nationalgrid

Offgrid Substation Environment for the Acceleration of Innovative Technologies

National Grid
Electricity Transmission

Network Innovation
Competition 2015

ofgem

RIIO NIC NETWORK INNOVATION COMPETITION

E Project Code/Version Number:NGETEN04/v1

Section 1: Project Summary

1.1. Project Title	Offgrid Substation Environment for the Acceleration of Innovative Technologies (OSEAIT)
1.2. Project Explanation	The project will modify an existing 400kV substation into an easily reconfigurable, field trial facility. This offgrid facility will replicate a live substation environment to overcome the operational barriers associated with the implementation of innovative methods and technologies on the electricity network.
1.3. Funding licensee	National Grid Electricity Transmission plc
1.4. Project description	1.4.1. The Problem(s) it is exploring There is a gulf between the sanitised conditions of test laboratories and the harsh reality of the national electricity grid. This makes the cost, complexity and safety implications associated with transferring outputs of research and development to the grid significantly difficult. Licensees are understandably reluctant to put the quality and security of supply they provide to their customers at risk in order to demonstrate the viability of new ideas with unproven track records. This results in many projects never being implemented in the live system. To the best of our knowledge, this bid provides a solution to this issue. There is no similar facility in the world capable of hosting live field trials of transmission and distribution applications. 1.4.2. The Method(s) that it will use to solve the Problem(s) A portfolio of projects has been identified to demonstrate the facility. 1.4.3. The Solution(s) it is looking to reach by applying the Method(s) A facility, managed through an advisory board comprising industry stakeholders, available to all GB Network Licensees. The project develops the facility from a Technology Readiness Level (TRL) 5 to a regulated, sustainable facility, TRL 8. 1.4.4. The Benefit(s) of the project The project will take advantage of a rare opportunity to secure a fully operational substation The result will be an enduring facility that will help facilitate the transition to low carbon electricity networks. New ideas can be brought into routine deployment more quickly, reducing the overall cost of re-engineering the network and without affecting consumer security of supply. The solution proposed will conservatively deliver the breakeven point for consumers by 2021.

1.5. Funding			
1.5.1 NIC Funding Request (£k)	12,015	1.5.2 Network Licensee Compulsory Contribution (£k)	2,780
1.5.3 Network Licensee Extra Contribution (£k)	11,120	1.5.4 External Funding – excluding from NICs (£k):	0
1.5.5. Total Project Costs (£k)	26,037		
1.6. List of Project Partners, External Funders and Project Supporters	Project Supporters *Network Licensees* Scottish Hydro Electric Transmission plc, Scottish Power Transmission Ltd. *Research Institutes* National Physical Laboratory (NPL), Electric Power Research Institute (EPRI), Centre for Sensors and Imaging Systems (CENSIS). *Suppliers* 3M, ABB, IBM, Megger, Siemens. *Academic Institutes* Cardiff University, University of Birmingham, The University of Manchester, University of Southampton, University of Strathclyde, University of Warwick.		
1.7 Timescale			
1.7.1. Project Start Date	4 January 2016	1.7.2. Project End Date	31 October 2020
1.8. Project Manager Contact Details			
1.8.1. Contact Name & Job Title	Iliana Portugues Innovation Programme Manager	1.8.2. Email & Telephone Number	iliana.portugues@nationalgrid.com ([redacted])
1.8.3. Contact Address	National Grid House – C3 Warwick Technology Park, Gallows Hill, Warwick CV34 6DA		

Section 2: Project Description[1]

2.1 Aims and objectives

The aim of this project is to convert an existing substation that is approaching the end of its operational life into an evaluation facility for live trials at various voltages up to 400kV and beyond. The facility will be unique in the world, significantly assisting all GB Network Licensees to maintain security of supply whilst optimising infrastructure investment. It will deliver benefits to consumers by accelerating the deployment of technologies capable of reducing both the carbon footprint and the cost of present and future energy networks.

This facility will underpin the effort which National Grid Electricity Transmission (NGET), along with energy industry stakeholders, are investing in innovation. It will support the successful de-risking of innovations to allow benefits to be maximised faster without adversely affecting supplies to consumers.

2.1.1 The Problem

Electricity network owners manage their existing assets to maximise value over their life and, where required, expand their networks to accommodate changes in supply and demand.

Historically, assets have principally been managed using interval-based maintenance interventions. This worked well on an electricity network that was designed and built around generation from large power stations that would flow in a predictable way through the transmission network and then through the lower voltage distribution networks to the consumer. The assets were designed for this duty, with a specified number of service years and deterministic time-based maintenance periods.

Transmission and distribution networks are now experiencing operating conditions that are significantly different from those for which they were originally designed and constructed. This is due to the growth and penetration of renewable and embedded generation, as well as changes in consumer behaviour. Such shifts in the location and nature of power flows impact upon the industry's ability to accurately forecast asset load profiles over asset lives.

The increasing use of non-synchronous generation, such as wind and solar, and its displacement of traditional synchronous generation has introduced a number of new challenges. The growth in power electronics associated with non-synchronous generation has increased the level of power quality issues. This increased switching on the network continues to generate rising numbers of voltage transients.

One recent example has been the impact of these local power flows on switchgear associated with voltage support equipment i.e. MSCs, SVCs and reactors. This switchgear is subjected to significantly different power flows and switching regimes than other switchgear on the electricity network. This has required us to specify different technical requirements and maintenance regimes. We have also had to create new degradation curves for these particular assets.

[1] This section refers to Appendices II, V, VII

All of these factors could have a detrimental impact on asset lives and performance capability. These changes are occurring rapidly and have potentially far reaching impacts. These changes creates two major challenges for asset managers as we monitor and manage our asset fleet:

- Firstly, the different and variable loading conditions undermine our historical experience and create new challenges about how we predict and optimise the way we manage our assets in the future.
- Secondly, there is a requirement to run our networks more efficiently whilst facilitating faster and efficient connections to low carbon generation.

Our existing network assets are ageing and in many cases are approaching end of life. There are sound commercial reasons for endeavouring to extend asset lives where possible. However, at the same time, many assets are predicted to have reduced lifespans owing to the changing network conditions.

A number of different interventions are possible as assets reach the end of their lives:

1. *Like-for-like replacement of an asset*.
   This can be expensive as replacements have long lead times and require system outages. These can result in increased network risk and potentially incur significant constraint costs.

2. *Replacement with new technology*.
   This has all the same issues associated with like for like replacement and also carries the additional risk associated with lack of experience of the new technology.

3. *Partial replacement*.
   This can be complex due to components either being difficult to source or becoming obsolete often necessitating a level of redesign, transferring designer's responsibilities on to the asset owner.

4. *Refurbishment.*
   This often requires the development of new work practices and technologies, the effectiveness of which need to be verified before widespread deployment across the network. Some refurbishments can also include partial replacements.

5. *Modification of operating conditions*.
   This requires a better understanding of the assets and system operating in these modified conditions before widespread deployment across the network.

6. *Life extension.*
   This requires better understanding of the degradation of equipment and the lead deterioration mechanisms. Hypotheses in this regard often take considerable effort and time to prove.

7. *Doing nothing.*

This potentially impacts the reliability of the network or cost to the customer. It therefore goes against the measures by which the performance of transmission and distribution operators are measured.

In addition to managing ageing assets, we also have to manage increased demand for transmission capacity in many locations. This is mainly achieved through expanding electricity networks to provide additional capacity. Interventions to achieve this include uprating the capacity of existing assets, building new network, or enhancing the capability above design specification if possible. Failure to invest gives rise to risks that could impact the security of supply, constrain renewable generation and incur significant constraint costs.

The experience of utilising existing asset designs that have evolved relatively slowly together with the accumulated knowledge gained over a 50 year period is the low risk option that has served consumers well over many years with world class levels of network reliability. To move away from this requires a high level of confidence that the results of any new approach will be sound for the next 40 years or more.

Replacing assets with new technology, refurbishing existing assets and modifying asset conditions may offer advantages in terms of both cost and expediency in comparison with like for like potential replacement. However, the uncertainty of their unproven track record makes their application risky. This risk of deploying new technologies, refurbishment techniques or operating methods onto the live network needs to be carefully managed if it is not to become a barrier to innovation.

Installing additional assets of the same type can increase capacity but does not necessarily provide the best value when compared with the choice to deploy a new technology and/or increase the capacity of existing assets. In many circumstances adding more of the same also poses environmental and visual challenges. The ability to reduce the time taken to deploy new technologies and operational practices onto the network, or eliminate the need completely, is therefore highly advantageous.

Significant innovation has been carried out at both the equipment and network level to develop a range of solutions that allow the network to be expanded and the assets to be managed in a more cost effective and safe manner. However, a significant proportion of the potential benefits of these solutions has been lost owing to the risks associated with the deployment of new technologies in an already, and increasingly, constrained system.

A recent example of one of our innovations is the installation of two 400kV transformers filled with synthetic ester at Highbury (the first of their kind). From the initial idea of using synthetic ester at transmission voltages, through laboratory trials, to successful factory testing of a single transformer and installation at a single substation, the time taken was over 10 years. This was despite the evidence that showed that ester-filled transformers can provide significant environmental and safety benefits, age at a lower rate when compared with conventional transformers and potentially reduce the associated costs of civil works in new installations. We believe a facility such as that included in this proposal would have significantly shortened the development cycle and enabled earlier deployment, yielding wider benefits.

GB Network Licensees, as prudent and responsible asset managers, also need to demonstrate and validate the residual life and capability associated with a legacy asset when it is subjected to different operating regimes, compared with when it was originally installed and commissioned decades ago. In the event of an incident, an adequate understanding of ageing and risk of failure must underpin how the assets have been managed.

To the best of our knowledge, there is presently no facility in the world for a utility to assess fully the lifetime and operational implications of running its assets (old and new) beyond their design life or differently to how they were originally intended to be run. There is also no facility that manages the risk associated with the deployment of new technologies onto the electricity network. There is apparently a lack of capability worldwide that allows a comprehensive assessment of new technologies and alternative asset management techniques in such a way that reduces the risks associated with full scale network deployment to an acceptable level.

The challenge of providing trial opportunities on the live network to reduce the risk of new technology and techniques is particularly significant at transmission level voltages where there are relatively small numbers of assets which are important in the context of the resilience of the network as a whole.

2.1.2 The Method

The project will modify a fully provisioned 400kV substation that has been superseded by a new modern substation facility and would otherwise be decommissioned. The substation was built in 1970 and is typical of its era, being built to the presiding design standards; it is representative of much of the electricity transmission and distribution infrastructure across GB. This is a very rare opportunity to retain and utilise a full substation with the entire functioning infrastructure in a live, but offgrid, environment.

At present, before installing a new asset technology on the network, a Network Licensee can seek reassurance in the results of research and would carry out 'type tests' to prove the design capability. The type testing process is valuable and allows certain aspects of the asset performance to be verified. However, it does have limitations and network licensees would usually seek ways to further reduce the risk of deploying the asset across their network.

This project will provide the GB Network Licensees with the ability to trial or pilot a new asset by exposing it to the realities of a 'live' substation environment before installation on the network alongside operational assets. We will be able to inject continuous AC voltages with simultaneous load current, DC voltage and transients. The table below states the energisation capabilities of the facility based on the preliminary design.

AC Voltage	0 to 550kV at 50Hz / 250kVA. Ability to inject harmonic levels up to 5% THD
DC Voltage	0 to 600kV DC injection. *With fast polarity switching
Impulse Voltage	1425kV lightning impulse / 1050kV switching impulse
Continuous Load Current	0 to 2000A at 50Hz into an inductive reactance of 0.2Ω
Variable Frequency Tertiary Supply Transformer	11kV 20-150Hz 250kVA

The proposed environment will allow the assets to be stressed and aged in a way that allows their long-term performance to be verified. The test environment will expose equipment to a range of onerous conditions to establish their impact on asset health, lifetime and residual risk. This is extremely difficult to achieve in a normal operational substation without putting safety and security of supply at risk. This project will remove a major barrier to the deployment of new technologies and will unlock the financial, environmental, operational, and safety benefits associated with a range of innovation projects.

In order to run assets more efficiently or harder, it is important to develop the capability to monitor their performance and condition in real time and predict lifetime in the form of time-to-failure. GB Network Licensees are obligated to maintain and replace their assets to deliver acceptable levels of availability, reliability, safety and environmental performance. It is difficult to gain confidence in new asset management techniques such as condition monitoring that may enable an asset to be kept in service longer if the impacts of an in-service failure are incompatible with meeting consumer expectations and carry significant financial penalties. In some cases we have been investigating particular technologies for over 10 years on multiple sites across the UK and abroad. However, further accurate data is required before there is an acceptable level of confidence to move to full deployment. The proposed test environment will provide a safe location where assets can be stressed and left to fail under controlled conditions without detriment to the local environment or continuity of supply. This will support new asset management techniques and operational practices to be deployed.

The proposed facility will give GB Network Licensees the opportunity to make a step change in the ability to challenge the conventional approach to asset life and maintenance within a reduced timescale without reducing system reliability and service to customers. It will also support the roll-out of new assets with increased speed and at a lower cost to the consumer. This will be achieved through the delivery of an offgrid substation capable of being energised up to 550kV (this voltage allows the ability to age equipment more rapidly than would be possible at 400kV). This

facility will be available to all GB Network Licensees and will allow short and long term deployment, development and demonstration of new technologies and techniques.

The users of the facility will have control over the environment in which they are working. This will allow assets to be tested to their full potential and beyond their design criteria in a safe environment, without any risk to the network, its customers and the environment. Evaluating asset performance could entail overstressing or accelerating their ageing by means of electrical, thermal and mechanical tests. An offgrid testing facility is not only safer, but will increase the understanding of asset failure mechanisms and predictive failure detection methods. This will provide greater knowledge about the maximum practically achievable asset life, deterioration rates and the ability of existing and novel monitoring techniques to detect asset deterioration. It will enable the ability to introduce and control defects in new and existing assets and were appropriate allowing them to fail. This would enable us to calibrate diagnostic and condition monitoring equipment/techniques and train operators accordingly. These capabilities will be pivotal in establishing the asset health of in-service equipment and will help us identify the threats to asset health and the residual life in legacy assets.

The facility will provide benefits to over 400 transmission substations in Great Britain and many thousands of distribution sites. The key benefits of providing a facility which will accelerate and evaluate innovative technologies and techniques in a real substation are twofold:

- New ideas can be brought into routine deployment more quickly,
- There will be an overall reduction in cost as the need to re-engineer (or over-engineer) the operational substation to avoid reduction in the customer security of supply will be minimised.

2.1.3 The Development

The development of an offgrid facility will allow various new technologies to be trialled and evaluated without impacting the main transmission or distribution systems. The facility will allow technologies to be investigated without the delays that could result from the complexity of trialling on the real network such as timing of outages or network availability. By having a facility that is offgrid, multiple systems can be tested in a controlled environment. This will yield the ability to compare approaches and novel techniques such as different refurbishment techniques enabling more rapid deployment of the most effective solutions. One way in which we could do this is by simultaneously simulating voltage and current for the investigation of temperature related equipment degradation. This is schematically represented in Figure 2.1 below.

The facility will allow the controlled acceleration of asset life degradation, with monitoring systems being used to measure asset performance through the use of a range of different stress factors. This will allow the industry to develop a greater understanding of the mechanisms that cause asset degradation and, as a result, identify methods for determining asset condition. This will enable the use of the correct approach at the right time throughout the lifecycle of the asset. Ultimately, costs to the consumer will be reduced whilst the same level of reliability is maintained.

The reduction in cost will result from reduced numbers and duration of outages and the maximisation of asset operational lives.

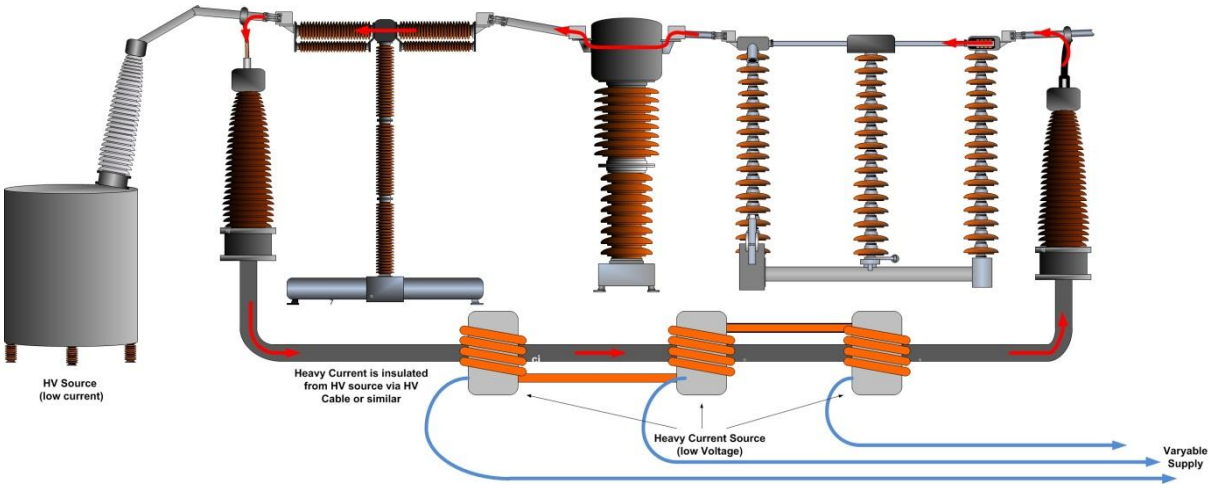

Figure 2.1 A typical method to simulate high voltage and load current without the fault current in the event of failure

The facility will be developed with the required functionality to allow:

a) Quantification of the effects of non-synchronous generation on asset degradation;
b) Comparison of different maintenance practices against their cost and impact on asset life; and
c) Development of an understanding of how changing power flows and power quality affects individual assets and bays.

These will all help inform the specifications required for the procurement of new assets, enable more effective management of existing assets and will enable more informed modelling that will improve network reliability and security of supply.

2.1.4 The Solution

By addressing the problems identified above through the methodology suggested, the resulting facility will enable the following:

a) Acceleration and improvement in the development and validation of innovation projects (including Network Innovation Allowance projects) by being able perform evaluations that would not be viable on the live network.

b) Development and trials of novel maintenance practices.

c) Accelerated implementation of new technologies and practices.

d) Improved industry knowledge about asset life cycle and condition by monitoring the ageing process of an asset, enabling the condition of an asset to be more accurately understood and informing the optimal intervention, such as maintenance or replacement and their timings.

e) Maintaining network, safety and environmental risk profiles to an appropriate level whilst trialling new technologies.

f) Development of spin-off ideas that will benefit the network through the experience gained in trials.

g) Provision of training and education for professionally qualified and developing engineers on new maintenance and refurbishment practices as well as training on new technologies.

2.2 Technical description of Project

The project will be based in North Wales, where we are currently in the process of decommissioning Deeside 400kV substation, as part of the Western Link HVDC development work. The map below in Figure 2.2 shows its location and the neighbouring area.

Figure 2.2 Map showing location of Deeside in North Wales

The existing Deeside substation is an outdoor site. It currently consists of 20 bays (including the busbar section and busbar coupler circuit breakers). The aerial photograph below in Figure 2.3 shows the layout overlaid with the conceptual design for the facility. The size of the operational land at the Deeside 400 kV substation is approximately 13 acres. However, as a result of the construction works at Connah's Quay involving the power station's bay and overhead line reconfiguration, there is further land available for the project, increasing it to 18 acres.

The availability of Deeside 400 kV provides a rare opportunity that we are unlikely to see again. Deeside has been compared against several other sites to understand whether this project could be delivered at other locations. Further details of the approach we took can be found in Appendix II.

We will redesign the substation to enable its alternative usage under the proposal. In order to maximise the benefit, we will preserve and modify existing buildings where possible. New buildings and roadways will only be constructed to complement the existing infrastructure. Details for the facilities that will be provided at the site, using

a flexible layout to enable maximum utilisation of the space, are provided in Appendix III.

Figure 2.3 Picture showing an aerial view of Deeside 400 kV substation

2.3 Description of trials and applications

In order to manage the project, the delivery has been divided into five different stages. Each of these stages has a programme of work associated with it. To maximise the benefit of the facility an innovation programme has been developed to run in parallel with the construction stages thus enabling advantage to be taken of the facilities as and when they become available. The innovation programme is based on some of the key areas defined in Section 3.3.2. A detailed explanation of each construction stage can be found in Appendix VII. A high-level view of the project plan and timescales for both the facility construction and innovation programme is shown below in Figure 2.4.

