WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Date of Submission

Jan 2020

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

Harmonic Mitigation

Project Reference

NIA_WPD_043

Project Licensee(s)

Western Power Distribution

Project Start Date

September 2019

Project Duration

2 years and 5 months

Nominated Project Contact(s)

Yiango Mavrocostanti

Project Budget

£425,375.00

Nominated Contact Email Address(es)

wpdinnovation@westernpower.co.uk

Problem(s)

It is expected that due to the increasing number of non-linear devices being connected to the distribution network, the harmonics in the network can become a challenge for Distribution Network Operators (DNOs). Existing solutions for managing harmonics are not suitable for dynamic networks with varying operating conditions or can be very expensive. Therefore, it is important to find alternative solutions in order to be able to manage harmonic levels in the network in a cost effective way.

Method(s)

The aim of this project is to develop an algorithm that can improve the network's harmonic levels by controlling existing Distributed Generation inverters and will be delivered by Swansea University. As part of this, a number of power system studies will be performed in order to develop, implement the algorithm and test its operation. The algorithm will also be tested in a simulated environment at a university laboratory. This project will provide recommendations as to whether a further project is recommended for the trial of the algorithm in the network. The technical work produced will be reviewed by Power Systems Consultants (PSC).

Scope

The project has been split into the following Work Packages:

- Work Package 1 – Literature Review, Model Creation and Base Studies: As part of this Work Package, a detailed literature review will be done on the already developed approaches to managing harmonics in the network and any algorithms that relate to the proposed approach in the Harmonic Mitigation project. Additionally, the MATLAB model of the network that will be analysed will be created and validated. The base case harmonic studies will also be run in this Work Package, providing the reference that will be used to assess the algorithms impact on harmonic levels in the following Work Packages.
- Work Package 2 – Algorithm Design, Development and Implementation for single inverter control: This Work Package will involve the design and implementation of the algorithm that will be able to control each inverter individually.
- Work Package 3 - Algorithm Design, Development and Implementation for multiple inverter control: As part of this Work Package, the algorithm will be further developed so that it can control multiple inverters.
- Work Package 4 – Hardware In the Loop (HIL) Testing: In this Work Package, the developed solution will be used in order to demonstrate the operation of the algorithm on an actual inverter at a university laboratory. As part of this test, the model of the network used in Work Package 2 will be used to simulate the test network and an actual inverter will be connected to this simulated network. The operation of the algorithm and control of the inverter will then be tested.

Objectives(s)

The main objectives of the project are:

- Completion of literature review on existing solutions for managing network harmonics.
- Creation of an algorithm that by controlling each inverter individually is managing the network's harmonics.
- Creation of an algorithm that by controlling all inverters in the network is managing the network's harmonics.

Success Criteria

The project will be considered successful if:

- The developed algorithm can improve the harmonic levels when controlling one converter.
- The developed algorithm can improve the harmonic levels when controlling multiple inverters.
- The Hardware In the Loop testing confirms the correct operation of the algorithm and successful response from the inverter.
- Knowledge is gained on whether the harmonic levels in the network can be improved by controlling existing inverters.
- Conclusions are made on whether a demonstration project is recommended.

Technology Readiness Level at Start

TRL 2

Technology Readiness Level at Completion

TRL 4

Project Partners and External Funding

Swansea University will complete all the Work Packages and Power Systems Consultants (PSC) will provide technical support by reviewing all deliverables and power system studies.

Potential for New Learning

The learning that will be generated in this project will be applicable by all UK DNOs since it will show through power system studies whether it is possible to manage the harmonics in the network using existing DG inverters. The design of the algorithm that will be developed and the final full code will be documented in the relevant reports and shared with all UK DNOs so that it can be studied on any other network.

Scale of Project

The project will involve a number of power system studies on one 33kV network in order to develop the algorithm and simulate its operation.

Geographical Area

The 33kV network fed by Tiverton BSP will be used in the power system studies that will be done in this project.

Revenue Allowed for in the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£382,837.50.

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 the 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)	X
A specific novel operational practice directly related to the operation of the Network Licensee's System	X
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 explain how the learning that will be generated could be used by relevant Network Licenses.

The learning that will be generated in this project will be applicable by all UK DNOs since it will show through power system studies whether it is possible to manage the harmonics in the network using existing DG inverters. The design of the algorithm that will be developed and the final full code will be documented in the relevant reports and shared with all UK DNOs so that it can be studied on any other network.

2b. Is the default IPR position being applied?

Yes	X

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

Yes	X

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

This is a research project and will provide an evaluation of the financial benefits of having alternative ways of managing network harmonics compared to existing solutions.

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).

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.

This project aims to show through power system studies whether the network's harmonics can be improved using existing network inverters and recommend whether a demonstration project of a replicable solution should be completed next.

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

2d. Does not Lead to Unnecessary Duplication

Yes	X

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

A Harmonic Mitigation algorithm has not been studied previously, therefore no duplication will occur as a result of this project.

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

Additional Governance Requirements

Please identify

that the project is innovative (ie not business as usual) and has an unproven business case where the risk warrants a limited Research and Development or Demonstration Project to demonstrate its effectiveness	X

i) Please identify why the project is innovative and has not been tried before

The project aims to develop an algorithm that can control existing Distributed Generation (DG) inverters in the network in order to improve the harmonic levels. If successful, it could provide an innovative solution for harmonic management that does not require expensive and bulky harmonic filters.

ii) Please identify why the Network Licensee will not fund such a Project as part of its business as usual activities

The TRL of the technology is low since a Harmonic Mitigation Algorithm has not been studied or implemented previously. Therefore, further work is required before implementing this technology as part of business as usual activities.

iii) Please identify why the Project can only be undertaken with the support of the NIA, including reference to the specific risks (eg commercial, technical, operational or regulatory) associated with the Project

This NIA project is necessary in order to provide the knowledge needed to decide whether an implementation trial of this technology is recommended. The algorithm needs to be developed and simulated in order to prove the concept before trialing.

This project has been approved by a senior member of staff