Electricity Network Innovation Competition Full Submission

Supplementary Answer Form

Project: __DC Share_____

Tick if this answer has been provided verbally: ☐

Project code	WPD/EN/NIC/07	Question Number	1
Question date	01 August 2019	Answer date	05 August 2019
Submission section question relates to		2	
Topic			
Question	Please explain how often the charge points would need to be used in order to break even on project delivery costs.		
Notes on question			
Answer	DC Share is a network equalisation project, which enables the capacity for rapid charging. As such the project does not consider the business case for the provision of the rapid charge points, and no level of charge point utilisation is required in order for the project to break even. DC share's premise is that rapid charging will be needed and funded and the commercial offering to the public will depend on the charge point provider chosen and the business model used. There are a variety of charging models on offer, including: • Vehicle manufacturers fund their own as a means to enhance vehicle sales; • local authorities may provide them or obtain grant funding for them to encourage air quality benefits; or • commercial operators and businesses may provide them due to financial benefits of using electric vehicles. DC Share will not develop new business models for rapid charger operation, although the trial may provide useful insights to the industry on this topic. The project business case is based upon the benefits provided by a more efficient way to provide the capacity required for the connection of rapid charge points, and is not related to charge point usage. However, as part of the project, and based on the results of the trial, an updated business case for BAU will be produced that quantifies charge point utilisation and pay back under different charge point operational models. The DC Share trial does require usage of the installed rapid chargers in order to validate the system:		

	• Economically - validate that the costs of rapid charging point grid connection can be reduced using the DC Share system; and • Technically - confirm that the method does provide the required capacity and the system operates coherently. Higher levels of charger utilisation will allow greater understanding of charger diversity, usage patterns and attititudes to management of charger power.
Attachments	

Electricity Network Innovation Competition Full Submission

Supplementary Answer Form

Project: DC Share

Tick if this answer has been provided verbally: ☐

Project code	WPD/EN/NIC/07	Question Number	2
Question date	01 August 2019	Answer date	05 August 2019
Submission section question relates to		2	
Topic			
Question	Please explain why this project could not have been delivered in a lab environment, including detail of the net benefit where this can be quantified.		
Notes on question			
Answer	Obtaining the level of demand needed to gain learning about equalisation management and control and to simulate the cars charging would not be possible in a lab environment. The DC Share trial will enable validation of the method via its use in a real world application so that actual substation demand profiles are used, and genuine charger demand patterns are encountered. Capturing user charging behaviours and their interaction with the rapid chargers is key to assessing the impact on the DC Share system. There are numerous interactions and dependencies between rapid charger usage and electricity network equalisation that can only be fully explored in the real-world environment. The benefits of the DC Share project are derived from a more cost effective scalable method for provision of high power in dense urban areas. Benefits of undertaking the trial in the field include: • Development of the system to TRL 8, a proven and qualified system. This would not be possible if the project remained in a lab environment. Once the project is complete it will be a model ready for roll out, although DNOs will need to decide how they want to integrate the system into their existing SCADA systems. • Undertaking this project in an urban area will provide learning about the practical requirements of installing a DC network, allowing time to develop new procedures for installation and use of DC networks. It will provide learning about the provision of reliable communications in a field environment (not a clean lab environment) and to investigate the communications requirements between the DNO and charge point provider.		

	• Learning will be gained about the viability of DC equalisation networks supplying rapid electric vehicle charging in urban areas. The EV user monitoring and surveys will provide useful information into current and future behaviour to enable understanding of the use of rapid chargers and demand diversity to be obtained. Utilising real users and vehicles would not be achievable in a lab environment.
Attachments	

Electricity Network Innovation Competition Full Submission

Supplementary Answer Form

Project: __DC Share_____

Tick if this answer has been provided verbally: ☐

Project code	WPD/EN/NIC/07	Question Number	3
Question date	01 August 2019	Answer date	05 August 2019
Submission section question relates to		2	
Topic			
Question	Please clarify whether the proposed project addresses a current use case.		
Notes on question			
Answer	DC Share addresses a current use case for rapid charge point deployment. Where grid connection costs are prohibitive, sub-optimal sites are selected in order to keep the costs down and low numbers of chargers can be deployed in desirable locations. This use case will face increasing challenges, as the number of electric vehicles increases and the existing spare capacity is used. This could become a barrier to electric vehicle adoption and usage if not addressed, hindering progress against two government targets: 1) The end of most internal combustion engine cars by 2040, and 2) Net zero greenhouse gas emissions by 2050. Ofgem's Future Insights Series, "Implications of the transition to Electric Vehicles" notes that given the speed of recent improvements in battery size and vehicle range, the need for rapid charge points could change significantly in the near term. The Requirement for rapid charging hubs is an emerging use case in relation to the uptake of electric vehicles as outlined in Section 2. The use of network equalisation techniques as an effective reinforcement method to address load growth has been explored in previous Network Innovation Competition projects. DC Share will explore a new method for providing this in tandem with rapid charging, exploring a cost effective technique for addressing load growth, which will be greatly influenced by vehicle charging requirements.		
Attachments			

