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NIA Project Registration and PEA Document

Date of Submission

Jul 2021

Project Reference Number

NIA2_NGESO006

Project Registration

Project Title

Resilient Electric Vehicle Charging: "REV"

Project Reference Number

NIA2_NGESO006

Project Licensee(s)

National Grid Electricity System Operator

Project Start

July 2021

Project Duration

1 year and 6 months

Nominated Project Contact(s)

Annu Tiwari

Project Budget

£350,000.00

Summary

Project Resilient Electric Vehicle Charging (REV) will analyse the impact of Electric Vehicle (EV) charging on grid short term (1 cycle to 10 seconds) frequency and voltage stability, and cascade fault prevention and recovery.

An individual charger has a relatively small impact on the grid. So, the analysis will therefore focus on categories of failures which could cause a correlated change by multiple chargers at the same time and/or local area.

Project outputs will be a failure modes effects analysis, raising awareness of the risks and suggestions for grid code updates mitigating key risks.

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

Within the next 30 years load on the grid from electric vehicle charging is forecast to rise substantially. At peak times of EV charging up to one third of load on the grid could be from EV charging. The demand management mechanism for shifting timing of this demand to off peak periods has been well studied along with the delivery of power to the grid through vehicle to vehicle to grid. However, the impact of electric vehicle charging on short term (1 cycle to 10 second) grid stability and recovery from blackout/brownout has not been studied.

EV Charging could have significant impact on grid short term stability which is currently unidentified. EV chargers are not simple resistive loads, for slight changes in voltage they can behave as constant power loads, with increasing current as voltage decreases. The negative dynamic resistance will impact grid stability potentially leading to an increased requirement for inertia. The size and scale of these, larger voltage changes and other communication related issues are not currently known.

Method(s)

This project will look to undertake the following scope of work:

WP1: Cause (How could EV charging make the grid less stable?)

- Identify the mechanisms which may impact short term grid stability and recovery from incidents.
- Failure Modes Effect Analysis to identify key items to investigate more.
- Define related test cases for EV chargers to quantify relevant performance.

WP2: Effect (How big could the impact be on the grid as EV adoption increases?)

- Consider from LV (Low Voltage) circuit level all the way to national inertia.
- Model the impact on UK wide grid stability. Power Factory
- Model the impact at distribution/LV feeder level.
- Demonstrate impact of a range of potential incidents.
- Identify incidents with the significant effect on grid stability.
- Review limitations of grid and EV charger modelling

Risk Assessment

In line with the ENA's ENIP document, the risk rating is scored Low.

TRL Steps = 1 (1 TRL step)

Cost = 1 (£350k)

Suppliers = 1 (1 supplier)

Data Assumptions = 3

Scope

- The project will analyse the impact of EV charging on grid short term frequency and voltage stability, and cascade fault prevention and recovery.
- An individual charger has a small impact on the grid. So, the analysis will therefore focus on categories of failures which could cause a correlated change by multiple chargers at the same time and/or local area.
- Brainstorming sessions with multiple stakeholders will be employed to identify the widest possible range of risks.
- EV charger response to power and control communication faults will be investigated by desk-based research and sample measurement.
- Identified risks will be analysed via desk research. From this a prioritised list of risks, in the form of an FMEA (Failure Mode Effect Analysis), will be produced for further investigation.
- Small scale grid simulation studies will be used to address uncertainties in the desk-based analysis.

Objective(s)

The final outputs will be:

- A research report on potential causes of instability
- A research report on the effects of instability (NIA Project Completion Report)

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

The ESO does not have a direct connection to consumers, and therefore is unable to differentiate the impact on consumers and those in vulnerable situations. Benefits to all consumers are detailed below.

Success Criteria

The following will be considered when assessing whether the project is successful:

- Identification of one or more "black swan" risks
- Impact on ESO risk management processes related to EV and DSR
- Contribution to behind the meter DSR regulation processes

- The estimate potential financial benefit of EV DSR by 2030

Project Partners and External Funding

Sygensys will be carrying out the work. No external funding.

Potential for New Learning

This is the first time that impact of EV charging on grid short term frequency and voltage stability, and cascade fault prevention and recovery will have been considered for the UK grid.

Project outputs will help to influence:

- Updates to grid code and supporting standards.
- Future versions of the Frequency Risk and Control Report and broader risk management activity.
- DSR standardisation activity, for example BSI Energy Smart Appliances

At the end of the project a detailed risks analysis will be provided and suggested areas where changes are recommended. There is a gap between recommendations and implementation.

Detailed consideration and implementation of recommendations into other documents would form part of BAU (Business as Usual).

