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.

NIA Project Registration and PEA Document

Date of Submission

Mar 2018

Project Reference Number

NIA_NGSO0011

Project Registration

Project Title

Application of New Computing Technologies and Solution Methodologies in Grid Operations

Project Reference Number

NIA_NGSO0011

Project Licensee(s)

National Energy System Operator

Project Start

March 2018

Project Duration

1 year and 4 months

Nominated Project Contact(s)

Alasdair Bruce

Project Budget

£130,000.00

Summary

The complexities of the system models upon which decisions are made during control room operations are increasing with high penetrations of distributed resources, which will require modelling greater detail within the distribution networks. New sources of data are now available, which provide the basis for conducting analyses at much higher temporal and spatial resolutions than in the past. The purpose of this project is to help meet the computational and robustness needs of such operational analyses. The scope of this EPRI project work stream “39.014 Application of New Computing Technologies and Solution Methodologies inGrid Operations” within the EPRI program 39 explores methods to leverage advancements in data processing, computing technologies, and optimization and numerical methods to enable efficient processing, simulation, and analysis of complex system models and at higher time resolutions. This is aligned to a number of strategic areas which have been prioritized as part of National Grid’s System Operator (SO) innovation strategy.

Third Party Collaborators

Electric Power Research Institute

Nominated Contact Email Address(es)

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Problem Being Solved

As the GB System Operator, National Grid’s control center operations role is becoming more complex; new reliability, economic and

public policy issues are emerging, causing the electricity system to change rapidly. Currently, computer simulations and system measurement data are used to analyze present system status and what-if-scenarios to derive succinct information for control room operators to make better informed decisions.
The complexity of models that influence these decisions is increasing; higher penetration of distributed resources requires more granular models for distribution networks. New sources of data (e.g. PMUs) are available at much higher resolutions than traditional control room data, such high resolution data provides the basis for conducting analyses at greater time and spatial resolutions than in the past.

Method(s)

Research projects run by the Electric Power Research Institute (EPRI) typically span multiple years. The research work planned in 2018 for this EPRI project will build on the EPRI Grid Analysis Toolkit (GAT) software's underlying solution engines and advanced system analysis applications. The project tasks and proposed research methodologies are divided as follows:
Task 1: Reduce the Set of Must-run Contingencies for Steady State Analysis. The 2017 research work carried out by EPRI focused on developing mathematical techniques (as compared to screening techniques) for reducing the overall number of "must-run" steady-state contingencies. In 2018, the work is expected to focus on enhancing and integrating those techniques into a proof-of-concept software tool for steady-state contingency analyses. It will also focus on using the tool for analyzing large, real system test cases.
Task 2: Improved Power Flow Methods. This task will focus on making further modeling and feature improvements to the existing EPRI-Grid Analysis Toolkit (GAT). The modeling improvements are expected to consist of designing and implementing the necessary functions and constraints for high-level applications, such as voltage analysis and control, contingency analysis, and system performance optimization:

- **Voltage Analysis and Control** – quantify voltage limits in terms of magnitude, angle, stability limit, and VAR reserve, and integrate with reactive power forecasting tools
- **Contingency Analysis** – quantify the initial trajectory, path, and destination of the operating point, based on physical system properties at the time of the event, and leverage contingency analysis for topology control decisions
- **System Performance Optimization** – quantify transfer capability, power system efficiency, and controllability, and shunt switching as performance objectives

The feature improvements include expanded input and output format for cases, contingencies (in conjunction with Task 1), and improved charting and reporting for analysis.
Task 3: Dissemination. This task focuses on holding presentations and producing material to perform this technology transfer.
For National Grid as the GB System Operator, the specific areas of this research programme which are of most relevance include the potential for enhancing current power system analysis tools, adoption of novel algorithms and learning from the case studies of implementation approaches.
The improvements to the EPRI Grid Analysis Toolkit and research on approaches for contingency analysis are elements of the project which we expect to learn from to further inform our system operation strategy.

