NIA Project Registration and PEA Document

Date of Submission

Nov 2016

Project Reference Number

NIA_NGGT0107

Project Registration

Project Title

Project EVA – Extreme Value Analysis

Project Reference Number

NIA_NGGT0107

Project Licensee(s)

National Gas Transmission PLC

Project Start

January 2017

Project Duration

1 year and 7 months

Nominated Project Contact(s)

Aoife McNally, box.GT.Innovation@nationalgrid.com

Project Budget

£512,500.00

Summary

A solution that encompasses simultaneous evaluation of financial, risk and operational performance, in particular, the inclusion of extreme value risks in the decision criteria will be developed. This will include both an extreme risk weighted NPV calculation and also a set of extreme risk evaluation criteria that provide visibility of the tail end risks, for example 'value at risk'. This will be robust enough to incorporate a range of data that varies in completeness, format and quality, ensuring the solution is practicable and does not rely on an unrealistic availability and quality of data. The solution will also support rapid 'what-if' scenarios analysis to support agile decision making. This will allow users to quickly test different assumptions and decision criteria. A generic business modelling platform will be developed that will allow a decision maker to holistically evaluate projects and investments based on these criteria.The project will demonstrate the power of the new risk modelling techniques as an investment decision support solution through three high value investment case studies. A stage gate will be undertaken after the first case study and Cranfield University will review the event tree and conduct Peer Review before refinement and progression to an additional two case studies.Through application to a number of case studies it is expected that a generic business modelling platform will be developed, that could be utilised on future investment decisions. The project concludes with an appraisal of the investment in software and training required to deliver embedded implementation within NGGT.

Third Party Collaborators

Business Modelling Associates

Nominated Contact Email Address(es)

Problem Being Solved

Many investment decisions within NGGT involve evaluating extreme value risks, which are low probability, high impact events. The tools and approaches that currently exist are not best suited to evaluate these situations. These decisions are made on schemes that could range from £10million to £200million in value. The difficulty in quantifying the value of mitigated risks means that over or underinvestment could occur, with the impact in both scenarios resulting in additional cost to consumers. Over investment can occur where the risk has been quantified at a higher severity therefore driving more costly work, whereas under quantifying the risk can result in higher overall costs due to further risks materialising.

There are two key challenges:

1. The volume and diversity of data generated by impact assessments makes the incorporation of quantitative risk assessments and scenario analysis within a single decision making framework challenging
2. The common approaches to cost benefit and net present value analysis tend to emphasise mean or expected values while undervaluing extreme value risks (low probability, high impact) and ignore uncertainty.

Method(s)

The solution proposed under this project seeks to address the shortcomings in quantifying the value of investments that involve mitigating extreme value risks. Business Modelling Associates (BMA) will apply risk analysis expertise to develop a model that encompasses financial, asset connectivity and operational risk modelling. It will deliver a methodology that will be broader and more far reaching in dealing with tail end risk and complexity. The technology used (Enterprise Optimizer) has been chosen due to its' flexibility in modelling risk, which can accommodate a wide range of data yet to be applied in the UK gas sector.

The platform is conducive to rapid and agile model development which will be used to deliver the dynamic model that supports rapid scenario analysis. A methodology that will enable robust assessment of the cost and benefits of investments that include extreme risks and extreme uncertainties will be developed. This will be achieved in 3 key work packages:

Constraint-based systems modelling approach:

- A comprehensive systems map will be build out drawing together all the information available from the existing risk and impact assessment. This system will include all events, options and constraints. This will ensure that all costs/benefits are appropriately captured for each investment option. The systems map will not only represent major events, such as catastrophic failure, but include operational costs, operational mitigations, planned and unplanned maintenance. Whenever possible uncertainty around events and interventions will be included.

- Where interventions result in future options which can be included and valued these will also be included, capturing the real value of options.

- All probabilities, uncertainties and impacts will be defined by time period to ensure that asset deterioration and increasing uncertainty are valued.

Modelling uncertainty:

- Where data is available, risks will be formally represented as probability density functions (PDFs) and a full Monte Carlo simulation will be run to quantify the full range of impacts of each risk. Where this is not possible tail end risks can be represented as discrete risk events following a best case, expected case, worst case approach.

- This ability to model a detailed event tree including multiple outcomes (from functional, to partial failures and catastrophic failure), coupled with an ability to tailor the representation of risk to the granularity of data available will allow the widest possible representation of risk to be included, making best use of the data available. This will allow a robust simulation of the outcomes, including risk events, of all decision options.

Net Present Value approach:

- For each outcome, event and intervention, a monetary value will be assigned. This will be weighted by the associated likelihood to derive a risk-adjusted net present value.

- Where uncertainty has been modelled using PDFs, net present value will be returned as a frequency density distribution. In this way, the uncertainty around NPV for different scenarios can be compared as well as the expected value.

April Update: During the course of the project an opportunity to further improve the assessment of low probability high impact events arose involving the development of a daily model to look at valuing emission specific outputs. This is the first time that these emission specific outputs can be modelled in this way. This information provides greater clarity and allows for a more informed assessment. The

additional funding required covers the cost to develop this daily model.

In addition for Case Study 3, an opportunity has been identified to complete a data analysis exercise to assess the relationship between compressor use, network demand, network supply/storage, linepack and asset reliability which will improve the modelling of the low probability events and subsequent impacts. The output will feed into the decision tree model and allow for the calculation of capability shortfalls and will quantify emission and fuel costs.