Electricity Network Innovation Competition Full Submission

Supplementary Answer Form

Project: __DC Share_____

Tick if this answer has been provided verbally: ☐

Project code	WPD/EN/NIC/07	Question Number	4
Question date	13 August 2019	Answer date	15 August 2019
Submission section question relates to		2	
Topic			
Question	Please detail the capacity which would need to be utilised in order for the project to breakeven, using a normalised tariff cost to consumers.		
Notes on question	Follow up to Question 1		
Answer	As explained in our answer to question 1, DC Share's premise is that rapid charging will be needed whether this is provided by an AC solution or DC equalisation networks. DC Share will not investigate the business model for rapid charger usage tariffs, business models etc. The DC Share business case is based on the difference between an AC reinforcement solution (new secondary substations and AC cables) and a DC equalisation solution (converters in existing substations and DC cables). The business case does not assume any revenue from charging, and hence the breakeven point is not affected by the charger utilisation. The economics and provision of rapid charge points in suitable locations in constrained urban areas is something that the EV industry, DNOs and local authorities are looking at more widely and DC Share will inform this discussion.		
Attachments			

Electricity Network Innovation Competition Full Submission

Supplementary Answer Form

Project: __DC Share_____

Tick if this answer has been provided verbally: ☐

Project code	WPD/EN/NIC/07	Question Number	5
Question date	13 August 2019	Answer date	15 August 2019
Submission section question relates to		2	
Topic			
Question	Please provide detail of the minimum levels of spare capacity within the substations elected for use in DC share. Furthermore, how have will you validate these capacity figures?		
Notes on question			
Answer	The converters are 250 kVA, we therefore will consider substations that have at least 250 kVA spare capacity during typical 24 hour demand profiles. Once we have identified a suitable trial area we will undertake measurements by installing Grid key monitors on the substation feeders for a predetermined amount of time to get an accurate view of the substation utilisations.		
Attachments			

Electricity Network Innovation Competition Full Submission

Supplementary Answer Form

Project: __DC Share_____

Tick if this answer has been provided verbally: ☐

Project code	WPD/EN/NIC/07	Question Number	6
Question date	13 August 2019	Answer date	15 August 2019
Submission section question relates to		2	
Topic			
Question	Please clarify what "demand" means in this context; is it users of the charging stations or the overall demand in terms of energy used?		
Notes on question	Follow up to Question 2		
Answer	The DC Share solution takes into account both the EV charging demand (50 or 100 kW) and the secondary substation (transformer) demand when performing the equalisation. Therefore the control system will manage overall demand in terms of energy used by AC commercial, AC residential and DC EV charging.		
Attachments			

Electricity Network Innovation Competition Full Submission

Supplementary Answer Form

Project: __DC Share_____

Tick if this answer has been provided verbally: ☐

Project code	WPD/EN/NIC/07	Question Number	7
Question date	13 August 2019	Answer date	15 August 2019
Submission section question relates to		2	
Topic			
Question	Please clarify how scenario analysis be developed across a range of possible locations. In terms of the overall usage and type of usage, what are the dependencies on the vehicle types which use fast chargers?		
Notes on question	Follow up to Question 2		
Answer	The trial will investigate scenarios to understand how the system will perform when used differently or in different configurations, to understand how these affect future implementations. The scenarios are based on how many vehicles are charging and at what power through the day. This will be largely determined by a combination of public and fleet charging behaviour at any given site. We intend to engage with both fleet and public EV charging users to gain an understanding of the different requirements for rapid charging. Scenario analysis will then consider different combinations of public and fleet vehicles using the charging hubs, resulting in different load and utilisation profiles at different location types. Furthermore, we will simulate some conditions to see how the system and users respond. For example it may be relevant to simulate a scenario where the charging demand is greater than that available from the substations, and so we have to reduce the charging demand, and see at what point this has a negative impact on users experience and perception. Alternatively we may wish to turn off a converter for a period and see how the system responds. This will assist in understanding what ratio of converters to charging points is currently required, the impact of an outage on the system, and so on. The only dependency on the vehicle types is their DC charging rate (50kW - 100kW) and connector type. We expect to have a mixture of vehicles in the		

