WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Date of Submission

April 2016

NIA Project Registration and PEA Document

Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form. The full completed submission should not exceed 6 pages in total.

Project Registration

Project Title	Project Reference
CarConnect	NIA_WPD_013

Project Licensee(s)	Project Start Date	Project Duration
Western Power Distribution East Midlands, Western Power Distribution South Wales, Western Power Distribution South West, Western Power Distribution West Midlands	Apr 2016	3 Years 6 Months

Nominated Project Contact(s)	Project Budget
Ben Godfrey, Innovation and Low Carbon Networks Engineer	£5,802,023

Problem(s)

As groups of neighbours acquire Plug-in Vehicles (PIVs), localised clustering of demand is likely to cause problems for electricity networks, as proven through the (Low Carbon Networks Fund) My Electric Avenue (MEA) project. MEA showed that approximately 30% of GB low voltage networks will need reinforcement by 2050, if adoption of electrification of transport is widespread (i.e. meeting DECC's High EV Market Growth Forecast). This represents a present day cost of £2.2bn to UK customers – Transform Model® analysis, based on UK Government forecasts of nearly 40 million PIVs on UK roads by that time. The UK Government is committed to the electrification of transport – as illustrated by its recent investment into ultra-low carbon vehicles such as its extension of grants for PIV chargers, PIV car subsidies and the Go Ultra Low Cities Scheme.

Which parts of distribution networks will be affected by PIV market growth is not understood – the MEA analysis used idealised network types. There is no tool available for assessing real LV networks to identify those at risk from PIV penetration and to identify the technical efficacy and economic viability of smart solutions (PIV demand control and V2G) against traditional network reinforcement.

The MEA project demonstrated that a simple form of PIV demand control on single LV feeders is a potentially viable option for managing peak PIV induced loads. The technology used in MEA (EA Technologies Patented Esprit) is not currently technically or economically viable and would be limited to single LV feeder demand control using a relatively unsophisticated on-off control method. This project does not involve the use of the Esprit technology.

Since the inception of MEA, "smart" chargers have been developed for the public charging arena, which are controllable for access and billing purposes. Alongside these smart chargers, control services have been developed and deployed to carry out the access control and billing services. These smart chargers also give the option to modulate the power taken by PIVs, giving a more refined set of demand control options than trialled in MEA. It is thought that these technologies could be adapted for domestic charger control to provide demand control services to DNOs across LV areas (rather than just single feeders). However, it is not known whether the application of these technologies to customers charging PIVs at home is technically viable and acceptable to customers. The technical challenges include: ensuring secure and reliable communications between the charger and control services; providing customers with information about the charging of their PIV; allowing the customer to state preference as to when they are charged (ensuring the control is as "fair" as possible to all); and investigating what, if any, compensation or incentives customers require to participate in PIV demand control. Also, the PIV market has and will continue to diversify with a range of battery sizes fitted to PIVs

and nominal charge rates growing (from 3kW to 7kW+), making possible peak loads higher and adding complexity to the challenge of PIV demand control.

In addition, vehicle to grid (V2G) services and associated technologies are being developed in the UK and abroad. The impact of mass V2G services on LV networks needs to be understood, especially as some V2G services (such as transmission frequency services) may adversely affect distribution network operations, in a similar way to solar PV generation. V2G could be a solution as much as a problem for LV network congestion, in that export mode could be used to address peak PIV demands - but as V2G has not been developed sufficiently at this time this is a poorly understood option. Furthermore, adapting the PIV demand control services to utilise V2G export mode to address PIV induced peak loads has not been proven This tool and the conflict between PIV demand control to meet DNO DSR needs and other services V2G can provide has not been investigated.

Method(s)

This project will use three methods to enable DNOs to identify which parts of their network are likely to be affected by PIV/V2G uptake, and whether PIV demand control services are a cost effective solution to avoiding or deferring reinforcement on vulnerable parts of their networks.

