

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

Feb 2016

### Project Reference Number

NIA\_ENWL014

## Project Registration

### Project Title

Optimising Oil Regeneration for Transformers

### Project Reference Number

NIA\_ENWL014

### Project Licensee(s)

Electricity North West

### Project Start

February 2016

### Project Duration

6 years and 8 months

### Nominated Project Contact(s)

Electricity North West Innovation Team

### Project Budget

£1,500,000.00

## Summary

Previous research carried out under an IFI project suggested that oil regeneration carried out in a window at the end or near the end of a transformers nominal life would extend life by approximately 10 years. The First Tier project deployed online monitoring equipment at five sites where the oil regeneration technique was used.

The NIA project will build on this research by exploring the optimum point to apply oil regeneration to a transformer fleet. It is acknowledged that the life of oil impregnated paper insulation determines the maximum potential life of a transformer, although other factors may cause it to fail earlier. This project scope will aim to determine if mid life oil regeneration can reduce the rate of paper degradation, and thereby further extend the lifespan of the transformer compared to oil regeneration at end of life.

For this project, ten 33kV paired transformers and three 132kV paired transformers (13 sites, 26 transformers) which are at various stages of their design life will be identified.

At each site, only one of the transformers will undergo oil regeneration. Online monitoring equipment will be installed on both transformers at each site to allow comparison of their oil condition and to determine the theoretical life extension over time. These results will be fed into the previously funded data visualisation software to allow consistent comparison.

Electricity North West will work closely with industry experts to validate the data and calibrate the life extension results.

The project will allow Electricity North West to develop its understanding of the effects of life extension on transformer failure modes and maintenance requirements and to identify the optimum window for oil regeneration in the life cycle of transformers.

## Preceding Projects

PRJ\_518 - Oil Regeneration

NIA\_ENWL004 - Combined On-line Transformer Monitoring

## Third Party Collaborators

Camlin

## Nominated Contact Email Address(es)

innovation@enwl.co.uk

## Problem Being Solved

As part of operating an efficient network Distribution Network Operators need to maximise the use of existing assets. This forms a key part of Electricity North West's Innovation strategy for RIIO ED1.

Electricity North West has proposed that approximately 50% of the 132kV and 33kV transformers due for renewal in the RIIO-ED1 period will now be refurbished and their oil regenerated to reduce their current Probability of Failure and extend asset life.

This approach aims to maximise the life span of the transformers past their original design life thus deferring their replacement and also avoiding de-rating based on age.

There is a need for further research and development to explore the maximum life of a transformer and understand the optimum point that oil regeneration can be applied in the life cycle of the transformer to take full advantage of the technique and maximise the life of the transformer.

An optimal lifetime window for conducting oil regeneration exists according to theoretical analysis but the extent of this window could vary with ageing characteristics of the insulation, operational conditions of the transformer etc

## Method(s)

The project will build upon earlier First Tier research into oil regeneration towards the end of transformer life by further exploring oil regeneration in transformers at the various mid points of their nominal life to determine whether deploying the technique earlier will extend the transformer's operable life further.

The project will carry out field trials to identify the optimum point at which oil regeneration can be used in the life cycle of a transformer. To ensure a representative sample of the transformer population is analysed, a varying number of transformers with different manufacturing periods, designs and operating environments will be selected at near identical twin transformer sites.

The oil will be regenerated on one of the twin transformers and both transformers shall be left to naturally age and be monitored over the projects duration to investigate the new expected lifespan of the mid life oil regenerated transformer compared to the untouched twin transformer. The results will inform the optimum intervention strategy which can then be utilised in future asset investment plans.

## Scope

Previous research carried out under an IFI project suggested that oil regeneration carried out in a window at the end or near the end of a transformers nominal life would extend life by approximately 10 years. The First Tier project deployed online monitoring equipment at five sites where the oil regeneration technique was used.

The NIA project will build on this research by exploring the optimum point to apply oil regeneration to a transformer fleet. It is acknowledged that the life of oil impregnated paper insulation determines the maximum potential life of a transformer, although other factors may cause it to fail earlier. This project scope will aim to determine if mid life oil regeneration can reduce the rate of paper degradation, and thereby further extend the lifespan of the transformer compared to oil regeneration at end of life.

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## Objective(s)

This project is split into three distinct phases:

**Phase 1** Research into and design / sourcing of an oil regeneration unit to carry out the oil regeneration at the 13 sites  
This phase to be completed by September 2016

**Phase 2** implement Oil regeneration at 13 mid life transformer sites and install condition monitoring equipment  
This phase to be completed by August 2017

**Phase 3** is the data analysis and optimisation of the oil regeneration practice  
This phase to be completed by February 2022.

## Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

## Success Criteria

Specification and sourcing of oil regeneration unit capable of delivering the required oil quality in a controlled manner.

Complete oil regeneration and condition monitoring equipment at 13 transformer sites at mid life

Data acquisition, analysis and validation to identify the optimum point of oil regeneration in a transformer life cycle

## Project Partners and External Funding

n/a

## Potential for New Learning

n/a

## Scale of Project

The project has been designed to allow a robust statistical sample of transformers sites – any reduction in the sample size would provide too little data for accurate comparison and would be open to a individual set of results having a major impact on the overall outcome.

As changes in oil chemistry can be slow, the 6 year duration of the project is considered important to allow modelling of the effects of oil regeneration over time.

Running the project over a 6year period will allow seasonal changes to be taken into account and to show a deviation in oil results over a number of years.

## Technology Readiness at Start

TRL3 Proof of Concept

## Technology Readiness at End

TRL8 Active Commissioning

## Geographical Area

Electricity North West licence area

## Revenue Allowed for the RIIO Settlement

Zero

## Indicative Total NIA Project Expenditure

£1,500,000



## 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)

It is estimated that the saving will be £15 million by carrying out oil regeneration and extending the life of 132kV and 33kV transformers at the middle/optimum point of their design life by 20 years within the RIIO 2 period for Electricity North West.

#### Please provide a calculation of the expected benefits the Solution

The savings have been estimated based on the transformers that are around mid life in the RIIO ED2 (94 x 33kV and 15 x 132kV) being regenerated and a further life extension past their original design life of an assumed 20 years, minus the cost of the regeneration process on a Cost Benefit analysis provides a £15 million saving in the RIIO 2 period.

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

The optimum oil regeneration window will differ dependent upon the transformer type and its operating conditions. This approach will aim to develop a range of optimum oil regeneration windows for approx 100 of Electricity North West's 132kV and 33kV transformer fleet of 460 transformers, which is 22% of our current fleet in the RIIO 2 period. As all DNOs have a similar age and type profile to ENW, it is assumed that this could be rolled out to all network licensees.

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

The cost of rolling this approach out across GB would be the cost of purchase and mobilisation costs of a new mobile regeneration unit(s) to each licensees, development/adaption of oil handling in the Licensees sites and some condition monitoring to validate the process. Therefore it is estimated at £1 million per Licensee and £14 million across GB.

### 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

The project will produce all Policies and Procedures relating to the installation and operation of the condition monitoring equipment which will be made available to all DNOs. In addition we will also provide the necessary information to allow DNOs to conduct their own analysis of the data and decide when intervention needs to occur

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

Maximizing the use of existing assets and optimizing the oil regeneration window

- 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