	trial that will have a spectrum of charging capability for which we will provide different sized chargers (50kW or 100kW). During the site selection phase, we will identify specific fleets with known DC charging capability (e.g. taxis, car clubs and commercial fleets – based on current discussions), whilst general public EVs will provide a more unpredictable mix of DC charging requirements. For connector types, we can expect that both CHAdeMO and CCS standards will be required so the charging points will have both connector types available. The trial will provide valuable learning about the user charging behaviour, level of charge at commencement, charge point occupancy rate, etc. leading to learning about diversity assumptions for future roll out. User surveys will investigate the suitability of different locations for charging hubs to inform future location choices.
Attachments	

Electricity Network Innovation Competition Full Submission

Supplementary Answer Form

Project: __DC Share_____

Tick if this answer has been provided verbally: ☐

Project code	WPD/EN/NIC/07	Question Number	8
Question date	13 August 2019	Answer date	15 August 2019
Submission section question relates to		2	
Topic			
Question	With regards to sub-optimal sites, and in reference to figure 9, please detail the volumes of installed equipment needed. How would, in figure 9, the equivalent AC system be developed and then costed?		
Notes on question	Follow up to Question3		
Answer	In the example shown in figure 9 we have assumed a similar implementation as that intended to be installed in the trial. That is four 250kVA convertors, and 1MVA of charging capacity. We have assumed that the chargers will be installed in two hubs, one at the delivery warehouse and one in the public amenities area. The DC cable connecting them in a ring totals approximately 1500m. If this additional charging demand was to be met by an AC solution, this could be met through deploying new substations along with the associated 11 kV reinforcement works at each charging hub location. Alternatively reinforcement of the existing substations (up rating of the transformers, new cabling etc.) could be implemented if possible. A similar scenario is described as the base case solution in the presented business case, with the associated equipment and installation costs determined in collaboration with WPD network planners.		
Attachments			

Electricity Network Innovation Competition Full Submission

Supplementary Answer Form

Project: __DC Share_____

Tick if this answer has been provided verbally: ☐

Project code	WPD/EN/NIC/07	Question Number	9
Question date	13 August 2019	Answer date	15 August 2019
Submission section question relates to		2	
Topic			
Question	In the selected substations supplying the Inverters, what load growth is afforded? Would there be an impact on the surrounding consumers in the vicinity of the substations selected should there be an increase		
Notes on question			
Answer	In developing the business case we have assumed 3% annual load growth. Through the benefits of equalisation substation capacity can be shared and hence the reinforcement of a substation can be deferred. This is achieved by the convertors at those substations that are lightly loaded importing power into the DC Ring, and the convertors at heavily loaded substations exporting power from the DC ring to the AC network. This means that there is additional power available at the heavily loaded sites to meet the demand. We have assumed 2 of the substations in the base case solution will require traditional reinforcement due to AC load growth, the first after 12 years, and the second after 25 years. We have also assumed that load growth at the remaining substations will occur but will be managed using innovative solutions. We have assumed that the DC Share equalisation benefits defer the need for these solutions by 6 years. The DC Share solution could also be expanded to increase the equalisation benefits if there are other less utilised substations in the vicinity, although this has not been directly considered in the business case. The DC Share solution will only draw power from those substations where it is available as determined through the control system. Hence DC Share will not affect surrounding consumers.		

Attachments	

Electricity Network Innovation Competition Full Submission

Supplementary Answer Form

Project: __DC Share_____

Tick if this answer has been provided verbally: ☐

Project code	WPD/EN/NIC/07	Question Number	12
Question date	27 August 2019	Answer date	29 August 2019
Submission section question relates to			
Topic			
Question	How confident are you that you can identify appropriate site locations without physically measuring capacity?		
Notes on question			
Answer	We are confident that we can identify appropriate site locations for both the trial location, and using learning from the trial, and for BaU application. In order to select the trial location the first consideration is to identify an appropriate area with charging demand, and a suitable user with a high utilisation fleet that wants to be involved in the project. Initial enquiries to this had have been positive. Following identification of the broad geographic area, we will then review the electrical infrastructure available. Using information available to WPD, such as: • customer numbers supplied from each secondary substation, • transformer and cable capacity, • Maximum demand indication, • demand profile class and • network maps showing the network configuration and customer connections. We will also perform site visits to understand local logistical issues, in terms of the geography and the electrical, transport and other appropriate infrastructure. If a location is deemed suitable following this initial analysis we will install Grid Key monitors at all substations that are believed to be appropriate, in order to confirm that the demand profiles are suitable for use in the project.		