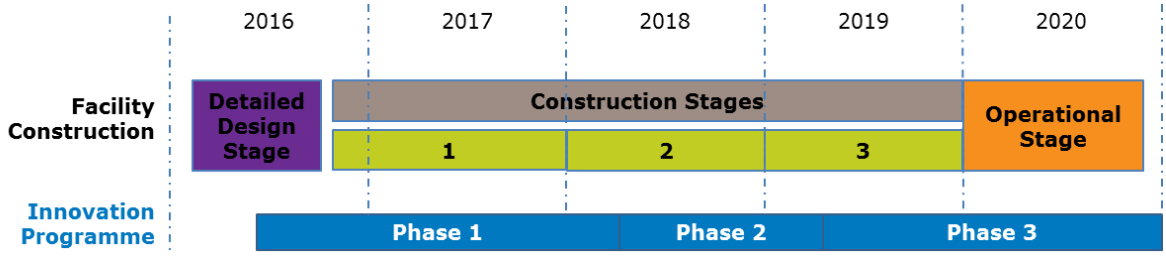

Figure 2.4 High level project plan

Maintaining stakeholder engagement is key to ensuring the facility provides maximum benefit to consumers. Throughout the preparation of this bid, we held several internal and external workshops to help us shape this project. Full details of these events can be found in Appendix V and Section 4.4.

We will continue our stakeholder engagement throughout the life of the project. One of our first deliverables will be the creation of a Technical Advisory Board. The main purpose of the Technical Advisory Board will be to agree the final design of the facility and prioritise the construction stages to ensure benefits are delivered as rapidly as possible. As the facility becomes operational, this advisory board will also oversee the innovation programme, prioritising the allocation of trial facilities, personnel and time to deliver maximum benefit to the consumer. It will also ensure that progress made is disseminated and that results from the projects undertaken are shared across all GB network licensees. The Technical Advisory Board will be chaired by our Head of Engineering at and we will invite representatives from each of the Scottish Transmission Owners (Scottish Power Transmission Limited and Scottish Hydro Electric Transmission Limited), representatives from the Distribution Network Operators, Ofgem. Other members from across the industry will be invited to participate, including academia and a Health and Safety representative. Ofgem will represent the voice of the consumer through its two representatives. Figure 2.5 below shows a high-level organisational chart of this governance. More detailed information regarding the governance of the facility can be found in Appendix XII.

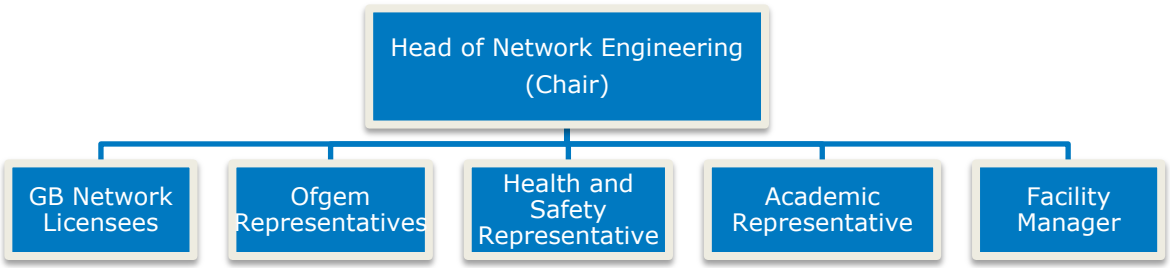

Figure 2.5 Graph showing representation at the Technical Advisory Board.

2.4 Changes since Initial Screening Process

As part of the thorough site location analysis, several changes in the delivery have occurred. The scope of the project is largely consistent with the submission for the Initial Screening Process. However, the following changes have occurred:

1. Given the level of preliminary work carried out so far, we have been able to revise the cost of the project down to £26m from its original estimate of £30m.
2. Given the capabilities of the selected site, we have introduced overhead lines to the scope of the proposal.
3. In light of stakeholder feedback, and given the capabilities of the selected site, we have included HVDC technologies to the possible technologies to be trialled.
4. We have added a parallel programme of work which could be undertaken using the facility which is intended to deliver value to consumers throughout the construction phases.

Section 3: Project business case[2]

This work is a good investment for consumers. It is a rare opportunity to use a fully functional substation due to be decommissioned that delivers a large return to consumers of £360m. This is in the Future Prospects Case, which you can read in Appendix X.

Under all scenarios considered, the benefits outweigh the cost to consumers. This is achieved through minimising costs and maximising savings. These savings are delivered through three areas:

1. Researching and developing new and unconventional technologies and practices
2. Extending the operational life of ageing assets
3. Implementing innovative solutions faster

This section describes this business case in more detail.

3.1 Context

The energy sector is experiencing a period of unprecedented change. The industry is faced with a number of challenges which include dealing with rising demand and reducing greenhouse gas emissions - all whilst maintaining security of supply, affordability and good value to consumers.

As a result, transmission and distribution networks are now experiencing operating conditions that are significantly different from those for which they were originally designed. This is due to the growth of renewable and embedded generation, as well as changes in customer behaviour. This makes demands and flows in electrical power over the whole system less predictable.

The increasing use of non-synchronous generation has also increased the challenges of maintaining power quality. These factors affect the ability to accurately forecast asset load profiles and the indicative statistical analysis used to predict the life expectancy of assets.

New approaches, techniques and technologies for expanding and operating electricity networks now need to be developed, tested and implemented to deliver value to consumers in this rapidly changing environment. Barriers to implementation need to be removed if we are to reduce the time taken to develop research and ideas into fully deployable solutions. The ability to trial and deploy innovations and decrease the time from development through to deployment is an imperative for utilities and customers alike.

However, there is some tension between the need to fully implement beneficial innovations as quickly as possible and making sure that such innovations have been fully tested, the risks identified and their impact on the existing system understood.

[2] This section refers to Appendix X.

The barriers that prevent the development and implementation of new technology and techniques into business as usual include:

- The risk associated with connecting unproven technology to the live electricity network – this can slow or even stop development entirely.
- The need to develop, trial and demonstrate new technology and applications in as realistic an environment as possible. At present, this is undertaken on the live operational network. However this is problematic, resulting in project delays and deferrals where testing conflicts with more critical business priorities, such as where installation requires outages.
- The need to develop and trial under a wide variety of conditions to represent the range of potential operating conditions. An example is testing under network events and faults. The facility will be able to simulate these faults whilst maintaining a safe environment through the use of the impulse generator to inject fast transients. These conditions are unpredictable, and progression of a project that deploys innovation can be severely delayed waiting for the right conditions to prevail.
- The time needed to develop an understanding of the lifetime operation of assets or the long-term effect of one asset on another.
- The ability to compare alternative technologies side by side is usually restricted when trialing at an operational site, because of limited space and limited availability of assets.

This bid proposes the development of a facility to overcome these barriers and deliver benefit to consumers through three areas that create value:

1. *Research and development of new unconventional technologies and practices:*

   These are technologies and practices that have a high risk of impact on the live network associated with them. Consequently, they would likely never be trialled at all.

2. *Extending the operational life of ageing assets:*

   UK electricity transmission companies currently hold assets with a net book value of approximately £14 billion. This value is expected to grow significantly over the coming years. The optimisation of interventions resulting in asset life extension has the potential create significant operational savings and reduce capital investment.

3. *Accelerating the implementation of innovation:*

   Speeding up making improvements enables earlier savings to be passed to consumers and also boosts the reliability and efficiency of the network, yielding further benefits.

3.2 Achieving best value for consumers

This bid addresses these issues by building an offgrid facility where developments and trials of technologies and practices can take place without putting consumers at risk.

3.2.1 Optimisation of costs and project delivery

The project takes advantage of the unique opportunity to secure a fully operational transmission site before it is decommissioned and demolished. The cost of developing such a facility from scratch has been estimated at £84m. However, this opportunity results in a significant portion of this cost being avoided, with the overall project costing £26m. This is a rare opportunity; we do not believe there is an alternative method of solving this challenge which would provide better value to consumers.

While construction is underway, we will progress a number of projects that will allow us to validate progress at different stages. These will demonstrate the capability of the facility to successfully accelerate the deployment of innovation into the network licensees networks, as well as develop new learning, which would otherwise have been impossible within realistic timeframes. This programme of work would also see benefits achieved earlier, while construction is still underway. The proposed set of projects can be found in Section 6.

3.2.2 Costs

We recognise the total investment necessary to deliver this project is significant and represents the highest in the Network Innovation Competition process to date.

Unlocking the value of this project is of great importance to us and we are convinced it will deliver significant value for many years. To demonstrate our commitment we will be funding 53% of the total cost. We will also be covering the first 50% of the construction risk identified, and propose that any contingency funded by the consumer would not be affected until NGET's allocation had been fully used. Furthermore, any unused amount will be returned to the consumer at the end of the project.

Figure 3.1 Project Costs

We believe this represents real value for money and that the cost of this project to consumers is entirely appropriate when balanced against the potential benefits which could be realised; conservatively £360m by 2050.

To make sure the project is delivered at a competitive cost, contracts will be managed through National Grid's estimating hub, procurement and finance departments. All internal labour costs have been prepared under International Financial Reporting Standards and include only costs directly attributable to employing the individual.

3.2.3 Generation of cashable benefits

There are three ways in which cashable benefits are realised:

1. Maintenance allowance (operating costs) outperformance

   GB Network Licensees are given an annual operating expenditure allowance to inspect and maintain their assets so they can deliver a safe and reliable network. If we are able to deliver a safe and reliable network for less than the allowance, the difference is shared between shareholders and consumers, based on a fixed RIIO sharing factor, of 47:53 for NGET in the RIIO-T1 period. On the other hand, if a network licensee spends more than their allowance to achieve the agreed outcome, the overspend is also shared by the same ratio.

2. Capital investment allowance outperformance

   Load related: GB Network Licensees have been given an allowance specifically for load related asset construction (i.e. for the capital costs incurred to accommodate changes in levels and pattern of network loading and changes in the use of the system). This allowance is increased or decreased if the load over the regulatory period diverges from that originally anticipated.

   If the utility delivers the associated outputs for less or more than the revised allowance, then the difference is shared with consumers on the same basis as the maintenance allowance above.

   Non-Load related: GB Network Licensees have also been given a set capital expenditure allowance to ensure they exit the RIIO period with the same risk profile with which they entered the period. If licensees spend less or more than the allowance, the difference will be shared with consumers on the same basis as the maintenance allowance mentioned above.

3. Direct revenue from the commercial hire of the facility to third parties

   Arrangements with third parties (non-network licensees) will be based on arm's-length, fully commercial rates both during and after the NIC period. Revenue made by the facility during the NIC period would be used to repay the consumer contribution.

3.2 Revenue passed on to consumers

The benefits realised by Transmission Owners will flow to consumers through savings to Transmission Network Use of System Charges (TNUoS). In many instances, the technologies or practices will also be, to some degree, applicable to Distribution

Network Operators, who would potentially also realise savings. The various routes through which savings will reach consumers are described in Appendix X.

3.3 Best Value for GB Network Licensees

This facility will be accessible to all network licensees on equal terms. This will be achieved through the development of Terms of Reference for the Technical Advisory Board which reflects this democratisation. During the NIC period, we would charge GB Network Licensees on a fully absorbed cost basis.

3.4 Sustainability and Growth of the Facility

The facility will be used by GB Network Licensees and third parties. To understand the future prospects of the facility we have investigated several routes of income. It is difficult to quantify the impact these sources would have on the benefits case and hence they have not been included. Nevertheless, it is clear from our stakeholder engagement that there is a keen interest from academic institutions and suppliers to use this facility.

3.4.1 Research Results

Over £300 million of taxpayer funds are spent every year on research and development of low carbon technologies through initiatives by the Department of Energy & Climate Change (DECC) and the Department for Business Innovation & Skills (BIS).

We have considered all of the Network Innovation Allowance projects currently underway, as well as some of the research conducted during the previous regulatory period, which was not implemented. Evaluation of 110 projects yielded the following results:

- 76 of 110 (69%) existing electricity transmission innovation projects (taken from the Smarter Networks Portal) would benefit from the existence of the facility, indicating the high level of use that would result from its development.
- The benefits resulting from this project portfolio show positive net present value.
- There are also a number of other benefits. These are described in Section 4.

3.4.2 Technological Opportunity

As part of our stakeholder engagement (described in more detail in Appendix V), we talked to our supply chain to understand the challenges they face commercialising novel technologies for the network licensees. We received a number of letters of support, showing that our suppliers believe this facility will allow new technologies to be implemented into our networks faster, safer and more efficiently, providing benefit to consumers, network owners and suppliers.

3.4.3 Industry Needs

We believe many of the innovations developed at this facility will be driven by business as usual activities. One example is type fault remediation (similar to vehicle recalls), where a fast refurbishment or replacement methodology needs to be developed to reduce network risk.

3.5 Financial Benefits

This project will provide financial savings of over £360m by 2050 as described as part of our Future Prospects Scenario detailed in Appendix X. The direct benefits presented are based on the results of the projects that will be developed, demonstrated and trialled within the facility.

In the worst case scenario where only these projects are delivered during the lifetime of the project, the consumer would break even in 2021. Figure 3.2 below sets out how savings would be realised. This is based on the highly conservative assumption that the facility would only be able to deliver projects equivalent in benefits to those funded by this bid every seven years. It does not include any benefits from the revenue generated through third parties. Furthermore, it assumes the benefits would reduce by 10% every 5 years due to the reduction in scope for efficiencies resulting from previous projects.

You can find more detailed support and analysis for the benefits case, including details of each of the innovation projects in Appendix X.

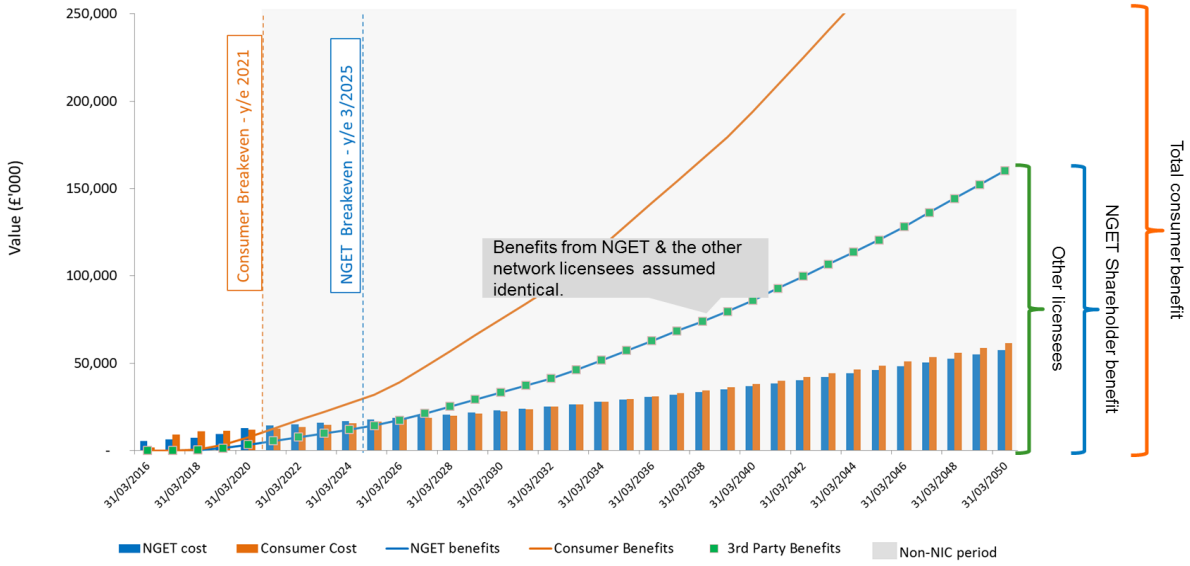

Figure 3.2 Graph of costs/benefits for futures scenario without commercial income

3.6 Summary

This bid delivers a good investment to consumers.

The project tackles the problems created by the rapid changes in the way networks and assets are designed, managed and operated as pressure rises to deliver more affordable, clean and secure electricity.

To be successful, this transformation requires new technologies and practices. The faster these are deployed, the faster the transformation and the quicker the benefits will be realised, allowing for low carbon technologies to be embedded without affecting network security or stability.

The financial benefits are significant and demonstrable, with the most conservative estimate breaking even by 2021 and achieving £360m by 2050.

Section 4: Benefits, timeliness, and partners[3]

A key contributing factor to the financial viability of this project is the unique opportunity presented to us by Deeside 400kV substation no longer being required for electricity transmission. Successful transformation of this site will deliver a unique facility for an affordable investment with a strong benefits case.

In order to maximise its value it is important that it meets the electricity industry's interests at large and the methodology described in this bid achieves this.

Value from this project is not only delivered in financial terms (Section 3) but also in the form of optimisation of projects, reduction in environmental impact and improvements in safety.

The optimisation of these benefits will be achieved through an effective prioritisation process determined by the governance structure for the facility. This governance plays a key role in the project's success.

This section details how these points are achieved.

4.1 Timeliness of this bid

This is a unique opportunity to secure and develop a facility capable of operating at 400kV and above. Entire transmission substations are very rarely decommissioned with only partial sites occasionally becoming available. The Deeside substation was programmed for demolition as part of the Connah's Quay scheme, but this process has been put on hold pending the outcome of this bid.

The estimated costs of building the proposed facility from scratch have been estimated at c£84m. By taking the opportunity afforded at Deeside project completion sits at £26m offering a c£58m advantage.

There is an urgency to start this project now to maximise the value obtained from its output by accelerated implementation.

4.2 Involvement of other partners and external funding

To maximise value generation, it is vital the facility is embraced by the whole electricity industry value chain, from suppliers to network owners. We have therefore taken a number of steps to make potentially interested partners aware of this bid. We also provided various routes for feedback on both the technical and commercial arrangements proposed.

4.2.2 Internal Engagement

Our internal engagement plan has consisted of a development and an information phase.

[3] This section refers to Appendices IV, V, VI

At the development phase, we organised asset-specific workshops. Workshop outputs documented the challenges faced when managing the whole life cycle of each individual asset, from procurement to demolition, whilst maximising value to the consumer. An innovation strategy was developed to deliver optimised Totex performance comprising a set of basic requirements:

- Appropriate safety standards
- No adverse effect on network reliability
- Be environmentally responsible

An off-grid substation environment facilitates the management of these challenges through its capabilities of simulating consumer load and system scenarios without impacting business operation or customers.

Internal engagement also demonstrated the value such a facility would deliver to our business and other network owners and resulted in National Grid agreeing to 53% of the total cost of this project.

The information phase is a continuous process through which we have engaged across the business at all levels.

We are ready to start work as soon as a positive result to this proposal is obtained.

4.2.3 External Engagement

External engagement has followed a similar route to the process described above.

We have had seven bilateral meetings and fifteen teleconferences with external stakeholders and engagement is continuing.

We held two workshops in London and Solihull inviting circa 100 stakeholders from network licensees, suppliers, academia and research institutes across national and international industry. We used these events to collate further views on the facility and make sure the design was an attractive proposition to all.

Active attendance and participation occurred in the ratios detailed in Figure 4.1 below.

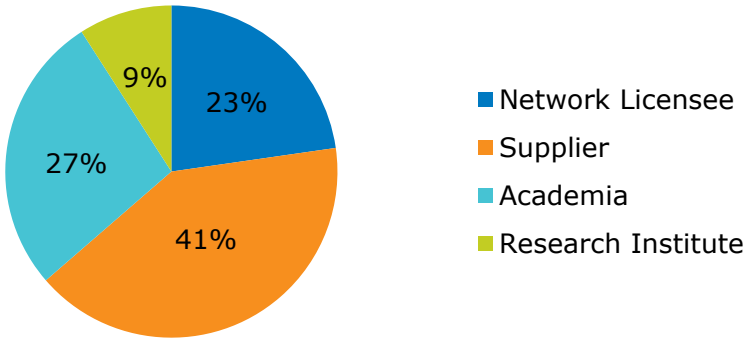

Figure 4.1 Event Attendance

Feedback was sought as part of the workshop and further conversations have continued to take place after the event. Recognising the commercial sensitivities of

some of the companies represented feedback was through an online survey. The feedback received is detailed in Appendix V.

4.2.3 Partners

As part of some of the bilateral meetings, we were approached by a number of stakeholders who expressed a desire to become a financially contributing Project Partner through the provision of assets and/or expertise.

Due to the unique nature of the facility and its intended purpose we have decided that the Project will have no financially contributing Project Partners to ensure the facility's neutrality is never under question and intellectual property is respected and controlled. We believe this is the best way to maximise the value such a facility can generate

Once established, we will seek to understand whether secondments or sponsorship and donation of assets from organisations can be considered to mitigate running costs or extend capabilities, providing no commercial advantage is sought or offered.

We will reinforce the neutrality of the facility through the Technical Advisory Board created as part of the governance process. This Board will be comprised of members from across the industry as well as other key stakeholders. A full detail of the governance is detailed in Appendix XII.