Scope

The complexities of the system models upon which decisions are made during control room operations are increasing with high penetrations of distributed resources, which will require modelling greater detail within the distribution networks. New sources of data are now available, which provide the basis for conducting analyses at much higher temporal and spatial resolutions than in the past. The purpose of this project is to help meet the computational and robustness needs of such operational analyses.
The scope of this EPRI project work stream "39.014 Application of New Computing Technologies and Solution Methodologies in Grid Operations" within the EPRI program 39 explores methods to leverage advancements in data processing, computing technologies, and optimization and numerical methods to enable efficient processing, simulation, and analysis of complex system models and at higher time resolutions. This is aligned to a number of strategic areas which have been prioritized as part of National Grid's System Operator (SO) innovation strategy.

Objective(s)

The objectives of the project are to enhance the System Operator's awareness and understanding of:

- new power system analysis tools, solution algorithms and implementation approaches/case studies
- optimization and numerical methods to enable efficient processing, simulation, and analysis of complex system models and at higher time resolutions
- how to utilize existing computing hardware and assess the cost of upgrades to increase the computing power available for individuals or systems

Where desirable, based on this learning from the EPRI project, improvements to the System Operator's existing approaches will be explored.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will be successful if National Grid is able to pursue new activities, or modify existing activities, using a robust evidence base provided by the EPRI research project work stream through the following deliverables:

1. Contingency Reduction (Software update for analyzing historical stability analyses and identifying the set of critical must-run contingencies) – expected 31/12/2018
2. EPRI Grid Analysis Toolkit (GAT) (Software update for EPRI-GAT Advanced Power Flow analysis with contingency analysis and other modeling and feature improvements) - expected 31/12/2018
3. GAT and Contingency Reduction Case Study (Technical Update describing the new developments and case study results) – expected 31/12/2018

Project Partners and External Funding

Each project facilitated by EPRI is funded through collaborators, including National Grid, that contribute to the development of the project portfolio and then express interest to be involved with a specific project once the portfolio is decided.
The total contribution from all EPRI members for the EPRI Program 39 in 2018 if $5,600,000 and the project work stream 39.014 has been allocated a total budget of $300,000.

Potential for New Learning

This project will help National Grid by providing new learning in the following areas:

- Approaches for development of new power system analysis tools, solution algorithms and/or implementation approaches by leveraging advancements in computing technologies and data processing.
- Optimization and numerical methods to enable efficient processing, simulation, and analysis of complex system models and at higher time resolutions.
- Strategies and key considerations in utilizing existing computing hardware and assessing the cost of upgrades to increase the computing power available for individuals or systems.

Scale of Project

This project work-stream associated with P39 is predominantly a laboratory or desk-based research project.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

The research undertaken in EPRI P39 and this project work stream 39.014 is predominantly carried out in the US with some in the UK. However, the programme carries out reviews of the latest research from across the world and also engages with participating EPRI members globally.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

The total indicative NIA expenditure for this project for 2018 is £130,000.

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:

n/a

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

n/a

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)

National Grid as the GB System Operator uses a range of power system modelling tools in order to provide relevant and accurate information to the Electricity National Control Centre (ENCC) in managing energy demand and supply, as well as responding to real-time system events. The higher the quality of the analysis that informs the ENCC, the better decisions can be made when making balancing or constraint management decisions. Reducing system operation costs would result in a direct financial benefit to consumers.
If the learnings and outputs from the project are implemented as part of National Grid's operations, the below estimated savings and operational efficiencies are expected:

- Reduced time (Network Access Planning and Control Room) spent performing system studies and contingency analysis due to faster computational time (~10% time saving)
- Reduced time (Network Access Planning and Control Room) time spent troubleshooting and resolving difficult to solve study cases (~5% time saving)
- Increased situational awareness of system conditions and planning activities by reducing the time spent on running and engineering cases thus allowing more time for analysis.

