NIA Project Registration and PEA Document

Date of Submission

Oct 2016

Project Reference Number

NIA_NGET0197

Project Registration

Project Title

Development of fittings analysis model

Project Reference Number

NIA_NGET0197

Project Licensee(s)

National Grid Electricity Transmission

Project Start

January 2017

Project Duration

1 year and 1 month

Nominated Project Contact(s)

Fan Li

Project Budget

£300,000.00

Summary

The current project is designed to maximise the utilisation of the OHL fittings condition information that is collected by National Grid, in order to gain better understanding on the future deterioration, and enable better long term planning. At the same time, it will evaluate the suitability of current asset management practices and make recommendations for new developments and improvements. The project scope include the following phases:

1. Analyse the condition information collected on a span-by-span, and component-by-component basis, and Explore the evidence in support (or otherwise) of the fittings investment strategy.
2. Review the process and support validation of the formula for assigning Asset Health Index (AHI) scores from condition assessments.
3. Compare the condition profile (risk profile) of OHL fittings with National Grid's deterioration model and explore different model types and forms as appropriate.
4. Study the interactions between different asset strategies, namely: fittings investment strategy, conductor investment strategy, and targeted fittings. Provide recommendations in terms of best practices for balancing cost, risk and process complexity for different strategy and policy options.

The anticipated project deliverables are:

1. A study facilitated by a summary report detailing the latest understandings to the end of life behaviours of fittings components using the up-to-date condition assessment information and engineering expertise.
2. A robust asset health model to facilitate the asset health process in a quantified and consistent manner, achieved after review, validate and refine the current asset health index assignment process.
3. A data-driven deterioration model and compare it with National Grid's existing deterioration model. At the same time a test trial for a number of models that are used in the infrastructure industry.
4. Case studies for the interactions of the models and the investment strategies, taking into consideration of cost, risk, performance, as well as process complications and regulatory implications. This will also include insights and recommendations to National Grid's existing process and strategies.
5. A comprehensive final report to summarise the findings and recommendations, as well as data and modelling details.
6. A project database contains the integrated, cleansed source data and the results of the analyses.

Nominated Contact Email Address(es)

Problem Being Solved

Since year 2013, National Grid has adopted advanced condition assessment techniques and enhanced database capacity in order to condition monitor the fittings located on overhead lines (OHL), on a span-by-span basis. This enables more granulised asset condition assessment that then drives replacement schemes on a case-by-case and span-by-span basis, instead of the previous, more traditional circuit-by-circuit basis. While savings can be derived in terms of targeting on the worst condition spans and components, the use of an innovative fittings strategy introduces a number of challenges to the practice of asset management (AM).

- the understanding of future deterioration for the granulised condition information is still being developed, and this impacts on long term planning.
- complexities introduced into the process and performance measures, particularly in the interaction between other, more traditional OHL asset management strategies such as OHL conductor deterioration and replacements.
- new data-science technology and methodologies that feed drive the new strategy need to be trialled in the form of impact analysis within a controlled working environment prior to implementation.

To understand the condition of assets and its future deterioration is a complicate issue. On the one hand, electricity transmission assets are subjecting to a large number of condition indicators that need to be categorised into a small (manageable) number of asset health index scores. On the other hand, those condition indicators change with time (heterogeneously) due to natural deterioration and asset management activities such as maintenance and repair. Data driven asset management models have been one of the most important and fruitful ways to answer those questions. The research proposed in the project will provide a framework of combining state-of-art data science, innovative condition assessment information, subject matter knowledge, engineering understandings, and expertise opinions to inform the risk management and investment management practices. This is particularly meaningful for the transmission and distribution network owners as most of the investment projects take long time to plan and deliver while collecting condition information can be expensive and time consuming. For the RIIO regulatory framework applied to the UK transmission and distribution networks, the asset health index (AHI) is an important factor that regulates the non-load related Capex. Reducing the uncertainties and inconsistencies around the AHI, and enhancing the ability of forecast deterioration are crucial in terms of achieving efficiencies while delivering outputs to the consumers.

Method(s)

The project will use a methodology of a data-driven, bottom-up approach, guided by engineering knowledge and expertise from subject matter experts (SME). It will be benefit from a variety of innovative data analysis techniques, including statistical methods, mathematical modelling and machine learning. Additionally, this work builds on the experience and knowledge from the previous research project (OHL Condition Assessment (10359 – NIA_NGET0140)). The methods are detailed in the following bullet points..

Creation of relational database
To support the requirements of the data analysis and modelling aspects of this work, a relational database will be created to capture all data sources used by National Grid for fittings asset condition. This will include additional data cleansing and validation, using both manual process and state-of-art text matching techniques..

End of life behaviours modelling
To understand the end of life behaviour of fittings, existing condition information can be used to determine what asset condition (types/number of defects, visual assessment etc.) would be considered indicative of end of life, and then determine the age profile of assets which are found to be in this condition. Depending on the type, amount, and distribution of the data provided, the analysis may take the form of correlation analysis and visualisations, dimensionality reduction, and unsupervised or semi-supervised clustering, and then validated by the SMEs

Data analysis and quantification
To review, model and validate the asset health index (AHI) process, it is proposed to analyse the relative contribution of each element to the overall AHI score, and (if necessary) quantify any top-down influences which may arise following engineering and management review. Any manual interventions in the process will be quantified by using machine learning techniques to train a classification model. The goal of the analysis is to validate the AHI assignment process in a data-driven fashion, working backwards from the end of life criteria identified in bullet point b) will also be used as inputs and validations. The relationship between span level AHI and circuit level AHI will be also reviewed, to understand how much variation can be expected within a single circuit.
Review and update the deterioration model

To compare the AHI process and the deterioration model, the model created in the previous phase of work will be used to simulate an asset portfolio. This enables a like-for-like comparison and solutions to resolve any differences will be explored. Additionally, this work will also explore detailed degradation modelling strategies and approaches published by other infrastructure asset owners such as

Network Rail, London Underground, UK Power Networks and United Utilities. Those modelling approaches (such as P-f type models) or data techniques (such as Bayesian or machine learning models) will be reviewed and tested to understand the applicability to the transmission assets.