4.3 National Grid Contribution and why NIC funding is required

Whilst there is no 3rd party funding in this bid, National Grid are covering 53% of the total cost of this investment (we understand this to be significantly higher than any other contribution ever made in a NIC bid to date).

With any major project there is always a contingency provision and we propose this is shared between National Grid and the consumer. As part of our commitment to delivering maximum value to the consumer we will spend the National Grid share ahead of the consumer. In this way, the consumer contingency budget will not be drawn upon until all of our reserves for this project have been spent.

Network Innovation Competition funds are essential to cover the remaining costs. We believe sharing this outlay with the consumer is appropriate due to the level of risk and the large costs required to secure and develop this opportunity, mindful of the wider benefits to the consumer.

4.3.1 Risk

A project of this kind has never been attempted before and its development has a level of technical risk which is unacceptable to any individual GB Network Licensee. Apart from the well-known risks associated with the delivery of innovation projects and inherent in the programme of work proposed as part of this proposal, there are also risks associated with the construction of the facility. Whereas National Grid have a long experience of managing both technical and construction works on old industrial sites, the overall combination of risk and the sharing of benefits make a shared contribution essential if this project is to proceed.

4.3.2 Cost

There is no other mechanism presently available to incentivise the investment of resources by GB Network Licensees on a high-cost, high-risk investment project with benefits to an individual Network Licensee not being secured until 2025. Due to the high potential gains a successful outcome can have across the electricity industry to consumers, suppliers and "UK Plc, we believe it is fair that the cost of this proposal be shared. This sharing results in a viable investment for both parties.

4.4 Accelerates the development of a low carbon energy sector

As mentioned at the start of this section, financial revenue is just one benefit of this bid. This bid also supports and accelerates the development of a low carbon energy sector.

At National Grid we are committed to increasing environmental sustainability, supporting the UK's transition to a low-carbon economy and reducing our own carbon footprint.

This project delivers on this commitment in all of its three value creation areas:-

- *Researching and developing new unconventional technologies and practices*
- *Extending the operational life of ageing assets*
- *Accelerating the implementation of innovation*

These are discussed in more detail below:

4.4.1 Researching and developing new unconventional technologies and practices

Managing renewable generation and active demand

Renewable generation, with intermittent output, is being deployed on the network at both transmission and distribution levels. Demand is at the same time becoming a more active part of the system by being more responsive to fluctuations in generation output.

In order to maintain the same level of service to consumers, the electricity networks will need to be sufficiently flexible to cope with this change in quantity, location and intermittency of power generation. Unconventional technologies and techniques have the potential to deliver a more flexible and adaptive system, in turn promoting the diffusion of low carbon technologies.

The OSEAIT facility will enable effects of intermittency on assets and systems to be understood and management solutions explored.

Developing novel insulating and conducting materials to reduce carbon footprint and improve efficiencies

The last decade has seen a surge in the development of new materials including polymers, oils, conductors and gases. All of these disruptive technologies have the potential to enhance the electricity network through improving transmission efficiencies, reducing visual impact and decreasing the carbon footprint of our asset base.

The facility will enable devices using new materials to be evaluated.

4.4.2 Extending the operational life of ageing assets

The work associated with the construction, transportation and installation of high voltage assets is significant and is estimated to have a considerable carbon footprint. This contrasts with the efficiency gains and more environmentally friendly materials which can be found in modern equipment. Quantifying this trade-off and including this information as part of the asset management decision process can only occur if information regarding asset performance and deterioration as it ages is obtained.

The facility will enable a richer understanding our assets and how changes to the electricity network impact their performance throughout their operational life and will allow GB Network Licensees to consider the carbon footprint of the various possible interventions at the time deciding which course to take.

4.4.3 Accelerating the implementation of innovation

Investments in innovation are characterised by uncertainty where a precise probability cannot be placed on failure. Short asset lives are usually assigned to innovative assets as there is no evidence for their whole life performance.

The search for reasonable certainty and understanding of potential risks may lead to long timescales for the deployment of technologies. This in turn increases the length of time for which investment is required and creates further risk aversion for GB Network Licensees and suppliers as a whole. For high capital cost investments, characteristic of the high voltage electricity sector, this is a particular challenge.

As explained in Section 3, new technologies and practices are required in order to address the transformation of the electricity network and allow for the integration of renewable sources and active management of demand.

The facility will enable acceleration the implementation of these innovations into business as usual will result in a faster modernisation of electricity networks capable of coping with more dynamic fluctuations of electricity. In this way, this bid further supports the drive for the decarbonisation of the energy sector and the reduction of its carbon footprint.

4.4.4 Reducing the Carbon Footprint of this Bid

We will maximise the value obtained in this area by considering low carbon methods to deliver the construction work.

We have incorporated a carbon assessment at the construction phase to identify how carbon solutions can be included. Examples of solutions being considered include:

- Low carbon concrete
- Insulation and energy efficient lighting to reduce energy usage
- Use of eco-welfare cabins in the construction site establishment (typically saving 70% on energy bills)
- Use of secondary aggregates

The trade-off to be obtained between cost and environmental impact will be carefully considered in the construction phase to maximise the overall value to the consumer.

4.5 The governance structure of the facility

The facility and its assets form part of National Grid Electricity Transmission's regulated asset base. As such, the overall responsibility and the operational budget will fall under the Director of Electricity Transmission Asset Management.

The facility itself will be the responsibility of the Head of Engineering for Electricity Transmission who will chair the TAB.

The TAB will agree the spend profile of the allocated budget and regularly review the project prioritisation. The TAB will also monitor the progress of the NIC bid at different stages and ensure the deliverables are challenged and reviewed. A large pipeline of projects and their prioritisation are important for the sustainability of this project and its long-lasting success. The initial draft of the terms of reference can be found in Appendix XII.

The TAB will invite participation from all GB Network Licensees, advisors drawn from academia, a representative with Health and Safety qualifications and Ofgem. Consumer interests will be represented through Ofgem or a delegated individual with the required expertise. Appendix XII contains further details on this structure.

4.5.1 Commercial arrangements

In order to ensure a continuous pipeline of projects, the commercial arrangements need to be satisfactory for to all parties. Due to the level of consumer investment, we have divided the commercial arrangements into two groups, those for all network licensees and those for third parties.

a. Commercial arrangements with GB Network Licensees

   During the NIC period, we would charge GB Network Licensees on a fully absorbed cost basis for any NIA/NIC innovation projects they would like to carry out at the facility.

b. Commercial arrangement with third parties

   Arrangements with third parties will be based on arm's-length, fully commercial rates during the NIC period. Revenue made by the facility during the NIC period would be returned to the consumer.

4.5.2 Project prioritisation

The facility will have a pipeline of projects from GB Network Licensees and third parties wanting to access the facility on commercial terms. The overarching process for prioritisation of projects will be officially approved at the first TAB meeting. To support effective prioritisation we propose a methodology which we believe will push the highest value projects to the top. Figure 4.1 below shows a high level flowchart of the process.

Each project proposed will be ranked 1-5 against a set of 7 criteria by each TAB member. The concept of whether each criterion should be weighted differently and the value this would take has not been fully developed.

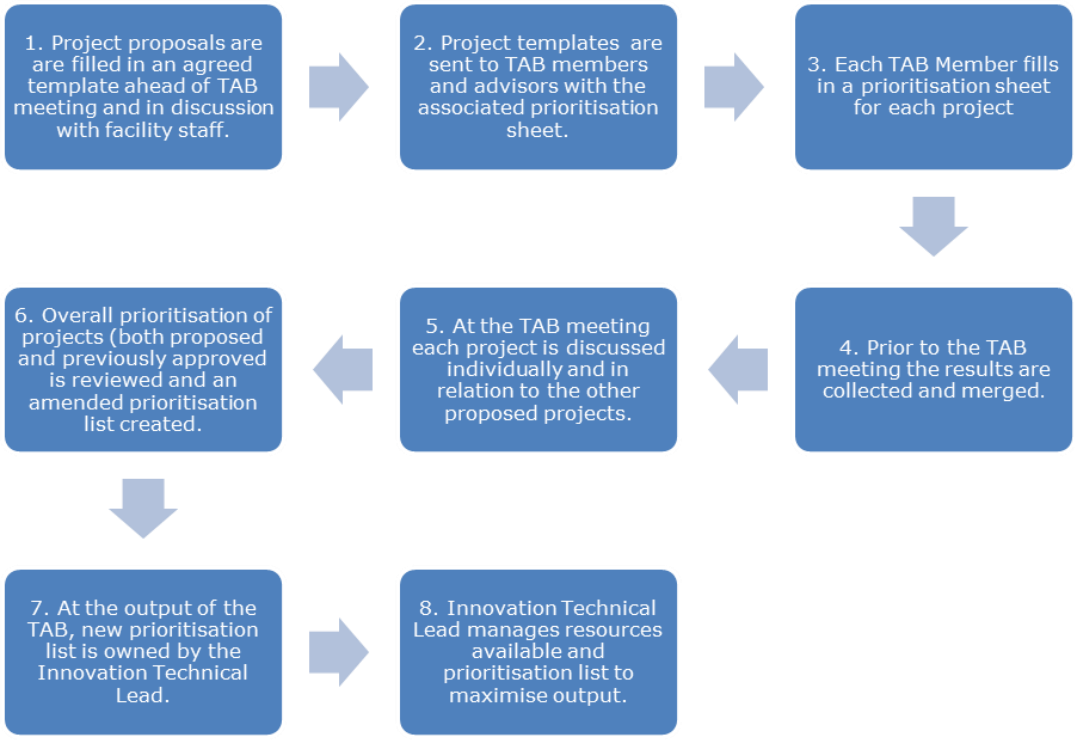

Figure 4.1 Proposed prioritisation flowchart

The suggested evaluation criteria are:

1. Benefits for GB consumers
2. Alignment with GB Network Licensee's strategy
3. Ease of implementation into Business as Usual
4. Length of project / realistic targets
5. Project risks and mitigations
6. Appropriate project budget
7. Capabilities required for delivering the project.

As part of the third point described in the flowchart, each member will complete their own column independently. This information would then be collated and the output sent prior to the TAB meeting.

The ranking of the projects would then be discussed and adjusted during the meeting and a final version created.

4.5 Summary

This project delivers substantial financial, environmental and safety benefits.

We have proposed a governance structure which safeguards the neutrality of the facility for the benefit of the consumers. The value provided to consumers and GB Network Licensees by this project will grow cumulatively throughout the lifetime of the facility and deliver sustainable benefits to the UK.

We are committed to this project, taking advantage of the unique opportunity presented to us with the decommissioning of the Deeside 400kV substation.

We cannot identify a similar set of circumstances arising in the foreseeable future. We recommend this value generation opportunity is embraced in this small window in which it is available.

We are ready to commence the project should this bid be successful.

Section 5: Knowledge dissemination[4]

Knowledge dissemination is a priority for us.

This bid delivers a strong business case through a facility with a governance structure in place that produces an independent programme of work aligned with consumer interests. Each project within this programme will yield useful learning through its delivery and as its output. We must share the knowledge developed and quickly roll it out across the whole of the GB electricity network if we wish to maximise the direct benefits from each project.

Benefits can also be obtained from the dissemination of learning across the whole supply chain and internationally. We have the ambition to be regarded as a world-leading facility where innovations can be understood and evaluated. We want this facility to be known as one which shares its learning and data, where appropriate, to advance the electricity industry as a whole.

This section describes the approach we propose to take in order to deliver this.

5.1 Generation of New Learning

A facility of this kind has never been attempted before and therefore we envisage there will be significant learning developed throughout its design and construction and ongoing use. We expect there will be some unexpected challenges which we will need to overcome. The knowledge arising will be shared with all Technology Advisory Board (TAB) members through appropriate briefing documents as part of the management of the construction phase.

Most of the significant new learning is expected to come from the innovation projects conducted at the facility. Due to the large number of these and the various stages at which they are expected to conclude, it is important to set out a plan detailing how the work will be recorded and learning captured. It is also important to understand who the beneficiaries of this learning will be since they will require different dissemination mechanisms. This will allow the output to be packaged appropriately. For GB Network Licensees, dissemination packages are likely to consist of Best Practice Guides, training material and videos, tools and software code. Requirements will vary for third parties, with the most common requests likely being for data with a document detailing its source and summary reports and videos. The selection of projects is analysed below, highlighting who would benefit from the new learning and therefore who would benefit the most from dissemination and learning.

5.1.1. SF_6 Lean Management and Repair Techniques

This project will review the common practices and develop lasting repair technologies. It will develop new approaches for common leak types such as gas to air bushings and high-pressure leaks that presently cannot be sealed effectively. This new learning is expected to be of most interest to GB Network Licensees with GIS equipment.

[4] This section refers to Appendix VI

5.1.2 Asset thermal model for Remote Operation

This project will deliver a generic, validated mathematical model that can combine load, measurements and forecast temperatures for various scenarios. As such both GB Network Licensees would be the biggest beneficiaries of this work.

5.1.3 Radio Frequency Interference (RFI) Sensitivity and Characterisation

This work will develop new learning through the development of a generic, automated model for the assessment of radio frequency signals and their association to the various degradation mechanisms in assets. The model will be validated against conventional measurements. The resulting model will be of interest to GB Network Licensees whilst the core data recorded will be made available to interested third parties, including suppliers, academia and SMEs looking to develop asset health monitoring equipment and software.

5.1.4 Evaluation of New Conductor Systems

This project will trial the various innovative conductor systems appearing in the market place. It will develop an understanding on how these conductors perform under stressed conditions, and how the environment can potentially impact their performance. It will also trial the jointing systems and all associated fittings for mechanical strength under various patterns. The output of this work will benefit GB Network Licensees' overhead line teams, suppliers and overhead line construction and installation companies.

5.1.5 HV Harmonic Impact on Transformers

This work will increase our understanding on the effects of harmonics (such as eddy currents, heating and losses) on supergrid transformers. With this knowledge, it will develop evaluation and mitigation techniques to extend the operational life of these assets. The output of this work will be of interest to GB Network Licensees and transformer manufactures.

5.1.6 Backfilling of Current GIS with Alternative Gases

The successful outcome of this work will result in suitable alternatives for SF_6 in legacy assets. It will provide asset management techniques for these new gases and well as the appropriate gas handling tools. A report detailing the analysis of how the insulation of these gases compares with SF_6 under various stress conditions would also be generated. As a whole, this work would be of main interest to GB Network Licensees and the suppliers of insulating gases.

5.2 General Knowledge Dissemination Approach

National Grid actively participates in industry forums such as CIGRE, IEEE, IEC and EPRI, which we have used in the past to gather ideas and disseminate our knowledge. We shall continue to use such forums for on-going discussions as well as informing our stakeholders on the progress of the facility.

In addition to these ongoing forums, the TAB, which contains industry and stakeholder representation, will monitor progress and ensure the outputs are challenged and reviewed. The TAB will hold regular meetings with a maximum of three months

between meetings. This will ensure continuous knowledge sharing to accelerate technologies and roll-out. As part of this, we will set up a secure knowledge-sharing hub for continuous sharing of ideas and knowledge as well as project outputs. This, alongside the training material and hands-on workshops will maximise the chances of fast implementation and increase value to the consumer.

This hub will be part of an online portal enabling the sharing of data, simulations and results of the work with a wide range of stakeholders with various access rights. By sharing the learnings in this way we will provide timely dissemination in one location to enable stakeholders to easily roll out the knowledge.

The facility itself will also assist significantly in disseminations. We will carry out intensive "hands-on" training and workshops to all interested parties and stakeholders.

As can be seen by the letters of support, there will be significant academic interest in the facility both as a trialling ground for their work and as a source of data to support their research. In both of these instances, the academic institutions will use traditional academic channels such as conferences, industry events and journal publications, to disseminate their work.

We can summarise the dissemination plan in the six categories described below.

5.2.1 National Engagement and Roadshows

This consists on dissemination of activities held at the facility itself or at national venues to provide updates with respect to the bid and summarise any significant learnings. We intend to run several of these events a year. We also intend to publish articles and successes in national media including the IET Magazine.

5.2.2 Specialised Training Courses and Videos

Where relevant to the project outcomes, we will hold specialised training course. These courses will occur towards the end of the work. They will be directed towards the relevant organisations staff and aim to focus on the practical outputs of the work. The objective is to accelerate the roll-out across the UK. As such training material and guidelines for implementation of the learning will be provided as well as videos demonstrating the work performed and the use or implementation of the output in question.

5.2.3 International Engagement

As part of our activities we collaborate with electricity network owners/operators and industry partners across the globe. We actively participate and hold senior positions in the Institute for Electrical and Electronic Engineers (IEEE) and CIGRE working groups and task forces. For each project we aim to publish conference papers and journal publications to ensure engagement at an international level.

5.2.4 New policies and standards

National Grid has always been at the forefront of new policy creation and has aimed to be involved in the development of new standards. This bid aligns itself with this ethos. The output for this work will feed into the work we perform in CIGRE, the IEC and IEEE and will be used to inform industry, policy makers and consumers alike.

5.2.5 Digital Media Activity

Digital media is a growing trend which cannot be ignored as part of a successful dissemination strategy. Where appropriate, we will use Twitter, LinkedIn, Facebook, YouTube and our website to continuously engage with our stakeholders and deliver news items.

5.2.6 Final Results

We will hold a close down workshop at the end of this work to deliver the final lessons learnt and Close Down Report. .

5.3 Intellectual Property Rights (IPR)

The project will comply fully with the default IPR arrangements for parts of the project which have been fully funded by the NIC.

Owning to the unique nature of the facility, and the various different approaches to the financing of projects, there will be various commercial arrangements put in place. Where NIC and NIA financing funds part of the project, the default IPR arrangements will apply. Several other scenarios for usage of the facility, both during and after the NIC period, have been considered and are summarised below.

5.3.1 The project is funded by the NIC

Example scenario	
NGET create a product, which is tested at the facility funded by the NIC. In this instance, the default NIC IPR arrangements would be in place, and all relevant licensing and royalty arrangements would apply. Where any royalties are earned from the project, these would be shared with customers in the proportion to the funds that have been contributed to the facility.	
During NIC Period	The default NIC IPR, licensing and royalties arrangements applies
Post NIC Period	This option cannot occur.

5.3.2 A network licensee driven project which is funded/part-funded by the NIA

Example scenario	
A network licensee undertakes a project that is funded by the NIA. The licensee utilises the facility that has been funded by the NIC, but pays full running rates for the use of the facility. In this instance, the default NIA arrangements would apply, however, the NIC arrangements would not.	
During NIC Period	The default NIA IPR will apply. In the case where NGET is involved, NGET's NIA arrangements will be used.
Post NIC Period	The default NIA arrangements will apply.

5.3.3 Network licensee driven project is not funded by the NIA

Example scenarios	
1. A supplier provides equipment (no charge) for NGET to test for the purposes of building confidence. In this instance, the IPR arrangements will have been agreed between NGET and the supplier, and therefore, will be subject to that agreement. 2. An academic institution undertaking research on behalf of NGET which has not been funded via the NIA but which utilises the facility as part of the research. In this instance, any IPR generated from the research will be subject to the agreement between the academic institution and NGET.	
During NIC Period	Default NIC IPR arrangements will not apply.
Post NIC Period	Default NIC IPR arrangements will not apply.

5.3.4 Third party project is not funded by the NIA or NIC

Example scenario	
A supplier undertakes a project which they fund entirely. The supplier utilises the facility that has been funded by the NIC, but pays full commercial rates for the use of the facility. In this instance, the IPR arrangements would be covered by the commercial terms set out in a contract that has been agreed between the parties involved.	
During NIC Period	NIC IPR arrangements will not apply.
Post NIC Period	NIC IPR arrangements will not apply.

5.4 Summary

We have designed a dissemination plan with an overall objective of maximising the value to consumers by delivering cashable benefits through all GB Network Licensees and other stakeholders as efficiently as possible.

We believe this is best done by an individualised approach to dissemination depending upon the project's requirements.

A good communications strategy is also vital to the long-term viability of the facility proposed. Our plan will communicate at both national and international levels to reach as broad a market as possible.

Section 6: Project Readiness[5]

We have used our experience of delivering large capital projects and technological world-first projects to develop a robust project plan that will maximise value to consumers. We have been optimising this plan and the associated costs throughout this process. In order to ensure focus on the prize is never lost, we have developed a set of successful delivery success criteria focused on delivering value to the consumer.

The project plan we have created maximises the potential for success whilst delivering value to consumers at all stages of the project.

The associated risks have been evaluated as part of our internal governance, we have mobilised all the support and management structure required to start this work as soon as funding gets awarded. The National Grid financial contribution to this project has already been sanctioned through our internal governance. We are ready to commence this project as soon as funding gets awarded.