Please provide a calculation of the expected benefits the Solution

The key deliverables from this project are the Contingency Reduction software and the EPRI Grid Power Analysis Toolkit (GAT). It is expected that by adopting these tools and novel methods, National Grid as the GB System Operator would be able to enhance its understanding of contingencies, voltage control and power system optimization to operate the GB system. Although the benefits cannot be accurately quantified, the expected value from doing this project will deliver financial benefits through:

- Reduction in operations and planning staff time spent to perform system studies due to faster computational time.
- Reduction in operations and planning staff time spent to troubleshoot or resolve difficult to solve study cases, e.g. merging external system models with more detailed internal system models.
- Increase operations and planning staff confidence in the results by solving more problematic cases that are not solved using other existing techniques and potentially avoiding additional investigation time.
- Increase assistance available for operations and planning staff to analyze system conditions and behavior reliability by reducing the time spent on running and engineering cases thus allowing more time for analysis or running additional cases.

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

It is expected that the outputs from this project will be relevant to the various National Grid control center operations for the GB network,

and would also be transferrable to the DNOs and the regional networks they manage.

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

As this project aligns with the strategic innovation areas for the GB System Operator and it aligns with existing activities to tackle the outlined challenges, it is expected that the rollout and adoption of the learnings from the outcomes of this EPRI research project can be facilitated through early engagement of the National Grid control room and Global Information Systems (Global IS) stakeholders. This will allow an early insight into the research work by EPRI and understand the considerations for using the deliverables in informing National Grid's systems operations and critical network infrastructure strategy.

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

All GB electricity network licensees own and manage data as well as systems to support their control room operations. Although National Grid is the GB System Operator, the challenges faced by other network licensees would also benefit from the learnings of this project specifically in the following areas:

- The research and future development of new power system analysis tools and algorithms.
- Case studies of implementation approaches which leverage on the advancements in computing technologies and data processing.
- Development of novel methods to enable optimal and efficient processing, simulation and analysis of complex system models at higher time resolutions, using new energy sources and granularity of data.
- Additional knowledge of how to best utilize existing computing hardware and assess the cost of upgrades to increase the computing power available for individuals or systems.

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

This project will help address the strategic innovation areas (Developing DSOs & whole system operability, Leveraging analytics in a data-enabled future, Harnessing a digitised grid) in the National Grid System Operator Innovation Strategy document published Feb 2018.

☑ Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

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.

By participating in collaborative projects through EPRI, National Grid can ensure that unnecessary duplication with other projects under NIA is avoided.

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

n/a

Additional Governance And Document Upload

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

There is a higher penetration of distributed resources in today's energy systems, including the GB system, this is pushing the need to add distribution level details into grid models. These new, unprecedented changes are making control center operations more complex requiring novel methods to process various data types, sources and how they are used to enable control room operators to make better informed decisions. The complexities of the system models upon which these decisions are made are increasing and the availability of new sources of data (e.g. PMU data) at much higher resolutions than traditional control room data are now available. Current tools and systems are limited in their capability to handle such high resolution data and conduct analyses at much higher time resolutions than in the past. The purpose of this research project is to help understand and meet the computational and robustness needs of such operational analyses. This requires investigation of innovative tools and methods which have not been researched before, which will be carried out by this EPRI project.

Relevant Foreground IPR

n/a

Data Access Details

n/a

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

Participating in this project as a member of the Electric Power Research Institution (EPRI) provides National Grid access to the latest state-of-the-art developments in this research area, access to the EPRI network to discuss, share best practice and positively influence the direction of future research. In addition, any changes to the systems, technologies and infrastructure used by National Grid as the System Operator need to be very carefully assessed as they can be disruptive to system operation and existing processes. This EPRI research project provides an opportunity to learn and validate the potential impact of such innovative developments before they can be considered for implementation into business as usual operations.

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

This project and its outcomes would help inform the future control room strategy especially with regards to the tools, systems and infrastructure we need to be future ready as the GB System Operator. NIA funding is the chosen funding route for this project as this would enable an easy way to participate in this EPRI project to be part of a worldwide network of experts in this field, whilst also benefiting from the learnings from other EPRI members who are System Operators in their respective geographies. By using NIA funding, this would also allow National Grid as the System Operator to reduce the risks involved in evaluating these innovation areas from the EPRI project research group, assess early on the implications if the learnings are to be operationalized, and disseminate the learnings to enhance the capability of the GB system and energy sector as well as enabling the transfer of the learnings to other network licensees.

This project has been approved by a senior member of staff

☑ Yes