Method 1: Modelling

This project will provide DNOs with an assessment tool to predict where PIV/V2G market penetration may cause network problems. This tool will, firstly, enable assessment of all (non-meshed) LV networks in a DNO's license areas to identify those most likely to be affected by PIV penetration. Secondly, the tool will enable more detailed assessment of those LV networks identified as being susceptible to PIV penetration to identify the level of PIV penetration that would present a problem and trigger reinforcement and enable assessment of PIV demand control and V2G as solutions to avoid or defer reinforcement.

Method 2: Monitoring

This project will develop an algorithm deployable on an existing substation monitoring facility that will enable the effect of PIVs on a LV network to be retrospectively analysed and allow the measureable impact to be compared against the modelling tool output.

Method 3: Mitigation

This project will adapt existing smart charger technology, including V2G chargers as they become ready to deploy and existing commercial charger management services and deploy these in a mass-market customer trial to prove the technical/economic viability of PIV/V2G demand control to avoid or defer network reinforcement and to prove that such systems are acceptable to customers. The customer trial will include a wide range of PIVs, with a range of battery sizes and charging rates to prove such systems can be deployed in a future with a diverse PIV market.

Scope

Network Assessment Tool

A network assessment tool will be developed that will allow (i) license-wide assessment of PIV penetration susceptibility of (non-meshed) LV networks and (ii) more detailed assessment of LV networks susceptible to PIV penetration to determine the level of PIV penetration that would trigger reinforcement action and the smart solutions to avoid or defer reinforcement developed in this project.

EV Monitoring

A monitoring algorithm will be developed that will detect PIV charging by directly monitoring the LV substation such that the number and potentially type/category of vehicles can be identified, the impact on the feeder cables and transformers understood and to produce guidelines for managing EV charging. The collected data from pre-established PIV clusters on the WPD network will be fed back to refine the Network Assessment Tool.

The Trial Programme

A smart charger test system will be established to (i) enable selection of suitable smart chargers for the customer trial and (ii) develop and test the PIV/V2G demand control services before and during the customer trial.

Up to 700 new PIV drivers will be recruited, in order to provide the project with statistically significant data ensuring diversity in driver behavior and PIVs (battery size and nominal charger rate). Trial participants (customers) will be sought from a wide area across WPD's licence areas, concentrating, but not exclusively, on larger conurbations and in particular the recently announced winners of OLEV's Go Ultra Low City Scheme in WPD's licence areas, namely Milton Keynes, Bristol and Nottingham & Derby. Trial participants will provide their own car for use in the trials. The project will provide trial participants with "smart" chargers for their home on their

agreement to participate in the trial, to be subjected to PIV demand control and to have data collected regarding their PIV usage and charging. This data will be used to inform development of the PIV/V2G demand control services and research into customer behaviours relating to their journey planning and charging behaviours. The customer trials will apply PV/V2G demand control on simulated PIV induced network stress scenarios. Customer acceptance of PIV/V2G demand control will be assessed by a contracted market research company.

Objective(s)

The objective of this project is to equip GB Distribution Network Operators with the tools and solutions to enable them to manage PIV market growth by (i) assessing their (non meshed) LV networks to predict which parts of their LV network will be susceptible to PIV penetration, (ii) determining whether PIV/V2G demand control services can be used to avoid or defer reinforcement, (iii) monitor LV networks to detect PIV charger installation growth, and (iv) procure and deploy PIV/V2G demand control solutions as soon PIV induced LV network stresses arise.

Success Criteria

The success criteria of the project is defined through successful delivery of the following:

1. An LV Network Assessment Tool for DNOs (an add-on to the widely used WinDEBUT LV design tool) that: a. Analyses and quantifies PIV related stress issues on LV networks (to LV area scale), including:

    i. Heuristics enabling rapid assessment of PIVs on LV networks through “topological” modelling of LV networks

    ii. Ability to include known PIV charger installations

    iii. Ability to forecast future PIV charger installations based on PIV market growth and forecasts

    iv. Flexibility allowing for future charger rating and PIV battery size developments b. Identifies best economic PIV solution: Demand Control/V2G/Reinforcement.