With this in mind, this section explains our plan to deliver this project successfully.

6.1 Requested level of protection required against cost over-runs

The requested level of protection against cost over-runs is of 5%.

6.2 Requested level of protection against unrealised direct benefits

The requested level of protection against unrealised direct benefits is of 50%.

6.3 Delivering this work through robust planning

Our planning for successful project delivery has focused on three areas; costs, execution and measurement criteria.

6.3.1 Cost Estimation and Minimising Overuns

There are three major cost areas in this project, labour ([redacted]), equipment ([redacted]) and construction ([redacted]). We have reduced these costs as much as possible from our Initial Screening Process proposal without increasing the risk of delivery.

For the labour elements of this project we have used our fully absorbed costs. These rates have been developed under the International Financial Reporting Standards (IFRS), global standards and are benchmarked against present industry figures.

Equipment cost estimates have been obtained through our standard procurement process, eliciting quotes through conversations with manufacturers and engaging with some of our partners.

Construction costs have been formulated by our specialised Construction Estimating Hub Team. As part of our Network Development Process, this Team uses three sources of information to develop an estimate [redacted]. These are:

[5] This section refers to Appendices V, VI, VII, IX, XII

1. [redacted]
2. [redacted]
3. [redacted]

Minimising cost overuns

Our experience of delivering complex, high-value projects like these allow us to be confident that we can deliver value to consumers through this project within the budget requested.

In order to minimise cost overruns these will be tightly tracked as part of our project management activities.

The highest risks are in the *construction phase* and we have introduced a 20% risk fund for this work. The amount of this fund is divided on equal terms between the consumer and National Grid. We have committed to spending our share first and to notify Ofgem should we require access to the consumer funded share.

The risk fund will be tracked separately against each job providing the granularity required to monitor progress against cost for individual tasks. If this fund is spent faster than anticipated, the reporting at the Technical Advisory Board (TAB) will determine options for de-scoping the work before project overspends occurs.

In order to minimise the possibility of this occurring, the construction works will follow our Network Development Process Framework and the works will be tendered out through our standard process once a detailed design phase has been completed. Based on the output, we will place strict commercial arrangements in place to ensure best value is obtained.

Cost overruns for *equipment* can arise due to lack of correct product specification at the time of requesting quotes or incorrect budgeting for any modification or adaptation required. In order to minimise this we have started a supplier engagement programme through both our procurement and stakeholder management teams. We will follow our standard competitive procurement practices and include additional maintenance support and enhanced warranties if necessary.

Resourcing and labour will be closely monitored. The range of staff levels involved in this project will guarantee the right person for the right job. Due to the uncertainties surrounding innovation, it might be the case that some of the innovation projects associated with this work require more time than anticipated.

The labour resource funded by this project has spare capacity to deliver projects beyond those proposed by the innovation programme. This headroom eliminates the risk of not being able to deliver the work presented here within the allocated budget. If this capacity remains available, the project will be able to deliver further GB Network Licensee projects or used for commercial services. The prioritisation of this work and resources will be managed through the TAB.

6.3.2 Project Execution, Review and Suspension

Robust project planning is a vital part of delivering a complex project such as this one. We are confident that our estimate of costs is accurate and our benefits analysis is conservative. The uniqueness of this work, introduces other risks apart from financial and it is advantageous to evaluate them before the start. In order to manage these, we have developed a comprehensive risk register with associated control measures. These risks have been categorised and included in Appendix IX.

Progress to each stage will be managed by a gated process described in detail as part of the project plan in Appendix VII. At each gate, the success of the stage and the feasibility and risks associated with continuing the work will be studied. The TAB will act as the gatekeeper.

These reviews will form part of a standard agenda within the TAB meetings, which will also incorporate a finance review and progress updates for the construction works and each individual innovation project.

Any request to modify the project or suspend it will be made to Ofgem as soon as it is practical.

6.3.3 Measurement Criteria and Shortfalls in Direct Benefits

We have developed a set of delivery success criteria for each stage of the gated process with the project and consumer in mind. The details of these can be found in Section 9. We will use these criteria to monitor progress against time, resource and budget to allow tracking of the value delivered against the projected benefits.

We have taken a very cautious approach to the calculation of benefits. A detailed analysis of the benefits and business case can be found in Section 3 and Appendix X. We have not considered any benefits arising from the commercial hire of the facility by third parties. Whist our supply chain has already been sending requests for access, these benefits are difficult to quantify and the associated error would yield an estimate with low confidence levels.

We have therefore analysed the individual projects proposed within the innovation programme from a financial and carbon footprint perspective. For those projects where these values are difficult to quantify, we have noted the existence of benefits but have not provided a figure for them.

We have then looked at two different scenarios, a Base Case in which the facility only exists for the duration of the NIC bid and a Future Prospects Case which assumes projects continue to happen at the same rate all the way to 2050. In both of these cases we have assumed a 30% utilisation of the facility, which is conservative.

Even in the worst-case scenario, this project has a strong business case in which the consumer breaks even by 2021.

6.4 Project Plan

This project is due to commence in January 2016. The project plan has six gates where the project will be assessed to ensure the project benefits are fully exploited and project risks understood, mitigated and controlled. These will align with financial year end to allow the control of budgets and measurement of performance. A summary of the plan for each financial year is presented on tabular form on the following sections.

In order to help envisage the proposed works, Figure 6.1 below shows a schematic diagram with an overlay of the construction works in the stages as detailed in Section 2.

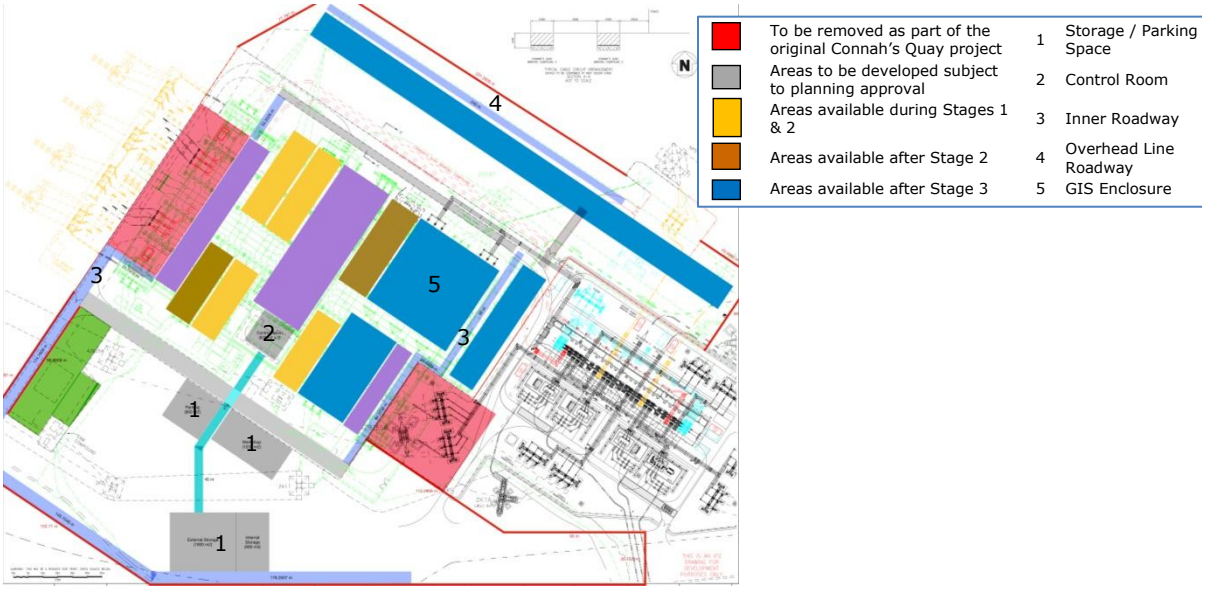

Figure 6.1 Schematic diagram of the development of the Deeside 400kV Facility

6.4.1 Financial Year 15/16

Tasks	Resources Required
<u>Facility Programme</u> • Recruitment Plan • Detailed Phased Designs • Planning Application • Site Investigation • Earthing Studies • Safety Procedures / Rules / Interlocking • Set up Technical Advisory Board <u>Innovation Programme</u> • Develop innovation programme for Phase 1	• NIC Project Manager • NG Support Staff • Contractors **Outputs** • First vacancies advertised • First meeting (kick-off) of the Technical Advisory Board held
Successful Delivery Reward Criteria	
• Terms of Reference Signed	

6.4.2 Financial Year 16/17

Tasks	Resources Required
Facility Programme • Purchase Equipment to deliver Phase 1 Innovation programme • Recruitment of Staff • Detailed Phased Designs • Planning Permission • Site Investigation • Earthing Studies • Safety Procedures / Rules / Interlocking • Commence Construction (areas 1 & 2) Innovation Programme • Develop detailed scope of for Phase 1 Innovation Programme • Deliver Phase 1 of Innovation Programme • Develop detailed scope of for Phase 2 Innovation Programme	• NIC Project Manager • Facility Staff • Support Staff • Contractors **Outputs** • Detailed planning application submitted • Phased build-out designs produced • Site investigation report completed • Report on earthing studies completed • Detailed planning application submitted • Site rules and safety procedures progressed • Detailed scope of work for Phase 1 Innovation programme • Commencement of Phase 1 Innovation Programme
Successful Delivery Reward Criteria	
• Approval and commencement of Phase 1 Innovation Programme and staffing • Detailed designs approved • Internet site launched	

6.4.3 Financial Year 17/18

Tasks	Resources Required
Facility Programme • Purchase of equipment to deliver Phase 2 Innovation programme • Construction of infrastructure (area 3 & 4) • Recruitment of Staff Innovation Program • Continued development of detailed scope for Phase 2 • Deliver Phase 1 Programme	• NIC Project Manager • Support staff (NG) • Facility staff • Contractor • Construction Staff **Outputs** • Infrastructure handed over for use • Detailed scope of work for Phase 2 Innovation programme Site rules and safety procedures finalised
Successful Delivery Reward Criteria	
• Approval of Phase 2 Innovation Programme and staffing • Complete Phase 1 Innovation Programme • Completion of Stage 1 construction	

6.4.4 Financial Year 18/19

Tasks	Resources Required
Facility Programme • Construction of infrastructure (areas 5) Innovation Programme • Deliver Phase 2 Innovation Programme • Develop detailed scope for Phase 3	• NIC Project Manager • Support staff • Facility staff • Construction Staff **Outputs** • Infrastructure handed over for use • Detailed scope of work for Phase 3 Innovation programme
Successful Delivery Reward Criteria	
• Delivery of Phase 2 Innovation Programme • Completion of Stage 2 construction • Approval of Phase 3 Innovation Programme and staffing	

6.4.5 Financial Year 19/20

Tasks	Resources Required
Facility Programme • Purchase of equipment to deliver Phase 3 Innovation programme Innovation Programme • Deliver Phase 3 Innovation Programme	• NIC Project Manager • Support staff • Facility staff **Outputs** • Facility Complete
Successful Delivery Reward Criteria	
• Completion of Stage 3 construction	

6.4.6 Financial Year 20/21

Tasks	Resources Required
Facility Programme • Develop detailed scope for Post NIC Programme Innovation Programme • Continued delivery of Phase 3 programme • Develop detailed scope of for Post NIC enduring programme	• NIC Project Manager • Support staff (NG) • Facility staff **Outputs** • Detailed scope of work for Post NIC enduring programme • Close-down meeting and closure report
Successful Delivery Reward Criteria	
• Complete Phase 3 Innovation Programme • Project Close and Closure Report	

6.5 Quality Control and Information Verification Approach

All information included within this proposal has undergone screening and review from both internal and external stakeholders. The internal screening and review process has included approval by affected stakeholders and the senior management team. In developing the proposal, including the purpose and technical capability of the facility, feedback was sought and incorporated from external stakeholders with whom workshops were held, a summary of which can be found in Section 4 and Appendix V.

6.6 Project Readiness

This project is ready to commence as soon as funding gets awarded. In preparation for its delivery, the project has already gone through Gates A0-B as defined in our company's governance procedures (details of which can be found in Appendix XII) and the construction programme is presently on hold awaiting outcome of this bid.

National Grid's funding contribution and resources have also been approved at the Electricity Transmission Investment Committee chaired by our UK Finance Director. This required support from across the business. The Head of Engineering will oversee its delivery and will chair the Technology Advisory Board (TAB). Further details on the project governance structure and terms of reference of the TAB can be found in Appendix XII.

This sanction and high level of investment, demonstrates our strong commitment for the successful delivery of this work.

6.6.1 Support Functions

There has been active participation of resources from finance, procurement, legal and human resources as part of this bid development. Their availability for the duration of this project has been agreed.

6.6.2 Project Delivery

As part of our commitment as a fair employer, the delivery roles directly created as part of this project will need to be advertised. The specifications, pay levels and job descriptions have been approved and are ready to be advertised. In the interim, resource will be seconded to this work.

As mentioned above, the construction work will follow our standard Network Development Process. As such an Investment Delivery Engineer has been assigned to this work.

We are fully prepared to start this project on schedule.

6.7 Summary

We have developed a robust plan with clear deliverables and measurement criteria placing us on a strong path to success. All work at Deeside 400kV has been placed on hold awaiting the outcome of this bid. This plan and the strong business commitment from across the whole organisation and at all the various levels places us allows us to commence the work diligently as soon as funds get approved.

Section 7: Regulatory issues[6]

In order to maximise value to the consumer, with Ofgem's agreement, we propose that revenues earned through the facility (after costs) would be returned to consumers for the duration of the project.

The Funding Return Mechanism in Part C of Licence Condition 3I appears to provide an appropriate type of mechanism, albeit that revenue earned by the facility will not be in the form of royalties from intellectual property. Licence Condition 3I.13 states,

> *"Returned Royalty Income is revenue earned from intellectual property generated through Eligible NIC Projects (whether undertaken by the licensee or any other electricity Transmission Licensee or Electricity Distribution Licensee), less Directly Attributable Costs, and that is payable to customers under the NIC Funding Mechanism, as calculated in accordance with the provisions of the NIC Governance Document."*

A suitable amendment to this licence condition could extend the provisions of 3I.13 to provide for return of revenue from this facility. Alternatively, Ofgem may consider that a less formal approach could be adopted (ie. without a licence change) and simply recorded via an exchange of letters. We would be comfortable with either approach.

After the project concludes, and to be consistent with other deminimis activity, we envisage such revenues would be treated as Excluded Services revenue.

For the duration of the Network Innovation Competition (NIC) project, we expect the facility will be used to deliver the associated innovation programme as well as other similar work for GB Network Licensees, suppliers and academic institutions. This is substantiated by the letters of support in Appendix VI.

Ahead of the completion date of the project the Technical Advisory Board will consider the options available and determine the future continued use of the facility.

7.2 Treatment of charges and revenues

The facility will be the only facility of its kind in the world. It is conceived to enable its users to undertake tests and trials that would be more expensive and incur higher risks to do on the live transmission network and cannot be performed at other laboratories.

To deliver the greatest benefit to consumers, when the facility is not otherwise required for the purposes of undertaking the Innovation Programme related to this NIC bid, the facility will be made available to others.

Table 7.1 below shows how we proposed to charge the different parties and how revenues will be treated.

[6] This section refers to Appendix VI

	National Grid Electricity Transmission		Network Licensees		Non-network Licensee
NIA/NIC project?	NIC/NIA	Non-NIC/NIA	NIC/NIA	Non-NIC/NIA	
Permitted Purpose?	✓	✓	✓	×	×
Charging basis for use of facility?	N/A for NIC facility projects[7]. Fully absorbed of others.	Fully absorbed	Fully absorbed	Arms-length business, normal commercial terms.	Arms-length business, normal commercial terms.
Deminimis activity?	×	×	×	✓	✓
Revenue treatment?	N/A‡	N/A*	N/A‡	During NIC project[8] 100% of revenue after costs returned to consumer via Return of Royalty Income see LC 3I.13	During NIC project[9] 100% of revenue after costs returned to consumer via Return of Royalty Income see LC 3I.13

We are of the view that it would not be in customers' interests for GB Network Licensees wishing to use the facility for the purposes of undertaking other approved NIC or NIA supported projects to be required to enter into agreements to access the facility on a commercial basis. We propose to charge on the basis of covering our fully absorbed costs only as these are deemed to fall within the remit of Permitted Purpose.

We believe the use of the facility by GB Network Licensees in relation to an NIC/NIA project will be consistent with the permitted purpose because, through the sharing of the knowledge gained, our transmission business may be able to improve the way in which it maintains, operates or develops its network and this will ultimately benefit consumers.

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‡ The project receives funding via NIC/NIA, NGET charges at cost (i.e. fully absorbed costs) so no net revenue
*the project is funded by the licensee, NGET charges at cost so no net revenue
[7] These are projects included in the NIC funding request and part of the initial use of the facility and as a result if funding for the NIC project is granted then these projects will not require additional funding.
[8] After the end of the NIC project, treated as Excluded Services revenue (ES5 category) or as determined by Ofgem as part of RIIO-T2.
[9] After the end of the NIC project, treated as Excluded Services revenue (ES5 category) or as determined by Ofgem as part of RIIO-T2.

Section 8: Customer Impact[10]

This work will not impact security of supplier to consumers. Generation customers have been informed of this project and would not be commercially impacted.

This section describes this in more detail.

8.1 Impact on Existing Generation Customers

In 2009, National Grid identified a number of strategic reinforcements of the Electricity Transmission System to accommodate anticipated new generation, including new nuclear and wind. This was in support of the UK government's 2020 renewable energy targets and to facilitate the reduction in the carbon footprint within the energy sector.

As part of these strategic works it was decided that the Deeside 400kV air insulated substation would be rebuilt at a higher rated 400kV 5000A gas insulated substation, which would be known as Connah's Quay 400kV substation.

Generation customers still connected at the existing Deeside 400kV substation include:

- E.On Connah's Quay power station (1380MW)
- EirGrid (530MW) HVDC Link

These generation customers have agreed to have their connections relocated as part of the decommissioning process at Deeside 400kV substation, and as a consequence these connections will be relocated to Connah's Quay 400kV substation as part of the rebuild project plan. This relocation will complete during the financial year 2017-18.

Due to the phased approach of this project there will be no direct impact on these generation customers. Once the relocation has been completed the two substations will be neighbours.

8.2 Impact on other Transmission or Distribution Customers

The proposed facility, will not be directly feeding to either; the National Electricity Transmission System (NETS), or any of the distribution networks. Integral to its conceptualisation and design is that there will be no risk of interruption, power quality issues or loss of supply to customers.

8.3 Impact to Customers in the proximity of the facility

One of the intentions of the facility is that it will provide the ability to test equipment to determine its point of failure. A possible effect of this is that upon failure a noise may be emitted. In respect of the location of the Deeside substation, it is approximately 250m from the nearest residential area and surrounded by a power

[10] There are no appendices associated with this section

station, the newly built Connah's Quay substation, the River Dee and the A548 and a trainline. Due to the industrial nature of the location, any disruption of the facility to any customer will be negligible. Figure 8.1 below shows an aerial view of Deeside and the surrounding area. In addition, the facility will be built using ballistic screens in order to mitigate any noise and ensure a safe environment.

The scheme to transfer the Deeside substation circuits to the new Connah's Quay substation is also underway, and will be completed by June 2018. Circuits will be transferred in a phased approach to ensure customer and network impacts are minimised. To balance the desire to deliver value early while managing the operational need, we will follow a phased construction and innovation approach based around this decommissioning programme.

Refurbishing this substation into an innovation facility hence poses no sustainable negative impact on local residents. Deeside is also located 400m from Deeside College, or Coleg Cambria so there is the opportunity to develop appropriate local linkages.

Figure 8.1 Aerial photograph of Deeside 400kV Substation

8.1 Summary

This project has been built to deliver best value to consumers. As for any project of this magnitude and complexity, it is important to minimise the impact to consumers.

This substation has been in operation for over forty years. This project will extend its life by converting it to an innovation facility. We will do this whilst managing and involving all our stakeholders and minimise the negative impact any work has on them.

Section 9: Successful Delivery Reward Criteria (SDRCs)[11]

In order to measure the success of the project, criteria are developed against which we can measure our performance. The following two tables describe these criteria. Their completion is a key deliverable and indicator of the project's overall success. Progress against these criteria will be monitored and reported on throughout the project's lifespan.

The first table details the criteria for the facility. These are defined project deliverables.

The second table looks at the success criteria of the innovation programme. The projects, detailed of which can be found in Appendix 10, have been divided into eight types and a criterion has been set for each. There are three delivery dates set, each to align with the Technology Advisory Board to be held at the end of each financial year:

1. Phase 1 project outputs will be delivered by March 2018.
2. Phase 2 project outputs will be delivered by March 2020.
3. Phase 3 project outputs will be delivered by October 2020.