	The final trial site location, and the substations utilise will be decided following this process. The project has an initial stage gate, Deliverable 1, which will describe the process and the outcome of the site selection task. Only 5% of the project costs are associated with Deliverable 1. The project trial site selection process will also inform how the process is performed in BaU application, by providing understanding of what the key information is in order to determine the appropriateness of a location. Account will be taken of the WPD plans that by the time of completion of the project they will have rolled out their Network Assessment tool which assesses each LV transformer and cable utilisation against rating. This may mean that the requirement to install grid key monitors to confirm the demand profiles present at the potential substation locations is not required in all cases.
Attachments	

Electricity Network Innovation Competition Full Submission

Supplementary Answer Form

Project: __DC Share_____

Tick if this answer has been provided verbally: ☐

Project code	WPD/EN/NIC/07	Question Number	13
Question date	27 August 2019	Answer date	29 August 2019
Submission section question relates to			
Topic			
Question	Considering the experience of LV Engine, how will you overcome the challenges of site selection?		
Notes on question			
Answer	We are unaware of the specific details of the LV Engine trial site selection as information on the site assessment criteria is not yet publicly available. However, we have had a brief conversation with a member of the LV Engine project team and are aware that locations for consideration must satisfy a number of criteria, including: • Logistics and space • Existing network configuration (both HV and LV) • Complementary load profiles between neighbouring substations • Existing types of installed equipment • Proximity to potential DC customers • Voltage fluctuations and phase unbalance • Presence of LCTs • No plans for other investments We understand that LV Engine has identified suitable locations, and that in BaU the requirement for suitable sites to fulfil multiple of these criteria concurrently is not necessary, as the trial sites are aimed at demonstrating the full range of Smart Transformer capability. The critical factors for the DC share trial location are: • Suitable locations and requirement for rapid charging • Suitable load profiles at 4 substations within a reasonable distance of the charging locations • Logistical and space consideration for both the substation and charging infrastructure, noting that the intent for the substation convertors is that they will be small enough to be housed in common designs of existing substations.		

	• No plans for other investments. DC share will install its own LV network and hence there is no reliance on the existing LV network configuration or equipment. There is also no reliance on the existing HV network or configuration, or requirement to demonstrate other functionality that LV Engine is demonstrating. Ricardo, Western Power Distribution and Electricity North West all have previous experience of site selection for innovation projects, and have successfully delivered these tasks.
Attachments	

Electricity Network Innovation Competition Full Submission

Supplementary Answer Form

Project: __DC Share_____

Tick if this answer has been provided verbally: ☐

Project code	WPD/EN/NIC/07	Question Number	14
Question date	27 August 2019	Answer date	29 August 2019
Submission section question relates to			
Topic			
Question	Please provide a comparison of this project and its outputs against those of LV Engine and Active Response.		
Notes on question			
Answer	DC Share will develop, design, construct and install a trial installation of an integrated DC network solution for: • Network equalisation, and • Provision of rapid EV charge points. The DC share solution is an integrated solution whereby both the substation converters (the connections between the AC and DC networks) and the EV charge points are controllable and can be operated holistically. This will provide a solution whereby: • Support is provided to existing AC substations by supplementing their capacity with latent capacity available from other connected substations, enabling deferment of reinforcement. • Rapid EV Charging is afforded utilising the latent capacity from all of the connected substations. This allows provision of rapid charge points at lower connection costs. The project outcomes are primarily • Technical validation of the system, • Validation of the Cost Benefit analysis, and • Learning around the application of the system in a real world environment.		