2. A functional specification for a technique to monitor and understand the effects of electric vehicle charging on LV networks across different levels of penetration

3. A functional specification and commercial framework for future procurement and deployment of PIV/V2G Demand/Export Control Services by DNOs to delay or avoid network reinforcement in cases where PIV installation numbers create network stress.

These will be available on the market for other DNOs to use and to adopt into business as usual.

Technology Readiness Level at Start	Technology Readiness Level at Completion
7	9

Project Partners and External Funding

Western Power Distribution, EA Technology and Fleetdrive Management

Potential for New Learning

1. Expansion of current understanding of the demand impact of charging at home on electricity distribution networks of a diverse range of plug-in-electric-vehicles (PIVs) – extending charge rates to 7kW+, introducing vehicle to grid technology and a range of battery sizes from 20kWh to 80kWh+.

2. A better understanding of how vehicle usage affects charging behaviour given diversity of charge rate and battery size.

3. Evaluation of the reliability and acceptability to customers of PIV/V2G demand/export control services and influence these have on driving and charging behaviour.

4. Evaluation of the technical/economic viability of smart charger and PIV/V2G demand control services to avoid/defer LV network reinforcement in the event of PIV induced network stress.

5. Development of a LV network assessment methodology that could be applied to other new energy technologies that may become widely deployed

Scale of Project

The project will develop a Network Assessment Tool for PIV penetration that will incorporate data from all of Western Power Distribution's license areas. The project encompasses a major trial of PIV/V2G demand control services involving in the region of 500 - 700 trial participants predominately in WPD's licence areas over a two year period. The trial will incorporate a diverse range of drivers and PIVs reflecting the range of battery sizes and nominal charging rates on the market during the trial period.

Geographical Area

UK Wide

Revenue Allowed for in the RIIO Settlement

Nil

Indicative Total NIA Project Expenditure

£5,221,821

Project Eligibility Assessment

Specific Requirements 1

1a. A NIA Project must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

A specific piece of new (i.e. unproven in GB, or where a Method has been trialled outside GB the Network Licensee must justify repeating it as part of a Project) equipment (including control and communications systems and software)	☒
A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)	☐
A specific novel operational practice directly related to the operation of the Network Licensees System	☐
A specific novel commercial arrangement	☒

Specific Requirements 2

2a. Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees ☒

Please answer one of the following:

i) Please explain how the learning that will be generated could be used by relevant Network Licenses.

The need to understand and manage the impact of PIVs and V2G on the network is a GB-wide challenge. The learning from this project will support all GB DNOs in their future network management to support the connection of PIVs and V2G.

Specifically, the Network Assessment Tool's module for assessing which parts of a (non-meshed) network is likely to be susceptible to PIV penetration can be adapted for all GB DNOs (taking data availability and network types into account). The individual network assessment module can likewise be adapted to other DNO's requirements to make use of project learning and the technical/economic viability of PIV/V2G demand control to defer or avoid network reinforcement. The exception being those license areas with meshed LV networks (parts of LPN and SP Manweb) where the tool will not be applicable.

The functional specification for a technique to monitor and understand the effects of electric vehicle charging on LV networks across different levels of penetration will be applicable to any distribution license area. As will the functional specification and commercial framework for PIV/V2G demand control services.

The tools, functional specifications, commercial frameworks, policies, procedures and training developed by this project will be published and promoted to all GB DNOs through the LCNI conference and project events.

ii) Please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the Project.

2b. Is the default IPR position being applied?

Yes	☒
No	☐

If no, please answer i, ii, iii before continuing:

i) Demonstrate how the learning from the Project can be successfully disseminated to Network Licensees and other interested parties

ii) Describe any potential constraints or costs caused or resulting from, the imposed IPR arrangements

iii) Justify why the proposed IPR arrangements provide value for money for customers

2c. Has the Potential to Deliver Net Financial Benefits to Customers ☒

i) Please provide an estimate of the saving if the Problem is solved.