Table 9.1. Successful Delivery Reward Criteria associated with the Facility

Ref	Criteria	Description	Evidence	Delivered by
9.1	Formal agreement on Terms of Reference with Technical Advisory Board members	In order to achieve the efficiency required to meet the projects objectives it is essential that the other Transmission Licensees fully engage in the Technical Advisory Board. An early indication that this project will succeed will be in this Board agreeing the Terms of Reference.	Signed Terms of Reference for the Technical Advisory Board in place by end of March 2016.	March 2016
9.2	Detailed design of the facility completed and approved	The completion of both the infrastructure and technical layout designs are an important milestone on the way to delivery of the overall project as they will determine the level of testing / evaluation that can be carried out and at which stage.	Detailed designs for all stages of construction and technical availability signed off by the Technical Advisory Board by end of July 2016.	July 2016
9.3	Design, develop and publish internet site	One of the fundamental knowledge and dissemination channels for the project is the utilisation of the facility website, which will provide a secure area to share the outputs with the other Transmission Licensees.	Successful creation and launch of the facility website by July 2016.	July 2016

[11] There are no appendices associated with this section.

Table 9.1. Successful Delivery Reward Criteria associated with the Facility

Ref	Criteria	Description	Evidence	Delivered by
9.4	Scope of work for the phase 1 innovation programme Approved	With there being a phased handover of assets it is essential to the project's success that a detailed plan be put in place, based on the assets available during this phase. This plan will also include any relevant Network Innovation Allowance (NIA) projects which are able to be undertaken at this time.	Agreement and approval of the phase 1 innovation programme by the Technical Advisory Board.	December 2016
9.5	Completion of stage 1 construction works	The completion of the construction of the buildings and the transfer of the protection and control panels to the new control room are a key milestone to the effective functioning and monitoring of the facility, as is securing the perimeter of the overhead line enclosure.	Successful approval and hand-over by NGET's Construction Team.	June 2017
9.6	Scope of work for the phase 2 innovation programme approved	The continuation of the phased handover of assets is essential to the project's success and a detailed plan is to be put in place, based on the assets available during this phase. This plan will also include any relevant NIA projects which are able to be undertaken at this time.	Agreement and approval of the phase 2 Innovation Programme by the Technical Advisory Board.	March 2018
9.7	Completion of stage 2 construction works	The completion of the construction of the internal access road is a key milestone to the effective functioning of the facility, as this will enable the necessary vehicles to be able to access all areas of the facility.	Successful approval and hand-over by NGET's Construction Team	May 2018
9.8	Scope of work for the phase 3 innovation programme approved	The continuation of the phased handover of assets is essential to the project's success and that a detailed plan is put in place, based on the assets available during this phase. This plan will also include any relevant NIA projects which are able to be undertaken at this time.	Agreement and approval of the phase 3 innovation programme by the Technical Advisory Board.	March 2019
9.9	Commencement of phase 3 innovation programme	The delivery of the innovation programme testing / evaluation is a key milestone within the project and the ability to commence operations at the facility is fundamental to the measurement of its success.	Appropriate dissemination and reporting on each of the projects uploaded to the facility website and published within the relevant journals / articles.	April 2019

Table 9.1. Successful Delivery Reward Criteria associated with the Facility

Ref	Criteria	Description	Evidence	Delivered by
9.10	Completion of stage 3 construction works	The completion of the construction of the Gas Insulated Switchgear enclosure is a key milestone to the effective functioning of the facility, as this will enable the delivery of GIS and SF_6 testing / evaluation projects.	Successful approval and hand-over by NGET's Construction Team.	May 2019
9.11	Approval of model for enduring facility.	The Technical Advisory Board will determine, based on the flow of projects, the future of the facility.	All required arrangements put in place, dependant on the findings of the Technical Advisory Board, of the future of the facility. These arrangements are to be fully documented.	October 2020
9.12	Project Close Down	All project learning will be consolidated and disseminated appropriately.	Close-down workshop. Closure report and the report submitted to Ofgem.	October 2020

Table 9.2. Successful Delivery Reward Criteria associated with the Innovation Programme

Ref	Criteria	Description	Evidence
Project 1-6	Successful application of new policy.	In order to utilise the condition monitoring and degradation curve research, it must be translated into a practically deployable policy which governs asset management decision making.	Sample of relevant investments tested to establish whether the replaced asset life had been extended by the policy.
	Successful knowledge dissemination	This will vary depending on the project and will be defined at project approval stage.	Workshops, training courses dissemination material.
Project 7	SF_6 Leakage is reduced	The research of better SF_6 management should be applied in the field to reduce maintenance cost and SF6 purchase cost.	SF_6 expenditure reviewed to ensure reduction (after adjusting for asset volume changed). Volume of work orders raised for SF6 top up to be checked annually.
	Successful knowledge dissemination	This will vary depending on the project and will be defined at project approval stage.	Workshops, training courses dissemination material.
Project 8	Reduction in false call outs.	By better interpreting thermal data, unnecessary call outs will be avoided, reducing cost	Number of false call outs will be tracked.
	Successful knowledge dissemination	This will vary depending on the project and will be defined at project approval stage.	Workshops, training courses dissemination material.
Project 9	Avoided increase in false call outs	As RFI surveys get rolled out cost increase would be incurred due to false call outs. By better interpreting RFI data, unnecessary call outs will be avoided, reducing cost increase.	The size and cost of the team carrying out the investigations will be monitored to ensure it does not expand.
	Successful knowledge dissemination	This will vary depending on the project and will be defined at project approval stage.	Workshops, training courses dissemination material.

Table 9.2. Successful Delivery Reward Criteria associated with the Innovation Programme

Ref	Criteria	Description	Evidence
Project 10	Ability to review asset layout and condition. Successful knowledge dissemination	Better re-use of civil assets and improved construction delivery efficiency. This will vary depending on the project and will be defined at project approval stage.	Project requires further development to establish possible tracking mechanism. Workshops, training courses dissemination material.
Project 11	Successful application of new policy Successful knowledge dissemination	In order to utilise the degradation curve research, it must be translated into a practically deployable policy which governs asset management decision making. This will vary depending on the project and will be defined at project approval stage.	Sample of relevant investments tested to establish whether the replaced asset life had been extended by the policy. Workshops, training courses dissemination material.
Project 12	Mitigation methodology rolled out. Successful knowledge dissemination	The understanding of the causes of noise will allow the development and application of noise mitigation technology. This will vary depending on the project and will be defined at project approval stage.	The number of investments replacing recently installed conductors due to noise complaints will be tracked. Workshops, training courses dissemination material.
Project 13	Successful application of new policy Successful knowledge dissemination	The better design should be translated into a new policy applied to new substation builds and some system refurbishments. This will vary depending on the project and will be defined at project approval stage.	A sample of like for like secondary systems will be reviewed to establish what cost reduction has been achieved. Workshops, training courses dissemination material.
Project 14	Successful application of new policy & technology. Successful knowledge dissemination.	The policy determining the use of gasses should be updated to reflect the new options. This will vary depending on the project and will be defined at project approval stage.	Sample of GIS tested to establish whether new gasses are being used. Workshops, training courses dissemination material.

Section 10: List of Appendices

Appendix I	**Benefits Table –** Summary tables outlining the financial and carbon benefits the project is expected to deliver.
Appendix II	**Location Selection Study –** Outlines how and why Deeside Substation was selected for the project.
Appendix III	**Conceptual Design and Trials -** Provides a technical description of the conceptual design of the facility and the studies which will be carried out at the facility including the use cases that will be addressed and example projects.
Appendix IV	**Alternative Facilities –** Capability comparison of other available testing sites.
Appendix V	**Stakeholder Engagement -** Describes the roles of the stakeholder groups and how they will be involved with the facility.
Appendix VI	**Letters of Support –** Letters from Network Licensees, Research Institutes, Suppliers and Academic Institutes detailing the advantages of the facility for themselves and the wider energy industry.
Appendix VII	**Project Plan -** Outlines the timescales, milestones and outputs of the project.
Appendix VIII	**Finance Commentary and Resourcing Plan -** further information regarding the assumptions made in preparing the project financial forecasts.
Appendix IX	**Risk Register and Contingency Plan -** Describes the risks identified as part of the project, along with the impact, likelihood and necessary mitigating actions.
Appendix X	**Business Case –** Supplementary information to Section 3.
Appendix XI	**List of Figures and Tables –** Provides the list of figures and tables included within the submission.
Appendix XII	**Governance Framework –** Explains the governance arrangements including the role of the Technical Advisory Board.

Appendix I – Benefits Table

Table A: Financial benefit

Financial benefit (£m)								
Scale	**Method**	**Method Cost**	**Base Case Cost**	**Benefit**			**Notes**	**Cross-references**
				2020	**2030**	**2050**		
Post-trial solution *(individual deployment)*	Base (Projects Funded by the NIC project)			7.2	51.9	136.3	These numbers represent the total benefits from the innovation programme directly funded by this NIC bid. These are innovation projects which will be carried out within the period of the NIC project, but which will have ongoing benefits to electricity customers. In order to evaluate these benefits, it is assumed that each of these projects will be successful, and result in a realistic level of benefits. As these projects are well scoped and understood, this is seen as a reasonable set of assumptions.	The assessment of project benefits is described further in Section 3 and Appendix X of this submission.
GB rollout scale *If applicable, indicate the number of relevant sites on the GB network.*	Base (Rollout to other GB Network Licensees)			7.2	51.9	136.3	We have assumed the asset base of all other GB Network Licensees combined is twice the size of ours. We have also assumed only a 50% effectiveness of the innovations on this asset base.	The assessment of project benefits is described further in Section 3 and Appendix X of this submission.

Table B: Carbon and / or environmental benefit

Carbon and/ or environmental benefit (MtCO2e)								
Scale	**Method**	**Method Cost**	**Base Case Cost**	**2020**	**2030**	**2050**	**Notes**	**Cross-references**
Post-trial solution ***(individual deployment)***	Base			0.1	0.6	1.7	These numbers represent the total benefits from the innovation programme directly funded by this NIC bid. These are innovation projects which will be carried out within the period of the NIC project, but which will have ongoing benefits to electricity customers. In order to evaluate these benefits, it is assumed that each of these projects will be successful, and result in a realistic level of carbon benefits. Evaluation of carbon benefits is inherently uncertain. It is estimated that there is ±25% uncertainty around these figures.	The assessment of project benefits is described further in Section 3 and Appendix X of this submission.
GB rollout scale ***If applicable, indicate the number of relevant sites on the GB network.***	Rollout to other GB Network Licensees			0.2	1.2	1.7	We have assumed the asset base of all other GB Network Licensees combined is twice the size of ours. We have also assumed only a 50% effectiveness of the innovations on this asset base.	The assessment of project benefits is described further in Section 3 and Appendix X of this submission.
If applicable, indicate any environmental benefits which cannot be expressed as MtCO2e.	**Post-trial solution:** [Explain any environmental benefits which cannot be expressed as MtCO2e] **Licensee scale:** [Explain any environmental benefits which cannot be expressed as MtCO2e] **GB rollout scale:** [Explain any environmental benefits which cannot be expressed as MtCO2e]							

Appendix II – Location Selection Study

In order to select the most suitable location the following process was followed to evaluate the 337 substations at 241 locations that National Grid Electricity Transmission (NGET) own within England and Wales.

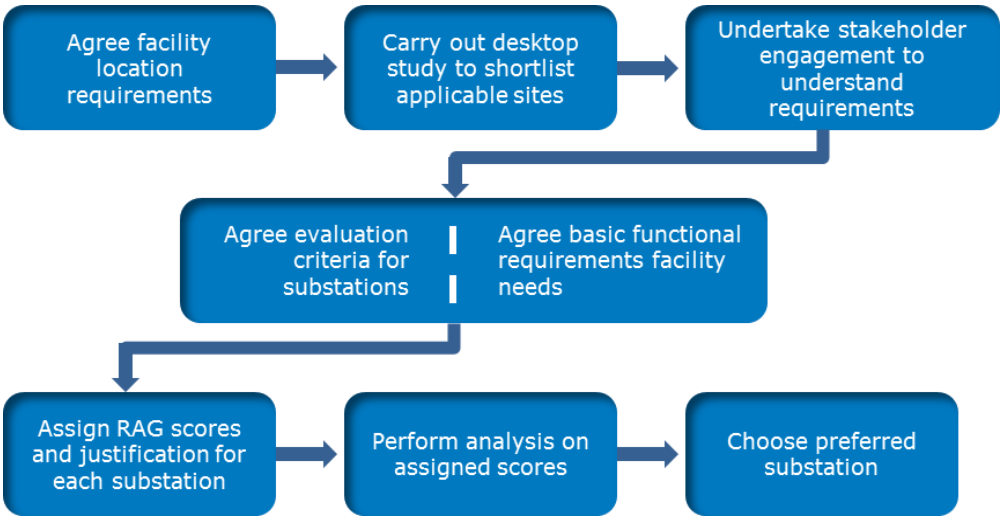

Figure II.1: The Site Options Selection Process Flow Diagram

In order to produce a shortlist of possible sites for the facility, a set of location requirements were developed by NGET as per the table below:

Table C: Set of location requirements

No.	Set of Location Requirements
loc_001	The facility needs to be in a central location for it to be readily accessible for use by other Network Licensees, academia, suppliers and research institutes.
loc_002	The facility must have sufficient spare land that will permit installation, expansion, operation, testing and maintenance for immediate and foreseeable needs.
loc_003	The location needs to be in an area of England and Wales where the annual weather patterns are comparable to the average conditions in the United Kingdom.
loc_004	Facility needs to be easily accessed by potential project partners and therefore needs to be located in close proximity to major international airports and roads.
loc_005	The facility needs to be located in close proximity to existing electricity infrastructure owned by a Licensed Network Owner.
loc_006	The facility should not be located in a densely populated area.

Once the location requirements were agreed a desktop study was undertaken to assign a Red-Amber-Green statuses against eleven regions of England and Wales based on their suitably for the location of the facility. The eleven regions chosen for the desktop study are based upon the substation regions currently used within NGET.

The results of the desktop study can be seen below in Figure II.2. The study resulted in the five regions that were given either a green or amberscore being investigated further.

From the results five possible substations currently owned by NGET were chosen for the next stage of the process. A sixth location was later included to represent the construction of a new facility on Brownfield or Greenfield land not owned by NGET.

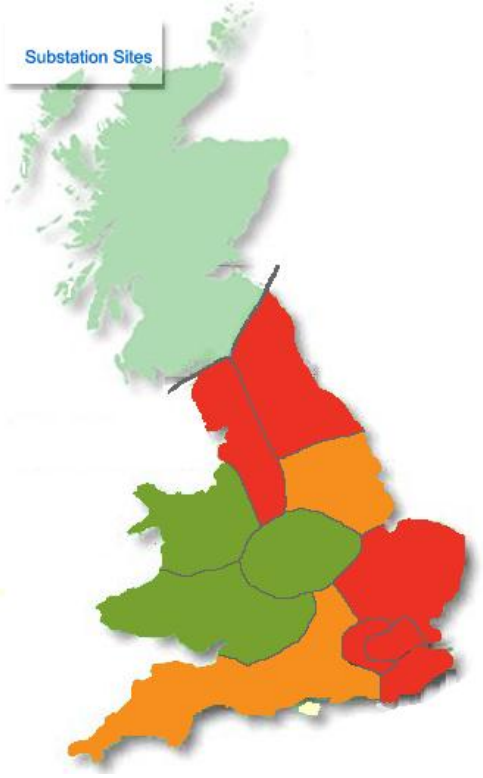

Figure II.2: The Results of the Desktop Study

As part of the site selection process NGET engaged with internal stakeholders from across Electricity Transmission Asset Management (ETAM) through various workshops, to identify the challenges that they faced when managing the assets within their area.

In order to collate further views on the facility, it was decided to host two workshops with stakeholders from across the industry. The details of these workshops are documented within Section 4 and Appendix V.

A set of evaluation criteria was also developed. This list of criteria was used to assess each of the substations in order to determine whether or not it was a suitable location for the facility. Table D below provides a summary of the evaluation criteria used in this stage of the process.

Table D: Evaluation Criteria

No.	Evaluation Criteria	Description
eva_001	Technical Performance	Complexity of the system, local network stability and thermal constraints, how expandable the site is, number of locally connected customers and its operability.
eva_002	Programme / Deliverability	Timescales for delivery of the project and discussion of potential blockers.
eva_003	Construction Complexity	Volume of work associated with the delivery of the project, the project programme and its complexity.
eva_004	Cost Estimate	Total project cost and profile.
eva_005	Operational Impact / Access	Number of outages required, the likely duration and impact on the remainder of the system, proximity to customers.
eva_006	Environmental	Environmental; ecological; archaeological; considerations.
eva_007	Land, Consents and Rights	Assessment of whether land and consents are required.
eva_008	Reputation and Third Party Impacts	Consideration of public acceptance; community relations; social impacts and local population.
eva_009	Interaction with other investment projects	Any interactive investment work occurring at the site at time of construction of the project.

The evaluation criteria and functional requirements were then used as a basis for comparing the different locations against each other.

Red, Amber and Green (RAG) scores (see Table E) were assigned for each site for each criterion (see Table F). Once all the scores were collated further analysis was performed against the list of sites in order to rank them in order of applicability to the evaluation criteria. As part of this stage of the process, sites were either discounted or parked and a single site was chosen as a potential location for the facility.

The outcome of the site selection process concluded that Deeside 400 kV substation was to be taken forward for further design and development following the analysis as it aligned with the facility's requirements.

Table E: RAG Indicators and RAG Criteria Guidance

Category	Indicator	Guidance
Technical Performance	RED	No existing asset base or infrastructure; major concerns and risks; major mitigation required
	AMBER	Existing asset base and infrastructure capable of voltages less than 400 kV; some concerns and risks; moderate mitigation anticipated
	GREEN	Existing asset base and infrastructure capable of voltages up to 400 kV; minor manageable risks
Programme / Deliverability	RED	Significant programme timescales; significant risk for programme variation; short longevity duration
	AMBER	Moderate programme timescales; moderate risk for programme variation; moderate longevity duration
	GREEN	Minor programme timescales; minor risk for programme variation; major longevity duration
Construction Complexity	RED	Significant construction works required; major construction complexity
	AMBER	Moderate construction works required; moderate construction complexity
	GREEN	Minor construction works required; not complex
Cost Estimate	RED	Significant cost risk; potential for major cost variance
	AMBER	No significant cost risk; potential for moderate cost variance
	GREEN	No cost issues foreseen; potential for minor cost variance
Operational Impact / Access	RED	Significant operational impact; major outage requirements; remotely located from most customers
	AMBER	Moderate operational impact; moderate outage requirements; located near a few customers
	GREEN	Minor operational impact; minor outage requirements; closely located to most customers
Environmental	RED	Significant ecological or archaeological concerns; major environmental impact
	AMBER	Minor ecological or archaeological concerns; moderate environmental impact
	GREEN	No significant ecological or archaeological concerns; minor environmental impact
Land, Consents and Rights	RED	Works require major planning consents; significant land purchase not required
	AMBER	Works require Local Town and Planning consents; moderate land purchase not required
	GREEN	Works classified as permitted development; land purchase not required
Reputation and Third Party Impacts	RED	Significant reputation risks; moderate potential impacts on third parties
	AMBER	Moderate reputation risks; minor potential impacts on third parties
	GREEN	Minor reputation risks; no interactions with other investment projects foreseen or planned for
Interaction with other investment projects	RED	Major interactions with other investment project(s) that add risk to the construction and delivery of facility
	AMBER	Potential for interactions with other investment projects
	GREEN	No interactions with other investment projects foreseen or planned for

Table F: Overall Summary

	Technical Performance	Programme	Construction Complexity	Cost	Operational Impact / Access	Environment	Land & Consents	Reputation & Third Party Impacts	Interaction with other projects	Overall
Deeside	G	G	G	G	A	G	G	A	A	G
Drakelow	G	G	G	R	A	G	G	A	A	G
Eakring	R	R	R	R	G	G	G	A	G	R
Hams Hall	A	A	A	R	A	G	G	A	G	A
Melksham	A	A	A	R	A	G	G	A	G	A
New site	A	R	R	R	R	A	R	R	G	R

Appendix III – Conceptual Design and Trials

This appendix provides a summary of the conceptual design and trials that the facility will offer to its customers. The facility will be designed and constructed to house the following capabilities:

Communications network

The site communications network will use fibre optic cabling. This has been chosen due to the high levels of electromagnetic noise expected from the test facility. At later stages however, various wireless communications systems will be integrated across the site.