	A secondary outcome is increased understanding regarding use of Rapid EV Charging facilities, both in terms of public and high utilisation vehicle (e.g. Taxi, delivery van) users. The operation of the DC network in a ring configuration offers benefits through: • Use of higher voltage to increase cable capacity and distances between converters; • Meshed configuration offering network resilience, multiple current paths between sources and loads, and the ability to make good use of load diversity; • Integrated control between the substation converters and charging demands to ensure that ratings are not exceeded. Active Response is an ongoing NIC project investigating the use of automatic network reconfiguration and power electronic devices (Soft Open Points and Soft Power Bridges) in order to optimise the capacity available in networks. The power electronic devices will offer network equalisation benefits. As such Active Response is looking to demonstrate techniques to optimise the capacity available to customers in existing networks via automation and equalisation. This capacity could be used for new customer connections or general load growth. Active Response will not demonstrate a new DC equalisation network specifically designed to offer both network equalisation and provision of Rapid EV charger points, in an integrated and managed solution. It is not anticipated that the Active Response solution applied to existing networks will meet the concentrated levels of demand required by rapid EV charging hubs. LV Engine will demonstrate a new "Smart Transformer" Device, enabling improved voltage control of the LV side voltage, phase balancing, and real/reactive power control. The "Smart Transformer" device will enable network equalisation benefits through interconnection with adjacent conventional transformers. Again, LV Engine will not demonstrate a new DC equalisation network specifically designed to offer both network equalisation and provision of Rapid EV charger points, in an integrated and managed solution. Each of the projects examines the benefits of providing network equalisation, but through a different mechanism. Application of these solutions is sensitive to the specific locations under consideration, for example: • the space available in substations, • type and magnitude of loads to be connected etc. We therefore believe that each of these three innovative solutions will be suitable for cost effective use in some EV charging scenarios (single rapid charging points) but not in others (provision of several rapid charging points in a hub arrangement).
Attachments	

Electricity Network Innovation Competition Full Submission

Supplementary Answer Form

Project: __DC Share_____

Tick if this answer has been provided verbally: ☐

Project code	WPD/EN/NIC/07	Question Number	15
Question date	03 September 2019	Answer date	05 September 2019
Submission section question relates to			
Topic			
Question	What is the likely size of site (area) required for each charging facility (allowing for vehicle movement etc)? In estimating the number of potential deployments, to what extent have you allowed for the possibility that a site of the required size will not be available (vacant or potentially so) in the locations where other criteria for deployment of the method are met? How does this possible limitation compare with that applying to the counter-factual?		
Notes on question			
Answer	One of the key objectives of the DC Share method is to provide affordable grid connection for anticipated rapid EV charging requirements. We are therefore expecting the rapid charge points to be located within existing car parking spaces, or in new spaces in an area that is undergoing redevelopment. The rapid charger provision would be required in these locations, whether they be supplied by a DC Share methodology, a conventional solution, or an alternative. The cars will park as normal in the bays, which will be either perpendicular or parallel depending on the specifics of the site. A standard perpendicular bay is 2.4 m by 4.8 m and a standard parallel bay is 2.8 m by 6 m. Rapid chargers are approximately 0.7 m in length and breadth (both AC fed, and the proposed DC fed units), and will be located in the most appropriate place for the specifics of the site. For the trial we are planning to provide two rapid charging "hubs" where users can be confident of availability. They can either be located adjacent to the parking bay, or on the road with the parking bays adjusted to suit. For example in a road with 8 parallel parking bays, we may need to reduce the number of bays to 7 and fit the rapid chargers (and some physical defences) on the road. Our first criteria for site selection is a location where users want to park to rapid charge i.e. it is the ability of the site to provide the car parking facility		

	that drives the site selection. The fact that short stay locations are often at the boundary of different demand areas (commercial and residential) drove the project concept. Local Authorities have targets to increase their charging infrastructure, indeed recent carparking provision has included the installation of ducting for future readiness. The counterfactual AC solution would require both the charging infrastructure and additional substation(s). In estimating the number of potential deployments, the roll out is driven by the estimated number of electric vehicles in use in the UK until 2050. This consequently informs the requirement for rapid charge points. We have assumed that these charge points must be provided (either via conventional solutions, the DC Share methodology or other alternative mechanisms) and therefore suitable charging locations will be identified. From the total rapid charger requirement, we have assumed that: • 40% of public rapid chargers, and • 50% of commercial rapid charging locations Will be in urban locations, as required by DC Share, with the remainder (e.g. motorway service station, out of town commercial locations etc.) being unsuitable. We have then assumed that of the remaining urban charging locations, a further 40% are not suitable for a DC Share solution and are discounted because the substation profiles will not be sufficiently different, the network geography is not suitable etc. The example provided in figure 9 is based on existing parking locations, one hub being in a commercial premise car park and the other hub being outside a shopping parade with perpendicular car parking bays and space on the verge for the rapid chargers.
Attachments	

Electricity Network Innovation Competition Full Submission

Supplementary Answer Form

Project: __DC Share_____

Tick if this answer has been provided verbally: ☐

Project code	WPD/EN/NIC/07	Question Number	16
Question date	05 September 2019	Answer date	10 September 2019
Submission section question relates to			
Topic			
Question	Please clarify the number of deployments that would be required for the project solution to break even.		
Notes on question			
Answer	Our analysis demonstrates that the DC Share solution will breakeven partway through 2028 (5 years after the project ends), when the cumulative number of deployments is 64.		
Attachments			