Case studies and implementation plan
This project is also to study the interactions in portfolio costs, risk and process complexity between different asset replacement strategies for OHL assets. To ensure a comprehensive comparison of the different fittings investment strategies, as well as their interactions with the conductor's investment strategies, this project will collect various comparison metrics via workshops with relevant National Grid's teams, e.g. planning engineers, investment management team, field engineers, etc. These workshops will help collect important information such as: 1) span-level cost data, for replacement parts as well as labour; 2)planning systems, processes and their complexity; 3) system access and land access, on a span-by-span level; 4) additional business and asset risks if not covered in existing risk framework. The project will then set up a model which will take above into account, as well as fittings AHI, conductor AHI, and any other factors identified by National Grid stakeholders, and produce scenarios and guidelines for choosing the most economical and appropriate asset investment strategy. Using the model developed above, a cost, and risk and benefits study can be performed regarding different investment strategies and assess the short term and long term business impacts.

Scope

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Objective(s)

The objectives of the project is to develop data driven models and draw new insights into the overhead line fittings system, in order to deliver values to both National Grid asset management business and the UK electricity consumers. The project will develop methodologies of enhanced level of utilisation of the condition information recorded by National Grid at the span level and component level, which is a valuable dataset of both research interest and long term planning. This project will also examine the impact of the new understandings to the asset management practices in terms of cost, risk, performance, regulation, as well as process complexities.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

As a research project, this project will take an exploratory approach using modelling and data science. The following criteria are expected to be met at the end of the project:

• Increased utilisation of the more granulised and up-to-date information from the innovative condition assessment methods for overhead line fittings.

- Increased/quantitative understandings of the overhead line fittings system, including end of life, condition/AHI classification, and future degradation behaviours.

- Increased transparency and consistency in the asset health assignment process and investment strategies.

- Quantitative models developed to understand the above and also can be used for National Grid's asset management practices.

- Optimised solutions based on studies on the interactions/optioneerings among different investment strategies, by taking into consideration of key investment drivers, and engaging with key stakeholders.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

The project scope detailed above is finalised after extensive engagements with National Grid asset experts, operation experts and investment experts to collect business needs. The main principle of the project is to deliver business value and consumer benefits using a data-driven asset management approach, drawing on outputs from previous work on data science and extending the learned in an aggregated approach. This includes new learnings in the area of pre-processing data; developments in end of life behaviours; refined AHI models that improve and enhance the current process; an applicability test for other models; and case studies for interactions of investment strategies and processes. Those elements, together with the proposed methodologies, strike a balance between exploratory and applied research, and also build in an element of demonstrating the benefit of research to enable fast deployment of research outcomes.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

This work will refine and improve the asset management understandings and processes that affect the OHL transmission network in England and Wales. The development work will be desk based including formats of computer-aided data analysis, interviews and workshops. The trials will be based on a controlled working environment with designed scenarios and case studies.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£300,000

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)

The efficiency from long term planning is difficult to fully understand, however, it is estimated that a savings of 2% per year could be realised, leading to an annual saving of ~£5million.

Please provide a calculation of the expected benefits the Solution

During the RIIO-T1 price control period the replacement of overhead line fittings (excluding full refurb) is estimated at ~£250 million. The learning from this innovation project will enable long term planning to unlock efficiency savings while reducing the risk of insufficient replacement that increases the risk of asset failure. The efficiency from long term planning is difficult to fully understand at this time, at the time of publication it is estimated that a savings of 2% per year could be realised, leading to an annual saving of ~£5million. (Investing in Britain's future – HM treasury, June, 2013)

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

According to Ofgem's NOMs (network output measures) methodology, the method can be replicated for all the DNO and TO networks with overhead line fittings. This aligns with Ofgem's requirement that TOs and DNOs have common methodology addressing asset health and deterioration that is quantified and data driven.

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

While the actual cost of rolling out depends on many factors such as maturity of the business, the asset management practices, the business strategies, and the advancement of the technology for each individual network licensee, the cost of rolling out the (proposed research) method will be minimal and shall be implemented through the continuous improvement that is embedded in most network licensees' business models. In the case of National Grid, for example, we estimated 200 man days to update the technical documents, improve the relevant process, and implement recommendations that are found from the project. In this case, the total roll-out cost is estimated at ~£100k for a 6 month programmer. Another form of rolling out can be through the knowledge sharing platforms with the industry, such as the IAM conferences and cross-sector workshops, which would include the associated of cost of attending/holding those events.

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

Transmission Owners (TOs) and Distribution Network Owners (DNOs) in the UK have a regulatory requirement have common practices to address asset health and deterioration that is based on quantified, data driven methodologies. Therefore, the findings of this innovation project will be relevant to all other network licensees. This is the particularly relevant as it is the regulation's interest to make those asset health and deterioration as comparable as possible across the networks. A data-driven project will fulfil this requirement and provide extensive learnings to all Network Licensees. What is more, this project will provide a method of taking into consideration of engineering knowledge and operational experiences that are accumulated by the Network Owners. Those new learnings can be implemented in both the regulatory framework such as network output measures and the asset management practices such as risk management and investment decision making tools.

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 fits within the managing assets value area of the Electricity Transmission Owner (ETO) Innovation Strategy.

☑ 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.

n/a

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

n/a

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

n/a

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

n/a

This project has been approved by a senior member of staff

☑ Yes