Control Room

The control room will be located centrally within the compound and will have one level. Full Supervisory Control and Data Acquisition (SCADA) facilities will be available on site for the local controller to use. There will also be an enhanced, synchronised, high-speed data collection system storing parameters from across the network. The purpose of these rooms is to provide a remote point to monitor the work being conducted. The lower section of the control room will be used to house the central relay panels for the site bays, along with batteries, battery chargers and remote terminal units.

Substation Bays – Common Facilities

Lockable kiosks will have connections to the site fibre optic communications network installed with sufficient capacity and bandwidth to allow remote monitoring including video monitoring. The bays may be equipped with standard interlocking facilities, including a block on local operations whilst the bay is energised. This will be determined as part of the detailed design phase.

The bays will be equipped with a local 11/0.415 kV transformer to provide testing supplies, and local supplies for monitoring equipment and emergency buttons to de-energise the bay and the testing supply in the event. When required, facilities for ballistic screening will be installed to allow for testing to failure to be carried out. There will be earthing points sufficient for the type of equipment being installed, and suitably rated earthing leads within each bay. The protection relay panels for the bays will be housed in the kiosks.

Transformer Bays

The 400 kV connected transformer bays will be selected from the decommissioned Super Grid Transformer (SGT) bays, and controlled by an ex-service circuit breaker. Maximum use of existing bund infrastructure will be made with modifications in order to allow large power transformers to be easily moved in and out of the bund. An easily accessible cable management system will be in place from within the bunded area to the kiosk to permit connections to be made to the marshalling point within the local control room quickly and easily.

Switchgear Bays

The 400 kV connected switchgear bays will be controlled by an ex -service circuit breaker which will be used to protect the device being tested. Some of the bays will have new bunds installed with the expectation that some of the equipment to be tested may contain oil.

Overhead Line Bay

The 400 kV connected overhead line bay will be controlled by an ex-service circuit breaker and will have space allocated so that, in future, impulse transformers or similar devices, could be installed. The bay will have connections to two ex-service 400 kV pylons composing a single span. The span of overhead line will be fenced off and integrated into the evaluation facilities compound.

Power Cable Test Bay

The 400 kV cable bay will be controlled by an ex-service circuit breaker and will have a section of ex-service cable available for evaluation. The facility to bury or install new cables in different backfill types, including ducted sections will be established.

Gas Insulated Switchgear Bay

There will be provision made for Gas Insulated Switchgear (GIS), which could be connected to the 400 kV supply, via an ex-service 400 kV circuit breaker. Maximum use of existing GIS equipment will be made.

Distribution Voltage Facilities

One of the existing 400 kV transformer bays will have an ex-service 240 MVA 400/132 kV SGT installed, its 132 kV cables will be diverted in order to supply two 132 kV bays. The 132 kV bays will be in a separate compound from the 400 kV apparatus, and will have space to install transformers to step the voltage down to 66 kV, 33 kV or 11 kV. There will be appropriate access for the impulse test device. Voltage supplies for distribution level applications will also be provided using step-up transformers powered from the 415V/11kV network as appropriate.

Summary

Considering the above, the facility will be re-configurable to be able to deliver various capabilities, including:

- Live-line working techniques on a section of overhead line
- Retro-fill of oil filled distribution and transmission assets with different insulation media
- Analysis of air insulated switchgear SF_6 leak detection, repair, replacement and recycling techniques
- Robotic techniques for condition monitoring
- Retrofitting techniques to existing assets (i.e. fitting existing transmission transformers with a tap-changer)
- Analysis of gas insulated switchgear SF_6 leak detection, repair and recycling techniques.

Appendix IV – Alternative Facilities

Table G: This is the facility we are proposing:

Facility	Country	Bushing	CB	Tx	GIS	ITs	OHL	Cable	P&C
Offgrid Facility (National Grid)	United Kingdom	✓ ≤550 kV	✓ ≤550 kV	✓ ≤550 kV	✓ ≤550 kV	✓ ≤550 kV	✓ ≤550 kV	✓ ≤550 kV	✓

Table H: This facility is a substation test facility:

Facility	Country	Bushing	CB	Tx	GIS	ITs	OHL	Cable	P&C
Gaochang Power Testing Centre (Korea Electric Power Corporation)	South Korea		✓ ≤23 kV				✓ ≤765 kV	✓ ≤420 kV	

Table I: These facilities are test facilities/laboratories in Europe:

Facility	Country	Bushing	CB	Tx	GIS	ITs	OHL	Cable	P&C
KEMA High Power and High Voltage Laboratory (DNV GL)	Czech Republic		✓ ≤345 kV	✓ ≤345 kV			✓ ≤345 kV	✓ ≤345 kV	
Technical Laboratory (PEHLA/ABB)	Czech Republic		✓ ≤230 kV						

Facility	Country	Bushing	CB	Tx	GIS	ITs	OHL	Cable	P&C
CESI High Voltage Laboratory (CESI)	Germany	✓ ≤230 kV	✓ ≤230 kV	✓ ≤230 kV				✓ ≤230 kV	
Institute of Electric Energy Systems and High Voltage Technology Laboratory (Karlsruhe Institute of Technology)	Germany							✓ ≤800 kV	
Ratingen Testing Facility PEHLA/ABB	Germany		✓ ≤100 kV						
Schaltwerk Berlin Testing Laboratory (Siemens AG)	Germany		✓ ≤230 kV	✓ ≤230 kV					
CESI High Voltage Laboratory (CESI)	Italy	✓ ≤230 kV	✓ ≤230 kV	✓ ≤230 kV				✓ ≤230 kV	
Medium Voltage Test Laboratory (PEHLA/ABB)	Italy		✓ ≤100 kV						
KEMA Laboratory (DNV GL)	The Netherlands		✓ ≤1200 kV	✓ ≤800 kV	✓ ≤420 kV			✓ ≤500 kV	✓

Facility	Country	Bushing	CB	Tx	GIS	ITs	OHL	Cable	P&C
NEFI High Power Laboratory (NEFI Council)	Norway		✓ ≤37 kV	✓ ≤37 kV				✓ ≤37 kV	
Advanced High Voltage Engineering Research Centre (Cardiff University)	United Kingdom		✓	✓					
HV Engineering Test Hub (University of Manchester)	United Kingdom		✓ ≤400 kV	✓ ≤400 kV					✓
High Voltage Electrical Laboratories (Narec)	United Kingdom	✓ ≤230 kV	✓ ≤230 kV	✓ ≤230 kV				✓ ≤230 kV	
The Tony Davies High Voltage Laboratory (University of Southampton)	United Kingdom		✓ ≤300 kV	✓ ≤300 kV					
Power Networks Demonstration Centre (University of Strathclyde)	United Kingdom								✓

Table J: These facilities are test facilities/laboratories in America and Canada:

Facility	Country	Bushing	CB	Tx	GIS	IT	OHL	Cable	P&C
Hydro Quebec Research Institute (Hydro Quebec)	Canada		✓	✓			✓		
Powertech Testing Laboratory (Powertech)	Canada		✓ ≤800 kV	✓ ≤800 kV	✓ ≤800 kV	✓ ≤800 kV	✓ ≤800 kV	✓ ≤800 kV	
KEMA High Power Laboratory and Battery and Energy Storage Test Laboratory (DNV GL)	USA		✓ ≤800 kV	✓ ≤800 kV			✓ ≤800 kV	✓ ≤800 kV	

Key

CB – Circuit breaker, disconnectors and earth switches
Civil – Civil foundations and support structure
Tx – Distribution and transmission transformers
GIS – Gas Insulated Switchgear
ITs – Instrument Transformers
OHL – Overhead line conductor, joints and insulator mediums
Cable – Power cables and accessories
P&C – Protection and Control

Appendix V – Stakeholder Engagement

This Appendix provides further information in respect of Section 4.

Internal Stakeholder Engagement

A number of workshops took place with technical experts from across the Electricity Transmission Owner business. A proforma was used as a basis for these discussions which looked to understand what challenges each technical area faced, and what testing was currently undertaken at other facilities. Attendees were asked what could not be performed with the options available at present.

Following analysis of the output from the workshops three primary challenges were identified:

- Implementing new technologies and practices
- Managing existing assets
- The changing generation mix

Follow on discussions took place, where feedback was sought with regard to what would enhance the value to the consumer, and what could be a more innovative approach to tackle the challenges which had been identified. The suggestion was put forward that a decommissioned substation could be utilised to provide a testbed environment for use by the industry to enable mitigation of the challenges faced. This was explored with both strategic internal and external stakeholders, via meetings and teleconferences, and was enthusiastically received. A decision was made to seek feedback from the wider Industry.

External Stakeholder Engagement

Meetings took place with various stakeholders from across the industry to explore the proposal further. Having received a positive response from the parties we engaged with it was decided to proceed with this proposal.

In order to obtain feedback on specific aspects of the proposal NGET held two events for external stakeholders and invited approximately 100 representatives from across the industry. Attendees consisted of a cross section of network licensees, suppliers, academia and research institutes. An overview of the NIC project was provided and a facilitated workshop then took place which posed a number of questions.

Stakeholders were also given the opportunity to provide feedback via a hard copy feedback form or an online survey and a number of stakeholders took this opportunity. Following the events several meetings were held with specific stakeholders to enable more detailed feedback to be obtained.

The reception from the industry has been exceptionally positive with a number of stakeholders making the offer to provide support and assistance with this proposal. For examples of this feedback please refer to Appendix VI.

Table K: Feedback received against each question asked:

What do you think the technical capabilities of the offgrid substation should be?
An ability to simulate both real and abnormal system conditions to enable testing of harmonics, fault levels, currents and volts. Have a mixture of ageing and new assets, to include an Overhead Line (OHL) section, with potential for HVDC cables, earthing, and site local area network (LAN). Testing capabilities for emerging protection, control and automation technologies and measurement, e.g. IEC 61850. Enable interfaces between electrical systems, such as transmission and distribution, in order to demonstrate inter-operability. Have the ability to access individual assets for testing in isolation purposes, as required. The capability to capture data from the various primary and secondary assets and archive as necessary.
How do you think your expertise could help us in delivering the project?
Experience of: • Development and manufacturing of new technologies • Developing and operating test facilities and test protocols • In the integration of DNO assets and systems • In analytics, modelling and measurement • Managing risk Sharing international experience, including links into EU Research Networks. Suppliers could provide more detail on operation and maintenance for training purposes. Multi-stakeholder partnering.

Once built, how would you use the offgrid substation, and how would this benefit your company?
As a testing facility in order to: • Demonstrate new technology (e.g. batteries for storage) • Develop new materials (e.g. corrosion protection materials) • Test new equipment (e.g. monitoring sensors on primary plant) To overcome system access issues, which in turn could reduce testing time, ensuring a quicker route to market for products, with a potential cost reduction benefit. Be able to understand asset life cycles and integrity of plant, in order to better manage the existing asset base either via the development of new materials, or revised policies and procedures. See how new solutions interface with existing assets in a 'real' environment. As a facility to trial technologies without potentially risking the safety of the existing live network. As a facility to showcase engineering in order to engage the next generation of engineers and also be able to undertake training for existing engineers. It would facilitate the development of best practice, policy and guidelines for the industry.
How do you believe the offgrid substation could accelerate innovation for the industry?
By facilitating the development of innovative technologies more easily to enable faster deployment into business as usual. By de-risking the process from pilot to production. Being a platform to enable sharing capabilities amongst stakeholders to drive innovation. Allowing potential cost reduction owing to the absence of additional costs associated with testing in other existing worldwide facilities.
What do you believe these challenges to be?
The network is becoming more dynamic and changeable owing to the changing generation mix, e.g. Photo Voltic (PV), wind etc. There is greater focus on extending the life of assets in order to reduce costs. Technical challenges exist in relation to the interaction between old and new technologies. The increasing requirement to manage the transmission network to cater for the changes on the distribution network e.g. storage. The adoption of new technical standards (based upon global experience). The environmental challenges, such as reducing carbon and gas emissions to lessen the environmental impact.

How do you believe this substation will tackle the challenges facing the Industry?
The facility will enable testing under a range of conditions / scenarios to better understand the network, leading to increased reliability. It will facilitate the development of testing techniques for condition assessment of ageing assets. It will provide an environment where new technologies can be integrated and tested connecting to existing old assets. The facility will give parties the ability to co-ordinate multiple assets in one single substation. Innovative solutions will be trialled more easily, allowing for the adoption of new products and standards. Evaluation of new environmental products and services can be tested for sustainability.
How else could the offgrid substation benefit the Industry?
Provide training for existing engineers, graduates and apprentices, allowing a safe environment for learning. Whilst also being a platform to showcase engineering to potential engineers. A centre for both technical excellence and research. Enabling the sharing of best practice across industry participants both within the UK, and further afield. Facilitate a faster route to market for new products and services, increasing UK export potential. Foster greater collaboration across industry participants including OEM's, SME's, Academia, Transmission Owners (TO's) and Distribution Network Owners (DNO's). Provide support to the Energy Systems Catapult.
Please provide any other comments you may have…
This is an excellent initiative which could allow improved research and understanding of High Voltage (HV) plant. Accessibility in site selection is key. The location needs to be central with good transport links. The governance framework is crucial to success. Intellectual Property arrangements need to be clarified to enable innovation to drive commercial and customer value. Great to see early stakeholder involvement. A great way to get the voice of the Industry from partners and competitors.

Appendix VI – Letters of Support

The following Letters of Support for the facility have been provided and are included within this Appendix:

Network Licensee	• Scottish Hydro Electric Transmission plc • Scottish Power Transmission Ltd
Research Institute	• Centre for Sensors and Imaging Systems (CENSIS) • Electric Power Research Institute (EPRI) • National Physical Laboratory (NPL)
Supplier	• 3M • ABB • IBM • Megger • Siemens
Academic Institute	• Cardiff University • University of Birmingham • University of Manchester • University of Southampton • University of Strathclyde • University of Warwick

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Scottish and Southern Energy
Power Distribution

Rebecca Dean
Senior Innovation Stakeholder Manager
National Grid
Gallows Hill,
Warwick
CV34 6DA

Stewart Reid
Head of Future Networks
Inveralmond House
200 Dunkeld Road
PERTH
PH1 3AQ

Date: 20 July 2015

Our Reference: NIC/OSEAIT/200715

Dear Rebecca,

Letter of support for National Grid Electricity Transmission's (NGET) 'OSEAIT' project

Thank you for your request of a letter of support for the NGET 'Offline Substation Environment for the Acceleration of Innovative Technologies' (OSEAIT) project. I confirm Scottish Hydro Electric (SHE) Transmission's position of project supporter.

SHE Transmission believes that the OSEAIT project is worthy of further development and demonstration through Network Innovation Competition funding. The substation testing environment could, we believe, enable benefits to customers and to transmission operators through the accelerated deployment of new technologies and techniques. We especially look forward to seeing how we may use OSEAIT for future training and testing purposes and appreciate the opportunity to benefit from the project by using the facility where appropriate.

We consider OSEAIT to be of interest in terms of knowledge capture and sharing and we are happy to support effective knowledge dissemination by attending events and offering input subject to the agreement of mutually acceptable and appropriate commercial arrangements. I confirm also that I am happy to sit on the Technical Advisory Board, and will attend quarterly meetings.

We look forward to sharing your experience of OSEAIT as you continue to develop this interesting project. Thank you for offering us the opportunity of understanding more about the project – we wish you every success with the NIC bid.

Yours sincerely,

Stewart A Reid
Future Networks and Innovation Manager

For and on behalf of SHE Transmission

RIIO NIC NETWORK INNOVATION

SP ENERGY NETWORKS

To:

Mr. John Zammit-Haber
Innovation Manager
Electricity Transmission Asset Management
National Grid, Warwick

Re: Offgrid Substation Environment for the Acceleration of Innovative Technologies (OSEAIT)

As a transmission network owner (TO) in Scotland, SP Transmission has been actively involved in R&D projects to help develop an economic and sustainable network. The UK electricity transmission industry is facing unprecedented challenges to facilitate a high volume of new renewable generation connections and to transfer power from Scotland to the south of England where demand centres are. There are strong needs to explore options to make better use of existing assets and to ensure new equipment (including information communication technology) can be tested and approved to safeguard the reliability and security of the electricity supply. OSEAIT is proposing to establish such a controlled environment to accelerate the innovation technology for transmission network. We support this proposal and will hope that GB transmission licensees can take a coordinated approach.

Technical Advisory Board:
As part of the governance framework for the OSEAIT facility to be delivered under the National Grid Electricity Transmission NIC proposal, it is intended that a Technical Advisory Board ("the Board")will be created.

If the OSEAIT application is successful, SP Energy Networks will nominate:

Martin Hill, Head of Engineering Design and Standards, SP Energy Networks

to be the member of board on behalf of the company to contribute to the steering of the project at different stages and to ensure effective knowledge sharing between electricity licensees.

May I take this opportunity to wish you every success!

James Yu PhD CEng MIET MITL
Future Networks Manager

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RIIO NIC NETWORK INNOVATION COMPETITION

CENSIS

Iliana Portugues
National Grid Electricity Transmission

14th July 2015

Dear Iliana,

CENSIS is delighted to support your prospective **Offline Substation Environment for the Acceleration of Innovative Technologies (OSEAIT)** Initiative, being put to the Electricity Network Innovation Competition.

By way of background, CENSIS has been funded with an initial £10M over five years from Scottish Funding Council, working in collaboration with Scottish Enterprise and Highlands and Islands Enterprise, to create economic impact by supporting innovation with commercially focused, industry led projects. These will include longer term Research and Development conducted through collaborative projects between industry and academia. The establishment of CENSIS was supported by Scottish industrial and university partners active in sensor and imaging systems technologies. Our aim is to develop into the UKs premier centre of excellence for industry led innovation in this significant economic area for Scotland and the UK. CENSIS will have a strong presence in UK and European collaborative R&D and reach out internationally to build an academic and industrial network which will achieve global recognition for our capability in Sensor and Imaging Systems.

Your proposed facility offers excellent alignment and synergy with CENSIS' objectives of achieving commercial evaluation and exploitation of sensing and imaging technologies alongside the needs for improved condition monitoring in the electricity distribution sector. It is also an area of development where CENSIS believes there to be significant future benefit for both the research and commercial sectors, through improved management and life extension impacts to the distribution network.

CENSIS would welcome the chance to engage with yourself and your researchers to ensure the maximum application and integration potential, of the scientific breakthroughs, is realised. Particularly we see the potential for the core facilities you propose to provide significant stimulus to the sensor systems market, and to lead to knock on activity in the development of new sensing and associated information extraction & provision to the electricity supply sector.

CENSIS would be keen to work with OSEAIT by engaging CENSIS in-house staff and resources covering industrial networks and technology landscaping, specifically:

- Company engagement support to ensure that OSEAIT is able to engage the best and most appropriate emerging SIS capabilities, and to convert those which are at the research outcome stage to commercial evaluation and exploitation.
- SIS technology and market road mapping assistance, and technical opinion, to characterise current landscapes and identify opportunities for research exploitation across sectors.

We hope your proposal is successful and look forward to working further with you.

Yours Sincerely

Ian Reid
CEO, CENSIS.

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Innovation Centres
Supported by The Scottish Funding Council, Highlands and Islands Enterprise and Scottish Enterprise.

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RIIO NIC NETWORK INNOVATION COMPETITION

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1st July 2015

Sarah Jeffery
Senior Innovation Stakeholder Manager
Electricity Transmission Asset Management
National Grid,
National Grid House
Warwick Technology Park
Gallows Hill
Warwick
CV34 6DA

RE: Support for "Offgrid Substation Environment for the Acceleration of Innovative Technologies".

Dear Mrs. S. Jeffery,

It is my pleasure to write a letter in support of the Off-grid Substation Environment for the Acceleration of Innovative Technologies. We believe that the proposed project would provide an environment suitable to trial innovative high voltage technologies, improve operator processes, and provide a controlled environment suitable for training the next generation of electrical engineers.

We fully support a programme that provides a platform for fast-tracking network innovation and supporting the future generation of engineers, and wish the National Grid every success in the competition.

Sincerely,

Andrew Smith

Dr Andrew J A Smith
Group Leader, Electromagnetic Technologies
Tel: +44 20 8943 6672
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RIIO NIC NETWORK INNOVATION COMPETITION

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3M

20th July 2015

Rebecca Dean
Senior Innovation Stakeholder Manager
National Grid
Electricity Transmission Asset Management
Gallows Hill
Warwick
CV34 6DA

HI Rebecca,

Further to the stakeholder event Bryan Corfield and myself on behalf of 3M attended in June in Solihull for the "Offgrid Substation Environment for the Acceleration of Innovative Technologies" – OSEAIT, which was a really well organised and executed event that was a great way to gain partner, customer and competitor insights and I have to say was refreshing to have input at such an early stage in the project and I think was extremely valuable and great learning for the industry as a whole.