Scope

A solution that encompasses simultaneous evaluation of financial, risk and operational performance, in particular, the inclusion of extreme value risks in the decision criteria will be developed. This will include both an extreme risk weighted NPV calculation and also a set of extreme risk evaluation criteria that provide visibility of the tail end risks, for example 'value at risk'. This will be robust enough to incorporate a range of data that varies in completeness, format and quality, ensuring the solution is practicable and does not rely on an unrealistic availability and quality of data. The solution will also support rapid 'what-if' scenarios analysis to support agile decision making. This will allow users to quickly test different assumptions and decision criteria. A generic business modelling platform will be developed that will allow a decision maker to holistically evaluate projects and investments based on these criteria.

The project will demonstrate the power of the new risk modelling techniques as an investment decision support solution through three high value investment case studies. A stage gate will be undertaken after the first case study and Cranfield University will review the event tree and conduct Peer Review before refinement and progression to an additional two case studies.

Through application to a number of case studies it is expected that a generic business modelling platform will be developed, that could be utilised on future investment decisions. The project concludes with an appraisal of the investment in software and training required to deliver embedded implementation within NGGT.

Objective(s)

The objective of this project is to develop an innovative approach to modelling extreme value risks that support investment decisions ongoing or as part of the Network Development Process (NDP). The analysis should encompass financial, asset and operational modelling to address extreme value events (low probability, high impact asset failures) and facilitate stakeholder engagement in investment decision making.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Success will be the application of the extreme value analysis in providing a consistent and detailed approach to a range of NGGT investment projects either ongoing or forecast as part of the Network Development Process (NDP). The approach should be innovative in systems modelling, encompassing financial, asset and operational modelling to address extreme value events (low probability/high impact asset failures), alongside the ability to facilitate stakeholder engagement in investment decision making.

The success of the solution will be:

- A dynamic model that supports rapid scenario analysis, so that scenarios and assumptions can be tested in a timely fashion.
- A flexible product that has the ability to be applied to multiple investment decisions
- Strong financial modelling ability ensuring the monetised impact of risks and investment options are robustly modelled.
- A number of scenarios run that produce a risk-adjusted NPV as well as articulation of the extreme risk scenarios, providing visibility of the tail end risk and confidence it is accounted for in the NPV calculation.
- Reporting capabilities using the Power BI Dashboards application
- Use as a high-level simulation tool of network activity and performance. It does not replace dedicated hydraulic model tool in this role, but provide a tool to rapidly run a wide range of network scenarios. In this role it can provide decision support that can inform high level analysis and identify where more detailed hydraulic or engineering modelling or analysis need to be carried out.

Project Partners and External Funding

Project Partner – Business Modelling Associates

External Funding – (nil)

Potential for New Learning

The potential for learning from this project is applicable across the gas industry, in particular around the approach to encompassing financial, asset and operational modelling to quantify extreme value events. The methodology will benefit customers, GDNs, Regulators and investors, by providing more confidence that investments being made are achieving the best possible trade-off between risk and reward. The principles of the Investment Decision analysis apply across both Gas Transmission and Distribution. This project will incorporate case studies from NGGT investment cases both current and future under the Network Development Process (NDP). With modification across the 3 work packages being delivered, the dynamic business modelling tool could be adapted to support investment decision making within the Gas Distribution Networks.

Scale of Project

Desk based trial in a working environment using live investment case studies for current and future investment decisions.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

Desk based work at Business Modelling Associates Offices and National Grid Warwick Headquarters

Revenue Allowed for the RIIO Settlement

None.

Indicative Total NIA Project Expenditure

£512,500

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 key benefit of the project is to support investment decisions by ensuring the right decision is made, ensuring that we do not over or underinvest. The impact in both scenarios can result in the cost to consumers being higher. Over investment can occur where the risk has been quantified at a higher severity therefore driving more costly work, whereas under quantifying the risk can result in higher overall costs due to risks materialising. The ability to encompass financial, asset and operational modelling to quantify risk of extreme value events will intelligently inform investment decisions to deliver best value for money solutions for our customers. Typically, investments made by NGGT range from £10million to £100 million. Through better evaluation of these extreme value events we anticipate reducing our capex reinvestment during the remainder of T1 and T2. Conservatively we have assumed that we will avoid one investment during T1 and T2 saving £10 million.

Please provide a calculation of the expected benefits the Solution

During RIIO-T1 and T2:

Base cost - investment made based on historic evaluation approaches =£10 million

Method Cost – investment avoided through extreme value analysis = £0 (saving of £10 million, minus cost of tool application)

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

The solution is being developed through the application of a number of ongoing case studies across Great Britain to the 'Enterprise Optimizer' analytics technology. Given the breadth of the case studies, if the tool was proven successful, it would be applicable across the National Transmission System upon implementation.

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

To be determined as project progresses. Cost will depend on business model e.g. development of an in house capability + purchase of software or analytical service.

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 develop an extreme value analysis model and approach using a number of relevant investment case studies. This will result in a platform specifically applicable to the National Transmission System, however the principles remain the same across both Gas Transmission and Distribution networks. Therefore with the right level of modification across the 3 work packages to incorporate more relevant distribution based investment case studies, the tool could be utilised in these investment decisions also. The methodology will benefit customers, GDNs, Regulators and investors, by providing more confidence that investments being made are achieving the best possible trade-off between risk and reward.

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

The project is aligned to our commercial theme.

☑ 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.

We have reviewed projects undertaken by the networks and have not identified any duplication.

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