Transform Model® analysis of the impact of PIVs on GB license areas to 2050, assuming the UK Government's high PIV market growth forecast, shows that by 2050 GB DNOs will have to invest £2.2 bn (present day costs) to reinforce LV networks due to increased loads induced by PIV chargers.

Further, by way of example, a Transform Model® analysis of the impact of PIV market growth on WPD's licence areas from 2020 - 2030 shows that WPD may have to invest up to £300 m in that decade to reinforce LV networks affected by PIV penetration.

If this project's methods are successful and applied by GB DNOs then considerable savings on these predicted costs are expected, being very conservative if the methods can only be applied in 10% of instances where reinforcement is required owing to PIV penetration then GB wide savings could amount to £200 m by 2050.

ii) Please provide a calculation of the expected financial benefits of a Development or Demonstration Project (not required for Research Projects). (Base Cost – Method Cost, Against Agreed Baseline).

The typical cost of reinforcing an LV feeder is £40,000 (Base Cost). Applying PIV demand control to avoid a reinforcement on a single LV feeder, would incur costs to establish substation monitoring (£5,000) and an annual cost of £100 per PIV charger for PIV demand control services. For any feeder with sufficient PIV chargers to trigger a reinforcement (MEA suggests 40% of customers, based on 3kW chargers, this will likely be a lower figure when 7kW+ chargers are installed) and with less than 36 PIV chargers installed the method (PIV demand Control) would provide a saving over a 10 year period. Given this figure is higher than the average number of customers on a feeder (30), the method will provide a cost saving.

iii) Please provide an estimate of how replicable the Method is across GB in terms of the number of sites, the sort of site the Method could be applied to, or the percentage of the Network Licensees system where it could be rolled-out.

The Network Assessment Tool will be adaptable to all distribution license areas, bar those with meshed networks (i.e. parts of LPN and SP Manweb). The functional specification for a technique to monitor and understand the effects of electric vehicle charging on LV networks across different levels of penetration will be applicable to all distribution license areas. The functional specification and commercial framework for future procurement and deployment of PIV/V2G Demand/Export Control Services by DNOs to delay or avoid network reinforcement in cases where PIV installation numbers create network stress will be applicable to all license areas.

iv) Please provide an outline of the costs of rolling out the Method across GB.

Adapting the Network Assessment Tool for other DNOs is dependent upon the types of network they operate and the availability of data to characterize these networks – adaptation could cost between tens of thousands of pounds up to £200,000 per DNO.

Adopting the functional specification for a technique to monitor and understand the effects of electric vehicle charging on LV networks across different levels of penetration will be a matter of adoption and adaption of policies, procedures and training – typically £50,000 per DNO.

Adopting the functional specification and commercial framework for future procurement and deployment of PIV/V2G Demand/Export Control Services by DNOs to delay or avoid network reinforcement in cases where PIV installation numbers create network stress will be a matter of adoption and adaption of policies, procedures and training – typically £50,000 per DNO.

2d. Does Not Lead to Unnecessary Duplication ☒

i) Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

While the My Electric Avenue (MEA) (I2EV) LCN Fund Tier 2 project was focused on the scale of the potential issue of electric vehicles clusters, assessing a suitable solution, and understanding the customer reaction, the project was limited to one PIV type (one battery size), one charger rate (3kW) and a relatively simple demand control solution (limited to single LV feeders, providing on-off control of chargers).

This project will develop an LV network assessment tool, along with more sophisticated service-based solutions that will enable DNOs to monitor, plan and manage PIV/V2G services over LV areas on their distribution networks.

There is no duplication or overlap in work areas.

This project will engage with the SSEPD's NIA Framework PIV (Smart EV) project that will define a communications standard methodology for connection of PIVs on the LV network; the two projects are complementary to one another yet have distinct and different outputs.

ii) If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

N/A