I envisage this being a great asset to National Grid and the wider Network operators as a one of a kind facility that will enable the development and transition of technologies from concept to commercialisation in a time scale that at present is not being able to be realised.

We at 3M fully support such a project and would enable us to trial concepts, products and solutions that we are currently developing for National Grid and would greatly assist with future developments.
We would be able to use the facility for testing in a real "live" environment which at present we are not able to do, technologies such as sensing, condition monitoring, replacement of greenhouse gases for various applications such as insulation for EHV Switchgear or transformer development.

As the facility would be in a controlled and accessible environment it would speed up the trial phase of product development and would enable us to carryout in depth testing and monitoring and use of Six Sigma processes that 3M uses extensively, as the process would be quicker using this facility other factors such as cost of development and testing could be reduced which in turn could reduce the cost of the products and solutions into the market and to the end user such as National Grid.

With the introduction of the new regulatory period, RIIO which now includes the Distribution Network Operators (DNO's), with focus on new Innovations and Technologies that improve the Network Operators processes and asset life etc. this facility would be integral to this development rollout into business as usual and benefit the consumer.

OSEAIT would also remove the risk of trialing products and solutions on live Networks where if a problem is found, then in the existing environment customer minutes lost (CML) could be a result of equipment failure or interruption with the negative impact for both operator and consumer alike.

Also with legacy equipment being used we would be able to develop retro fit solutions and test them for the existing Network where the largest gains are to be had in development of solutions for "future proofing" the Network rather than replacement again at a cost saving for the operator and ultimately the consumer.

Services for maintenance can also be developed and training for procedures for installation of these technologies as well as operational training for Network Operators.

Within the facility I would like to see the provision of a section of Overhead Line (OHL) and the ability to generate harmonics that are causing Network issues currently with the large amount of renewable generation being fed onto the Network, so being able to test equipment with harmonics I think would be a great benefit and one which maybe unique in this type of facility.

The outputs of the testing and development could also benefit the wider industry but concerns about protection of IP would have to be carefully considered.

If we at 3M can be of any assistance at this stage please don't hesitate to contact me.

Regards,

Mark Gledhill
Business Development Manager – Future Networks
Electrical Markets Division

ofgem

RIIO NIC NETWORK INNOVATION COMPETITION

ABB

Date: 21 July 2015

Rebecca Dean
Senior Innovation Stakeholder Manager
National Grid
Electricity Transmission Asset Management
Warwick

Dear Rebecca,

ABB Letter of Support Offline Substation Environment for the Acceleration of Innovative Technologies (OSEAIT) NIC Submission

ABB (www.abb.com) is a leader in power and automation technologies that enable utility, industry, and transport and infrastructure customers to improve their performance while lowering environmental impact. The ABB Group of companies operates in roughly 100 countries and employs about 140,000 people.

National Grid Electricity Transmission (NGET) is proposing to develop a substation environment for testing innovative substation technologies at voltages of up to 400 kV. National Grid have suggested in their submission and subsequent workshops that this will allow the electricity sector to maximise the benefits to consumers arising from emerging technologies and novel operating practices by accelerating their implementation and deployment. ABB understand that OSEAIT will be located on a decommissioned substation in a central location and will be available to all GB network owners and operators.

It is ABB's view that if a facility such as that proposed by National Grid allows the acceleration and acceptance of new and innovative electrical plant technology onto the UK Transmission and Distribution System then the potential benefits observed by ABB in other global applications will be realised by UK customers, in lower energy bills and by utilities and network operators, with higher reliability and lower operating costs.

ABB looks forward to working with National Grid, should this proposal be successful.

Yours sincerely

Stephen Trotter
Managing Director
Power Systems
ABB UK & Ireland

pp David Hughes
David Hughes
Managing Director
Power Products
ABB UK

ABB Limited

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IBM

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15 July 2015

Rebecca Dean
Senior Innovation Stakeholder Manager
National Grid
Electricity Transmission Asset Management

Dear Rebecca,

Many thanks for sharing the concept of the "Offgrid Substation Environment for the Acceleration of Innovative Technologies (OSEAIT)" that National Grid are seeking to establish. Globally IBM is heavily involved in helping utilities improve the availability and performance of their networks and services and having the ability to, in one place, the ability to combine a 'real world' substation environment, test deployment of new technologies and approaches, and easily collect and analyse performance data from as near actual operating conditions as you could find, would be a facility that would be both incredibly valuable, but also unique worldwide.

In the USA IBM has been involved in the development of the CenterPoint Energy "Smart Grid" Technical Centre which specifically looks at the digitisation of the electricity distribution system. This centre has delivered significant benefit to the industry by way of demonstrating, in a realistic manner, the value of new technologies and approaches. We are therefore, fully supportive of the development of a facility within the UK that serves the electricity transmission network for all aspects of technology development, not just digitisation.

Given this perspective, we are very keen to support the OSEAIT proposal in any way we can. We see the OSEAIT as a global facility where we can both collaborate with National Grid, and also conduct independent work with other partners, enabling :

1. Development and testing of new capabilities, involving both IBM Research and other clients from across the Industry,
2. Use as a reference site where IBM can demonstrate technologies which have been developed with National Grid and other parties.

To expand further upon how we believe the facility could specifically benefit IBM, and also the wider industry; we see that the OSEAIT facility could meet an immediate need in the following areas:

- Real time / real life demonstration of the use of analytics across circuit(s) / the substation as a whole
- A test bed and demonstrator for the integration of Information Technology and Operation Technology data
- The application of advanced visualisation tools such as 'virtual reality'
- An implementation of end-to-end smart grid architecture for advanced grid optimisation
- Provision of the underlying asset management and analytics systems for the day-to-day operation of the OSEAIT facility

We wish National Grid every success with its proposal.

Yours sincerely

Sincerely

Associate Partner - Asset Management
IBM Business Analytics & Strategy

ofgem

Megger

Rebecca Dean
Senior Innovation Stakeholder Manager
National Grid
Electricity Transmission Asset Management
Gallows Hill
Warwick
CV34 6DA

10th July 2015

Dear Rebecca,

This is a letter of support for National Grid's Electricity Network Innovation Competition submission for the Offline Substation Environment for the Acceleration of Innovative Technologies (OSEAIT) project.

Megger is a UK based electrical test and measurement equipment manufacturer specialising in the electricity supply industry. Megger's products test the operational condition of the electrical infrastructure in power generation, transmission and distribution systems.

Megger specialises in high voltage substation testing and high voltage cable testing. As I'm sure you are aware, to maintain a reliable supply to the consumer it is essential that power utilities undertake testing and maintenance programmes to ensure the good condition of their assets. Failure of any part of the system can result in catastrophic damage, injury or death to staff or the public and financial penalties for loss of supply.

The assets in a substation are highly stressed due to the significant energy demands placed on them and the degrading effects of aging. The correct operation of protection systems is essential to ensure safety and the protection of assets in the event of a fault. Condition monitoring allows potential faults to be identified and rectified before they cause an unplanned outage. This aids decision making, increases efficiency, extends the life of an asset and improves ROI. This is particularly relevant in the new RIIO period as operational expenditure is now a key measure.

Megger makes a wide range of test equipment to help power utilities assess the condition of their assets. It can be difficult however to show and demonstrate new innovative technologies in the real world as it involves obtaining access to a substation. It can be months or even years to gain access to a particular site as most substations tend to be working on load and may not be isolated easily. There are safety, access and control issues to overcome in a working substation and even if access is granted there is usually only a short time period available with follow up visits unlikely.

This is particularly the case with transmission substations as they are key network connection points. It is therefore very difficult to access them to try out new products or applications. The consequence is that potential innovations that would be beneficial to the power utility are either delayed or not shown at all. In addition, research and development of these innovations is difficult for the same reasons.

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RIIO NIC NETWORK INNOVATION COMPETITION

Megger

We therefore conclude that National Grid's proposal for an offline substation that can be isolated from the grid for the purpose of testing new innovations is a good idea. It will allow network operators to try new technologies in a safe, controlled environment with little or no impact on the rest of the network. It will also provide a site for education of power engineers which is extremely important as the industry faces severe skill shortages across the board. I am sure the educational establishments in the UK could also benefit, helping to fill the skills gap and provide opportunities for research.

The OSEAIT project in our view would speed up R&D, product development, testing and approvals that would benefit both Megger and the network operators. It should accelerate technologies, increase knowledge sharing across the industry and ultimately improve the UK's capability and efficiency in the power sector.

Best Regards

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SIEMENS

Ms R Dean
National Grid
National Grid House
Warwick Technology Park
Warwick
CV34 6DA

Monday 6th July 2015

Dear Rebecca,

I am writing to offer our support as Siemens for the National Grid's Offline Substation Environment for the Acceleration of Innovative Technologies (OSEAIT) project. We think it is a very worthwhile and excellent initiative and will support in any way we can.

We believe that the introduction of the OSEAIT project would offer many opportunities to us as a supplier and benefits to National Grid's stakeholders including the following:

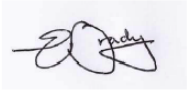
- to trial new technologies in a safe environment which can ultimately add value to NG stakeholders, for example, Gas Insulated Lines utilising a more environmentally-friendly gas could help reduce costs, reduce visual impact and present minimal risk to the environment
- to trial new processes, for example, simulating and trying new methods to reduce time at site can lead to reduced costs, reduced outage requirements and improved health and safety performance
- accelerate the implementation of new technologies, solutions onto the transmission network and lead to more effective innovation

We believe that the OSEAIT project would offer benefits to the wider industry including:

- a facility for safe learning and educating new engineers
- a showcase to attract new talent into the industry e.g. through school and college visits
- a forum for sharing knowledge, between suppliers and utilities, for example, with regard to improving health and safety performance.

If there is anything we can do to help and support you with this exciting initiative, please don't hesitate to contact me.

Yours sincerely



Edward Brady
Account Director, National Grid

Siemens Transmission & Distribution Ltd Sir William Siemens House Princess Road Manchester M20 2UR Tel: 0161 4465000

Cardiff School of Engineering
Director of School Professor Phil Bowen BSc CEng FIMechE FInstP FLSW
Ysgol Beirianneg Caerdydd
Cyfarwyddwr yr Ysgol Yr Athro Phil Bowen BSc CEng FIMechE FInstP FLSW

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6 July 2015

To Whom It May Concern

Offgrid Substation Environment for the Acceleration of Innovative Technologies

(Offgrid Substation), by National Grid

I am writing to highlight the benefits of high voltage substation-based test facility and express a very strong support for the proposed offgrid substation that National Grid is planning to build on the England and Wales transmission network. Such a test facility will accelerate development and design of new high voltage plant technologies for use in both transmission and distribution systems. It will also facilitate trial and early deployment of novel technologies that normally require years or even decades to be trusted for use on the electricity networks. Furthermore, unique in-service tests and experience could be achieved for a range of new/novel HV equipment, applications of new technologies for control, measurements and condition monitoring, and, more importantly, validation/refinement of modelling approaches for steady state, dynamic and transient behaviour of the plant and system.

Unlike many fields of research, high voltage plant and equipment require full power system test environment to prove/validate the performance of any new technology that is to be introduced on the transmission/distribution networks. The proposed offgrid project will address this shortfall, and will help save very high costs of testing/certification at overseas dedicated test houses.

The proposed offgrid substation would help demonstrate, trial and deployment of the following research activities/innovations at Cardiff University:

- *Gas Insulated Lines (GIL) and Gas Insulated Substation (GIS) systems using alternative gases to SF_6:* Cardiff University is working on a more environmentally-friendly gas to replace SF_6 gas, with funding from EPSRC and the electricity industry. The offgrid substation would be the ideal test bed for this new technology.
- *Compact substation concepts using vertical and delta bus bars:* simulation studies based on solid scientific grounds have shown that significant footprint saving can be achieved in substation with new busbar layouts. The offgrid substation could be used to be and test a demonstration bay.
- *Trial of Outdoor performance of novel insulators with textured surfaces:* a novel design of insulator surface using textured pattern has been patented by Cardiff University. This is shown, through laboratory tests, to have superior flashover and dry band properties under polluted condition. Outdoor testing under harsh environment would help deployment of such innovative technology on the electrical networks.
- *Nonlinear electric field grading techniques and materials for high voltage plant*: new microvaristor filled insulation compound are being developed to improve the ageing performance of electrical plant through better control of electric field distribution. Such technology would benefit from being tested under the in-service working conditions of insulators and bushings
- *Fast measurements of currents and voltages on the high voltage conductor:* new transducers that sit on the high phase conductors have been development and tested in the laboratory. Testing in a substation environment would help not only refine the design and performance but also define practical installation and maintenance procedures.

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Cardiff School of Engineering
Director of School Professor Phil Bowen BSc CEng FIMechE FInstP FLSW
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- *Narrow broadband communication systems for substation and line monitoring, control, and phase measurements:* new standards for communications in electrical systems have now recognised the advantages of narrow band technologies. Such systems have been developed at Cardiff, and a test at a practical substation would accelerate its deployment on the networks.
- *New earthing and safety approaches for large substations:* a new approach and software has been developed at Cardiff University to carry out risk assessment at large transmission substations. This is now finding its way into CIGRE, British and IEC standards. Such modelling could be evaluated on the offgrid substation using real system faults by carrying out staged faults at the substation. Several other investigations can be undertaken during these staged faults.
- *Validation of transient simulation models for switching surges and including new overvoltage protection approaches:* Cardiff has now a long established experience in transient modelling of electrical networks. Such expertise allows design of safer and protected networks under transient and surge conditions. For example, the connection of new renewable energy/power plant requires careful consideration of insulation coordination and overvoltage protection to avoid failure on connection. The offgrid substation would help validate and improve the various models being used.

Overall, this proposal has potential to bring together various specialists and experts in high voltage plant / systems technologies and may incentivise collaborations between industry and academia, which in turn could help UK innovation and research in this field.

The Advanced High Voltage Engineering Research Centre at Cardiff University is a well-established centre of excellence with internationally leading research in high voltage plant for over 50 years. It has helped better understanding of HV phenomena, insulation systems, insulation coordination and overvoltage protection, earthing systems and safety. It has a well-founded high voltage laboratory, and recently an added unique high impulse current laboratory to investigate the effects of lightning on electrical components and aircraft. Over the past two decades, over 100 research projects were successfully completed for the power industry (manufacturers and utilities), EPSRC, and the aerospace sector.

Yours sincerely,

Professor Manu Haddad

Director of Advanced High Voltage Engineering Research Centre,
School of Engineering,
Cardiff University

RIIO NIC NETWORK INNOVATION COMPETITION

UNIVERSITY OF BIRMINGHAM

College of Engineering and Physical Sciences
School of Electronic, Electrical and Systems Engineering

Professor Xiao-Ping Zhang
Professor of Electrical Power Systems

Director of Smart Grid,
Birmingham Energy Institute

Tel: +44 121 414 4298
E-mail: X.P.Zhang@bham.ac.uk

Friday, 10 July 2015

Sarah Jeffery
Senior Innovation Stakeholder Manager
Electricity Transmission Asset Management
National Grid, National Grid House
Tel: +44 (0)1926 654055

Dear Sarah,

Ref: Offgrid Substation Environment for the Acceleration of Innovative Technologies (OSEAIT)- National Grid Network Innovation Competition Proposal

From the recent Stockholder Consultation Workshop, I got to know that NGET are proposing to develop a substation environment for network licensees to test innovative substation technologies at voltages of up to 400kV. This would reduce the deployment risks and development time of emerging technologies and novel operating practices.

In the power industry sector, there has been an increasing need to have a real substation environment to test emerging technologies and hence accelerate the deployment of these technologies. The proposed facility is unique and fundamental to promote innovative substation technologies towards a sustainable energy supply. It is envisaged that with the support of this facility, new R&D collaborative opportunities in the UK will be created.

The proposed facility will also bring excellent opportunities for university students to understand both the operating practices and innovative technologies of a real substation. This would result in innovation oriented university education and hence would have the great potential to help transform our education. The facility could be used by our PhD and MSc power engineering programme students as an innovation element in their curriculum in particular.

The proposed facility will be beneficial significantly to both the UK power industry sector and education sector. Hence I would like to support this proposal very strongly.

Sincerely yours,

Professor Xiao-Ping Zhang
Professor of Electrical Power Systems

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RIIO NIC NETWORK INNOVATION COMPETITION

MANCHESTER 1824
The University of Manchester

Professor Martin Schröder
The University of Manchester
Vice-President and Dean
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Professor of Chemistry

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David Wright
National Grid
National Grid House
Warwick Technology Park
Gallows Hill
Warwick
CV34 6DA

16th July 2015

Dear David,

I am writing to express the University's support for the *Offgrid Substation Environment for the Acceleration of Innovative Technologies (OSEAIT)*.

OSEAIT will bring significant benefit to the UK customer by reducing the risk associated with the deployment of new technologies. While the introduction of new technologies on to a high voltage network can be partly understood through standard HV tests, there are limitations in what can be accomplished in a traditional test environment. OSEAIT will provide particular benefit given its ability to energise equipment over longer periods with and without defects being present. This will reduce risk and allow side by side comparisons of new primary plant technologies and play a vital role in developing improved techniques for life extension. OSEAIT will deliver significant value to customers as it reduces the cost of new capital assets, extends the life of existing equipment and avoids constraint costs that may otherwise result from failures of early stage technology. This is a particularly valuable proposition as we see increased pressure on transmission system capacity and the use of new technologies such as HVDC.

The University of Manchester is delighted to support the development and operation of OSEAIT to ensure the success of the initial phase in delivering value from the IFI/NIA project portfolio. We would also look to support National Grid in working with other organisations such as the Energy Systems Catapult and Innovate UK to ensure OSEAIT can be used to deploy more rapidly the pipeline of innovative technologies that relate to electricity transmission and distribution.

We have a number of relevant activities at The University of Manchester. We operate the largest University High Voltage Laboratory with the ability to test equipment at levels for the 400kV system. OSEAIT would provide a longer term test environment that is complementary to the offer made by this facility. We also have the largest real time digital simulation capability of any UK University, and this is likely to be of value to OSEAIT in the evaluation of new protection and control systems.

The Sir Henry Royce National Materials Institute will also be based in Manchester and will supply the UK with a leading capability to discover new materials and to translate laboratory scale work into full scale production. Energy materials will be a key theme of the Institute and we believe there will be many opportunities to prove the capability of new materials that could significant reduce the costs and extend the life of HV equipment.

The specific ways in which we can provide support to OSEAIT are as follows:

1. **Support the development of OSEAIT through the design and construction phases**: We would look to work with National Grid as OSEAIT is developed. A number of staff members would be able to provide guidance on the specific facilities that OSEAIT should develop in areas including HVDC, overhead lines, switchgear, live line working and protection / control. We also have staff working in the University High Voltage laboratories who could share their experience and contribute to the overall design process.

2. **Establish a long-term relationship with OSEAIT to support the transition of innovation projects into business as usual and the development of an innovation pipeline of new projects**: We propose that the University becomes a formal partner to OSEAIT and we allocate an academic member of staff to work with National Grid for a defined period. This member of staff would:

    a. Provide input into the strategic and operational plans of OSEAIT
    b. Provide academic input in the development of new use cases for OSEAIT and identify opportunities to use it in translating low TRL level research into projects that will benefit the UK customer
    c. Work with National Grid to engage third parties who could make use of OSEAIT including equipment suppliers and transmission / distribution network operators
    d. Work with the academic community to disseminate the opportunities associated with OSEAIT and to manage academic involvement including the placement of researchers at the OSEAIT facility
    e. Look to leverage other sources of funding that could be used at the OSEAIT test site

3. **Provide access to the The University of Manchester HV laboratories, our real time simulation capabilities and other relevant facilities**: We would look to agree access to the University of Manchester HV laboratories that have the capability to test equipment at 400kV levels. A relationship between OSEAIT and the University HV laboratories would be particularly beneficial given the locality of the facilities and the ability to share equipment across two sites. The HV laboratory would be useful in performing short duration tests (similar to type tests) before equipment was trialled at the OSEAIT site. Our real time digital simulation capabilities could also be made available to OSEAIT. In both cases there is an opportunity for sharing of both staff and equipment between the two sites. There is also considerable expertise and facilities at the University of Manchester in the areas of material testing, structural analysis, environmental assessment and corrosion / protection.

4. **Transfer Our Existing 400kV Test Equipment**: We have an existing set of test equipment located in Scotland and would look to transfer this to OSEAIT. This equipment allows energisation of high voltage insulators over long time periods and is complete with a 231kV transformer, weather station, fog sensor and high resolution instrumentation.

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We look forward to working with you to develop this project.