Scale of Project

The project spans 15 months with 1 project partner. It will be desk-based research.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

We will be based upon the GB ESO area of operations.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£350,000

Project Eligibility Assessment Part 1

There are slightly differing requirements for RIIO-1 and RIIO-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RIIO-2 / RIIO-1).

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations (Please complete sections 3.1.1 and 3.1.2 for RIIO-2 projects only)

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

Load on the grid from electric vehicle charging is forecast to rise substantially and EV charging could have a significant impact on grid short term stability. This project will support the energy system transition by identifying high risk areas, enabling National Grid ESO and wider stakeholders to better plan for the impact of EV charging on a low inertia grid, and to predict the impact of EV charging on short term grid stability ahead of such issues arising.

How the Project has potential to benefit consumer in vulnerable situations:

Not required.

Requirement 2 / 2b

Has the potential to deliver net benefits to consumers

Project must have the potential to deliver a Solution that delivers a net benefit to consumers of the Gas Transporter and/or Electricity Transmission or Electricity Distribution licensee, as the context requires. This could include delivering a Solution at a lower cost than the most efficient Method currently in use on the GB Gas Transportation System, the Gas Transporter's and/or Electricity Transmission or Electricity Distribution licensee's network, or wider benefits, such as social or environmental.

Please provide an estimate of the saving if the Problem is solved (RIIO-1 projects only)

Not required.

Please provide a calculation of the expected benefits the Solution

Not required - research project.

Please provide an estimate of how replicable the Method is across GB

As identified in the Future Energy Scenarios 2020 Report, by National Grid ESO. The uptake of EV's will increase substantially by 2050. Estimated predictions foresee that by 2050 up to 80% of households will smart charge their EV's, with up to 45% providing Vehicle to Grid (V2G) services. Hence, V2G services could provide up to 38GW of flexibility which will have a significant impact on grid stability and on resilient demand side response.

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

As this is a research project, the final outputs of the project will aim to give an outline of the potential changes and costs to mitigate these risks.

Requirement 3 / 1

Involve Research, Development or Demonstration

A RIIO-1 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 system 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

RIIO-2 Projects

A specific piece of new equipment (including monitoring, control and communications systems and software)

A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven

A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)

A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology

A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution

A specific novel commercial arrangement

Specific Requirements 4 / 2a

Please explain how the learning that will be generated could be used by the relevant Network Licensees

Every network must deal with uncertainty in demand and generation (supply). This project is designed to give insights and recommendations to National Grid ESO and wider stakeholders, to mitigate the risks of short-term grid stability, caused by Electric Vehicles with a low inertia grid.

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

Not required.

Is the default IPR position being applied?

Yes

Project Eligibility Assessment Part 2

Not lead to unnecessary duplication

A Project must not lead to unnecessary duplication of any other Project, including but not limited to IFI, LCNF, NIA, NIC or SIF projects already registered, being carried out or completed.

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

This is the first time that the impact of EV charging on grid short term frequency and voltage stability and cascade fault prevention and recovery will have been considered for the UK grid.

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

Not applicable.

Additional Governance And Document Upload

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

- This project is looking at changes due to increasing load from EV charging and demand side response management.
- It is the first time that impact of EV charging on grid short term frequency and voltage stability, and cascade fault prevention and recovery will have been considered for the UK grid.
- There is a substantial risk that without action this will cause new, currently unknown, failure mechanism.

Relevant Foreground IPR

The following Foreground IPR is expected to be generated from this project:

- A research report on potential causes of instability
- A research report on the effects of instability (NIA Project Completion Report)

Data Access Details

If it is deemed necessary to have access to background IPR to utilise the results, a request may be submitted to the ESO and project partners, if this is a reasonable request then any relevant data may be anonymised and redacted where necessary to protect any sensitive information. We don't foresee any requests for background IPR access being necessary.

The terms on which such data will be made available by National Grid can be found in our publicly available "Data sharing policy related to NIC/NIA projects" and <https://www.nationalgrideso.com/future-energy/innovation/get-involved>. National Grid already publishes much of the data arising from our NIC/NIA projects at www.smarternetworks.org. You may wish to check this website before making an application under this policy, in case the data which you are seeking has already been published.

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

Due to the nature of the project and that it is researching potential future impacts to the grid based largely on assumptions, this does not fall into current BAU.

Please identify why the project can only be undertaken with the support of the NIA, including reference to the specific risks(e.g. commercial, technical, operational or regulatory) associated with the project

The learnings from the project can be shared more widely to the Network Licensees which could not be achieved if deemed as BAU activities.

This project has been approved by a senior member of staff

Yes