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

Oct 2015

Project Reference Number

NIA_NGGT0086

Project Registration

Project Title

Mathematical Baseline and Error Detection Techniques for the Analysis of Unaccounted For Gas (UAG).

Project Reference Number

NIA_NGGT0086

Project Licensee(s)

National Gas Transmission PLC

Project Start

April 2017

Project Duration

3 years and 1 month

Nominated Project Contact(s)

Quentin Mabbutt

Project Budget

£113,000.00

Summary

Unaccounted for Gas (UAG) accounted for £51m and £43m commodity costs in 2013/14 and 2014/15 respectively. Any reduction in UAG has a holistic impact for all UK gas consumers.National Grid's UAG management is multi faceted, involving both site based witnessing and the use of desktop analysis models. Most of these models are based on regression and energy use metrics and it has long been realised, that as these techniques have to analyse daily UAG volumes, they are not of sufficient sensitivity to indicate anything but the most gross errors. Currently, daily average UAG is 0.09% of NTS throughput, which corresponds to all measurement systems operating within their contractual obligations (NExA, SCA, NEA) at a holistic bias level (+/- 0.1%). Measurement uncertainty is a measure of meter behaviour about a mean and as NTS UAG is determined from cumulative daily site total flows, individual flow errors can offset. This makes tracking individual site behaviour problematic due to overall data 'noise' within the UAG calculation.

It is proposed to explore alternative mathematical techniques to develop a set of robust models for the determination and monitoring of biases in UAG data. The techniques will be refined to provide a model set that can allow time efficient data analysis, which allows more individual site measurement issue can be addressed with in the commercially defined close out periods.

Nominated Contact Email Address(es)

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Problem Being Solved

National Grid is responsible for the management of Gas Transmission Shrinkage of which the major component is the Unaccounted for Gas (UAG) element and contributed £43m to total shrinkage (community) costs in 2014/15. UAG is mainly attributed to meter error as a consequence of measurement uncertainty but it can also be as the consequence data error, whether systematic or individual occurrences. Thus the detection of errors within the measurement arena resulting in UAG is very problematic.

While there is considerable work by asset owners and National Grid to maintain high levels of metering management and best practice to improve measurement and minimize data error, UAG is still a feature of NTS Shrinkage.

To gain further understanding of the dynamics of UAG, a dedicated mathematical study is to be undertaken to explore the 'music in the numbers' by exploring the latest mathematic analysis techniques. These techniques will sit outside the standard data mining activities and will incorporate the use of non-linear dynamical (Chaos) analysis, matrix and Bayesian methodologies. This study will through a set of defined methods, aim to provide a deeper understanding of observed UAG providing analysis techniques which will improve its management and minimization.

Method(s)

The programme will be conducted in conjunction with the Mathematical Department of Manchester University and will concentrate on the use of mathematical techniques to provide a deeper understanding of UAG behaviour. The programme will be initially focused on providing an assessed UAG baseline and expected tolerances around that baseline for the NTS. From this baseline analysis, the programme will aim to deliver a range of additional mathematical techniques to further assist in the management of UAG by improving measurement/data error detection. Defining UAG behaviour in terms of a robust baseline will assist the focus of UAG management improving flexibility and capability.

Deliverables: Analytical

1. Development of a robust baseline methodology for expected UAG as a consequence of the NTS operation.

    {C}a. Use basic site flow data and the UAG calculation to determine a robust evaluation of a likely tolerance band for expected NTS UAG volumes.

1. 2. Calibrate baseline analysis against historical behaviour.
   3. Provide base models to embed in National Grid's BAU UAG analysis tools suite.

2. Development of UAG analysis techniques.

2. 1. Provide a range of desktop mathematical techniques to support the on-going analysis of UAG.
   2. Calibrate model and techniques against known measurement anomaly data sets.
   3. Provide a suite of modeling techniques and methods to embed in the proposed National Grid 'UAG analysis HUB'.

3. Deployment

3. 1. User analysis of the models.
   2. Continuously re-calibrate models against near term and historic data sets.
   3. Embedding the techniques within the BAU UAG management processes.

Scope

Unaccounted for Gas (UAG) accounted for £51m and £43m commodity costs in 2013/14 and 2014/15 respectively. Any reduction in UAG has a holistic impact for all UK gas consumers.

National Grid's UAG management is multi faceted, involving both site based witnessing and the use of desktop analysis models. Most of these models are based on regression and energy use metrics and it has long been realised, that as these techniques have to analyse daily UAG volumes, they are not of sufficient sensitivity to indicate anything but the most gross errors. Currently, daily average UAG is 0.09% of NTS throughput, which corresponds to all measurement systems operating within their contractual obligations (NExA, SCA, NEA) at a holistic bias level (+/- 0.1%). Measurement uncertainty is a measure of meter behaviour about a mean and as NTS UAG is determined from cumulative daily site total flows, individual flow errors can offset. This makes tracking individual site behaviour problematic due to overall data 'noise' within the UAG calculation.

It is proposed to explore alternative mathematical techniques to develop a set of robust models for the determination and monitoring of biases in UAG data. The techniques will be refined to provide a model set that can allow time efficient data analysis, which allows more individual site measurement issue can be addressed with in the commercially defined close out periods.

Objective(s)

To develop a comprehensive set of mathematical models to assist in the management of UAG through:

1. The development of a robust suite of UAG baseline (tolerance) models.

2. The development of a suite of mathematical analysis techniques to assist in the on-going management of UAG.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

It is proposed to evaluate the programme in terms of the following success criteria:

1. Baseline Determination:-
   The introduction of a baseline metric into the standard UAG management process will greatly assist in the assessment of the effectiveness of the control and monitoring processes being employed. This should enable the UAG management techniques to be refined and targeted in specific areas greatly improving response and holistic management with all stakeholders.

2. Mathematical Analysis Techniques:-

The mathematical techniques will build on the baseline analysis to provide a suite of tools and models that will be embedded into National Grid's UAG management processes.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

The proposed programme will develop the techniques to undertake robust baseline and tolerance analyses of UAG and also provide a suite of techniques to monitor near time behaviour against these baselines efficiently.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

UK based application. Available to all transmission and distribution meter asset owners

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

Total Project Cost - £113,000

NIA Expenditure - £59,000

EPSRC Contribution - £54,000

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)

Implementation of the models resulting from the programme are expected to facilitate greater control and potential reduction in UAG each year (currently costing ~£40m / year). Improvemetn would be as a consequence of early meter/data error detection and early resolution improving within close out data quality (reconciliation avoidance) and near term reconciliation (early meter error detection – cost avoidance).

Please provide a calculation of the expected benefits the Solution

N/A - Research

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

Results of the programme will be made available and articulated across a number of forums. The models will be developed to run on standard computer operating systems without the recourse to specialist non-standard proprietary software. The results of the programme will be made available and National Grid Gas Transmission will share with other potential users their experience. Use of the techniques across other sectors may still require some additional rationalisation to align with individual computer systems.

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

To fully embed the processes within the business, it is expected that there will be commercially available software licensing costs which are projected to be in the region of £500/user.

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 development of mathematical techniques to assess large data sets will have numerous potential applications across the energy transmission industry. UAG is a unique phenomenon to the gas industry but analysis of time based data, outside the traditional data mining techniques, could provide more a focused analysis leading to greater understanding of the underlying trends being analysed.

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

n/a

☑ 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