning about requirements for and use of rapid chargers.
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.
None

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).
No supply interruptions are expected due to the urban environment with alternative supply arrangements in which the trial will be undertaken. Consideration is being given to the provision of the electricity for the charge points which will be progressed during the FSP preparation.
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.
Not Applicable, only pertinent to electrical power sector

Are there any further details the Licensee considers would support its submission?
WPD and ENWL will support the project including: • Provision of data (e.g. loadings and rating, network diagrams etc.), • Review of equipment design documents and specifications including control system, • Trial site selection, • Cable installation, • Trial data, results and analysis, • Business case validity, and estimation of applicability/impact in the DNO licence areas, • Involvement at project dissemination events, • Project Deliverables. The site trial will take place on WPD's network. The equalisation cable will be procured during the project and a preferred WPD contractor will be used for equipment installation.

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