Yours sincerely

Martin Schröder
Vice-President & Dean
Faculty of Engineering and Physical Sciences

RIIO NIC NETWORK INNOVATION COMPETITION

UNIVERSITY OF Southampton

To Whom It May Concern

20 July 2015

Dear Sir

Offline Substation Environment for the Acceleration of Innovative Technologies

National Grid Electricity Transmission (NGET) has applied for Electricity Network Innovation Competition funding to develop a substation test-bed for trialling innovative substation technologies at voltages up to 400 kV.

In order to meet its commitments to reducing greenhouse gas emission, at reasonable cost, whilst maintaining security of energy supply, the UK's electricity transmission networks must change dramatically. Significant investment in new (often novel) assets will be required, whilst the operation and maintenance of extensive legacy assets will need to change to meet new system conditions and changing patterns of generation.

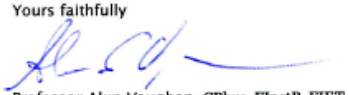
In addition, environmental constraints and public pressure will bring changes to transmission practices, such as reducing the use of SF_6 gas and increasing the use of undergrounding.

The development of a substation test-bed capable of trialling innovative substation technologies and practices will be of significant benefit in reducing the risks of introducing novel plant onto the system. It will also allow innovative condition monitoring systems and maintenance practices to be trialled in a realistic environment without the need for costly outages on the live network. Together, these will accelerate the development of electricity transmission networks fit for a low-carbon future.

We have worked with transmission plant manufacturers on the development and testing of new transmission plant and monitoring technologies. This work was carried out in laboratories controlled by the manufacturer. Commercial sensitivities restrict the opportunities for sharing this information with the transmission network owners. The development of an independent facility will generate knowledge that can be shared across GB electricity energy networks, minimising costs and maximising the opportunities for roll-out across the GB networks, thus maximising the benefits to consumers.

We believe that the development of a comprehensive facility to trial (and hence de-risk) the deployment of novel plant, monitoring systems and operational practices is an effective response to the need to develop electricity transmission networks fit for a low-carbon future.

Yours faithfully



Professor Alun Vaughan, CPhys, FInstP, FIET, SMIEEE
Head of Electronics & Electrical Engineering Research Group

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Sarah Jeffery
Senior Innovation Stakeholder Manager
Electricity Transmission Asset Management
National Grid, National Grid House
Warwick Technology Park, Gallows Hill
Warwick, CV34 6DA

University of Strathclyde Engineering

Dr Victoria Catterson
Institute for Energy and Environment, University of Strathclyde
Royal College Building, 204 George St, Glasgow, G1 1XW

2nd July 2015

Dear Sarah,

I am writing in support of your application for Network Innovation Competition funding for the Offline Substation Environment for the Acceleration of Innovative Technologies (OSEAIT).

As a lecturer in condition monitoring at the University of Strathclyde, I investigate new technologies for understanding the health of power industry assets. One critical challenge facing the industry is the need to reduce costs associated with management of an aging asset fleet, without negatively impacting system reliability. My research has the potential to reduce maintenance costs through the use of prognostics, where statistical models predict the time until failure of a given asset.

At the moment, it is difficult to increase the Technology Readiness Level (TRL) of prognostics from lab-based demonstration to deployment within the field. One of the barriers is the difficulty of proving the technology will not negatively impact system reliability, i.e. before a field trial can take place, the prognostic system must be provably robust, but its robustness cannot be tested without a field trial. The OSEAIT will be a proving ground for new technologies, allowing deployment in a realistic environment, but without exposing the utility to service risk. The facility will allow practical deployment issues to be identified, thus providing a key step in the path to integration of new technologies in the business-as-usual practice of utilities.

The University operates the Power Networks Demonstration Centre (PNDC), an 11 kV distribution network and substation facility for transitioning new technologies through from research to deployment. However, the challenges of asset fleet management for a transmission network operator such as National Grid are significantly different from the challenges at the distribution level. In particular, your challenge is to manage a portfolio of fewer but higher value assets. This significantly affects the cost-benefit calculations associated with a new technology, and the practical aspects of deploying within a transmission substation are also very different. For these reasons, the OSEAIT is a complement to the facilities at the PNDC, and will allow a type of testing and evaluation which cannot be achieved within the UK at present.

In short, I believe the OSEAIT is a unique facility, which could accelerate the deployment of innovative technologies for management of assets within transmission networks in the UK.

Yours Sincerely,

Victoria Catterson

Victoria Catterson
Lecturer, University of Strathclyde

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RIIO NIC NETWORK INNOVATION COMPETITION

WARWICK
THE UNIVERSITY OF WARWICK

Development of an Offgrid Substation Environment for the Acceleration of Innovative Technologies (OSEAIT)

David Wright
Director, Electricity Transmission Asset Management
National Grid House
Warwick Technology Park
Warwick
CV34 6DA

17 July 2015

Dear David,

The University of Warwick is the leading research intensive university in the Midlands, and was ranked 7th overall in the UK's the Research Excellence Framework in 2014. The University fully supports your proposal for an off grid substation and confirm that such a facility would be of significant value to our research.

The proposed investment in OSEAIT is critical to the development of the transmission grid infrastructure for the next 50 years. Innovation in this vital national asset will require the introduction of new technologies at an unprecedented rate over the coming years in order to ensure the National Grid is fit for purpose and able to deliver the role of system architect. The facility will allow the testing and validation of innovative new equipment in a carefully controlled environment which is isolated from the main network, whilst being able to operate it under full rating conditions. Isolation from the main grid is essential, as it allows new equipment to be subjected to a thorough range of fault conditions, which cannot be allowed on the main network. Thus untested equipment can be de-risked before it is operated live on the grid. No such facility is available in the UK, and therefore we believe that this facility is essential to maintain our network as one of the most reliable and flexible in the world, whilst keeping it at the cutting edge of technology. The facility will be beneficial to the grid operator in evaluating new equipment, as well as equipment developers and a number of research institutions such as the University of Warwick. We fully support this proposed investment in this rapidly evolving, cutting-edge technology area vital to consumers and businesses in the UK. In addition we believe that this investment is essential if we are to transition to low-carbon energy sources on which all our futures depend.

In 2015 the Chancellor of the Exchequer announced £60m of capital funding for phase 1 of an Energy Research Accelerator (ERA) to give the UK a clear lead in the critical area of energy research and development. Based upon a partnership between the Midlands research Universities known as the M6 – the Universities of Aston, Birmingham, Leicester, Loughborough, Nottingham and Warwick – as well as the British

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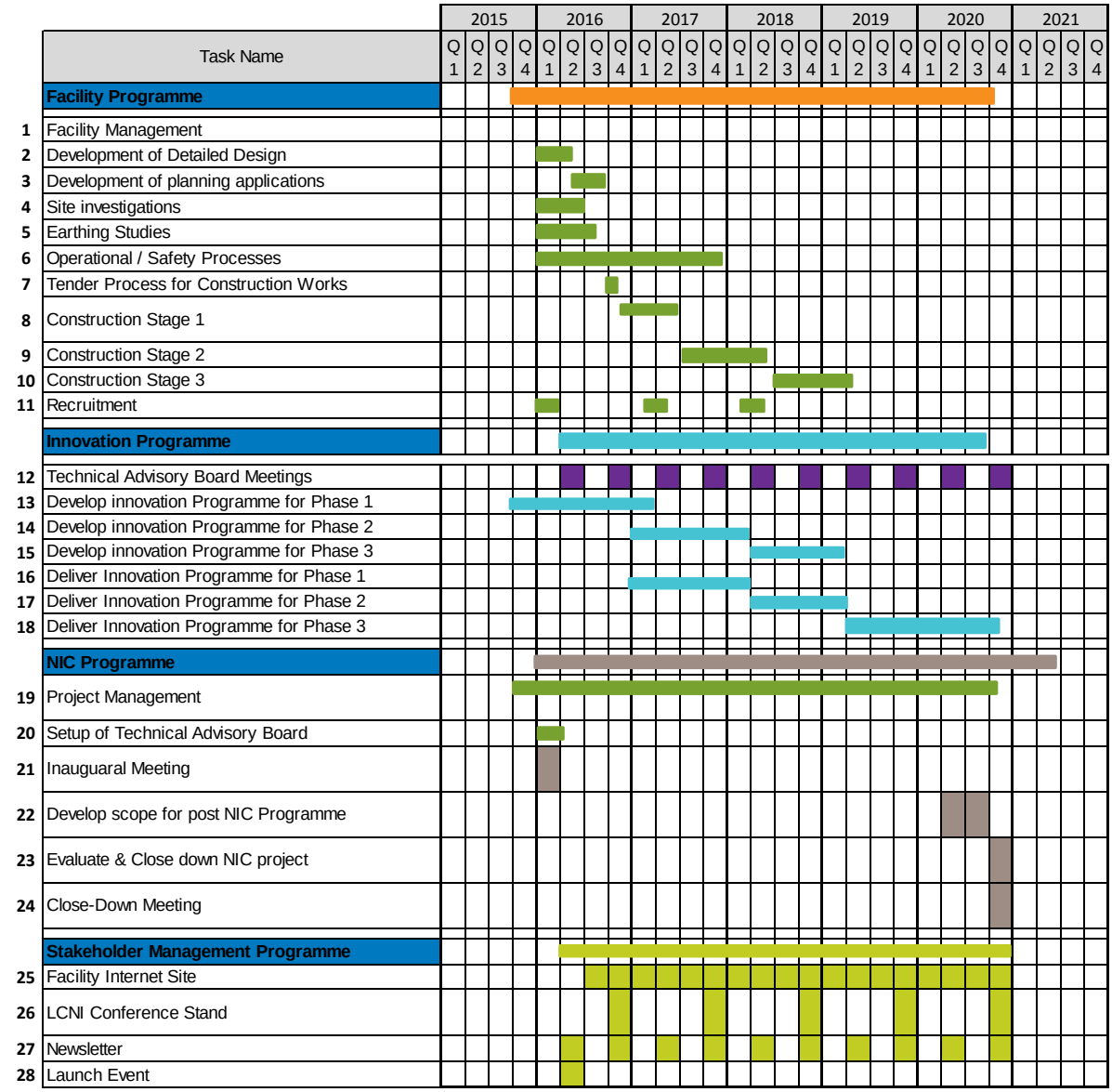
Geological Survey, ERA will become a multi-faceted centre of excellence focused on developing much needed new technologies for the energy sector. We strongly believe that whilst ERA and OSEAIT are independent initiatives, their aims are highly complementary. Through the strategic partnership between National Grid and the University of Warwick we will ensure that the two initiatives together deliver value and benefit to the consumer over and above that which each would deliver in isolation.

If you have any questions or would like to discuss this further then please do not hesitate to contact me.

Yours sincerely,

Professor Tim Jones
Pro-Vice-Chancellor (Science, Engineering and Medicine)

Appendix VII – Project Plan



Appendix VIII – Finance Commentary and Resourcing Plan

The financial workbook being submitted as part of this overall submission is made up of the following elements:

- NIC Innovation Programme Equipment
- Construction
- Construction contingency
- Dissemination Costs
- Facility Staff
- National Grid Support Staff
- Labour Contingency
- Consultants

NIC Innovation Equipment

An annual budget has been established to enable the purchase of the equipment which has been identified as being required for a facility of this nature.

The purchase phasing has been calculated based on bulk purchase at the earliest requirement for that specific piece of equipment. E.g. 3 mobile safety screens are required by the projects spanning multiple years – all 3 screens will be purchased in the first year to benefit from bulk purchase discounts. This methodology has been applied across all equipment.

Construction

Subject to the results of the planning application and site investigation, provision has been made for the construction of the following:

- internal roadways
- Car Parking Area
- Perimeter Fencing
- Control Room
- Workshop and Storage
- Potential Remediation Works
- Communications and SCADA

The following supplementary costs to the base costs above are also incurred:

- Contractor detail design fees
- Contractor project management during construction
- Temporary works i.e. site establishment and maintenance during construction
- Fee charged by the contractor in addition to cost base above
- National Grid costs for administering construction

Construction Contingency

[redacted]. NGET will take a 50:50 share in any unknown costs that are funded from the contingency during construction.

Communications / Stakeholder Engagement / Dissemination

A provision has been made to cater for dissemination, communications and stakeholder engagement by way of a facility website, bi-annual newsletter and attendance at a range of conferences for each year of the project.

Facility Staff

Facility staff will be recruited on a phased basis following approval that the project is to continue. The figures below are shown on a full time equivalent rate:

Facility Staff
NIC Project Manager
Facility Manager
Innovation Technical Lead
Site Engineer
Fabricator
Test Engineer
Administrator
Second Site Engineer
Second Fabricator
Second Test Engineer
Second Administrator
Innovation Analytical Lead
Analyst

National Grid Support Staff

In order to deliver some elements of the project it would be necessary to utilise resources from the following National Grid departments.

Support Staff
Finance
Human Resources
Land & Consents
Construction
Legal
Procurement

- Human Resources to assist with the recruitment of facility staff.
- Finance to assist in the setup for the required banking facilities.
- Land and Consents to assist with all stages required to prepare and submit the detailed planning application and assisting with the construction phases to ensure that any relevant restrictions within the planning permission have been adhered to.
- Procurement to assist in tendering and purchasing the various items and test equipment and for the construction phases.
- Construction to assist with the construction phases of the facility.

- Legal to provide support with supporting in the formation of the Technical Advisory Board terms of reference, support in setting up the necessary IPR documents, consultation on the enduring governance for the facility post NIC.

Labour Contingency

A labour contingency of [redacted] has been included on the National Grid Support Costs. This is to reflect a level of uncertainty around the amount of time that will be needed for initial setup due to the unprecedented nature of this project.

Consultants

Provision has been made for 2 consultants (power system and earthing studies) to be used within the design phase to assist in the detailed earthing studies which would need to be carried out and also with writing the site safety procedures, rules and the interlocking designs in accordance with the rules.

Consultants
Earthing Studies Consultant
Operational / Safety Processes

We have also included for a detailed site investigation to be carried out during the design phase to be able to understand what, if any, contamination exists within the site and what considerations should be given to any remediation works and also whether any provision would need to be made for certain types of wildlife.

Provision has been made, in accordance with the advice received from the National Grid Land and Consents team, for a detailed planning application to be made covering all of the proposed construction works and modifications.

Appendix IX – Risk Register & Contingency Plan

Table L: This appendix provides an extract from the project's risk register.

Area	Risk Description	Consequence	Current			Target			Action Planned (Accept, Avoid, Reduce, Transfer)
			L	I	O	L	I	O	
Delivery	Conflict of interests at Technical Advisory Board with regards to direction of project.	Project stalls and delays are caused.	4	4		2	2		Adequate Terms of Reference and direction of project are agreed upfront with key stakeholders.
Finance	NIC bid unsuccessful	The project will not go ahead.	3	3		1	1		Address largest areas of concern arising from ISP and develop project to increase confidence of success.
Outputs	Facility is not sustainable by the end of the NIC funding period	Facility will close down and land and assets sold or dismantled	3	3		2	3		Reduce - understand stakeholder appetite from start and develop sustainable plan through funding.
Delivery	Lack of effective project management	Project gets delayed and costs escalate	2	4		2	3		Experienced project manager to run the project has been identified and committed.
Technical	The design of the facility does not allow value to be maximised.	Opportunity is lost as many innovations cannot be accelerated into implementation	2	4		1	1		Detailed design of facility developed with stakeholder engagement and Technical Advisory Board approval required.

Finance	Estimated costs are substantially different to actual costs	Potential project funding gap. Alternative funding required.	2	3		1	3		Reduce - Ensure cost estimates are thorough and realistic and reflect full scope of work. Validate estimates based on tenders and market knowledge. Appropriate contingency to be included.
Delivery	Delayed installation and commissioning due to local problems	The project is delayed	2	3		1	1		Reduce - careful and detailed up-front planning and liaising with the various associated schemes; project plan not too tight. Develop a dynamic innovation programme to allow modifications if required
Outputs	Outputs are not disseminated appropriately to maximise benefit	Reduction in value of investment. Lessons learnt are not shared.	2	2		1	2		Reduce - Stakeholder engagement plan in place for adequate knowledge dissemination processes and methods.
Delivery	Failure to recruit essential skilled staff	Quality of work reduces and/or delays to delivery.	2	2		1	1		Key resources identified and committed. Technical experts, specialists and engineers within the business allocated time to support if/when required.
Delivery	Staff Turnover	Staff turnover causes delays to project.	3	2		2	2		Staff turnover possibility must be accepted. Engagement and standard business practices will be followed to maintain staff.
Delivery	Planning Permission	Control room cannot be build and offices can undergo only minor refurbishment	2	4		1	2		Engage with planning authority as early as possible and keep heights and impacts of development to a minimum

Key:

L - Likelihood 1 – Rare 2 – Unlikely 3 – Moderate 4 – Likely 5 – Common

I - Impact 1 – Insignificant 2 – Minor 3 – Moderate 4 – Major 5 – Catastrophic

O - Overall

Appendix X – Business Case

As part of the business case analysis, we have analysed three scenarios:

1. *Low Case:* Only the initial set of projects is delivered, but benefit only arises on National Grid assets (R&D is not adopted by 3rd parties). Their benefits come into force and continue until 2050 in line with the assumptions provided against each of the individual projects.

2. *Base Case:* Only the initial set of projects are delivered
In this scenario, the project benefits comes into play the year the project gets delivered and continue until 2050 in line with the assumptions provided against each of the individual projects detailed further on in this Appendix.

3. *Future Prospects:* GB Network Licensee Innovation continues after RIIO-T1
To understand the outlook for the facility, we have included additional innovation projects taking place at the facility until 2050, following a similar benefits profile as those for the base case and recurring every seven years. For this scenario, we have assumed Opex costs would continue past 2020 for site operation, inflating at 4%. This results in year on year benefits growth.

Under the three scenarios, benefits are shared between the consumer, all GB network licensees and National Grid with the consumer breaking even in 2021 for both cases. This is due to the way savings flow through the two mechanisms described in Section 3. Figure X.1 below depicts this.

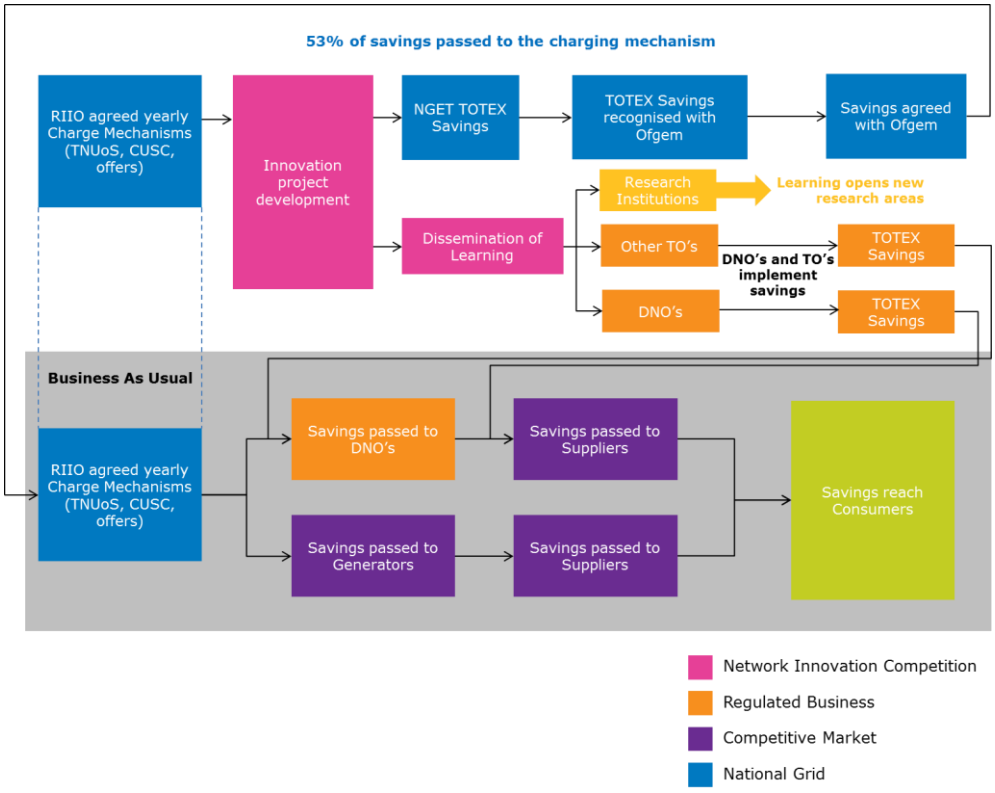


Figure X.1 Flowchart depicting flow of savings through to the consumer

When comparing the three scenarios in terms of consumer benefits, as shown below in Figure X.2, all return the consumer investment before 2024, with the Future Prospects scenario delivering over £300m by 2050.

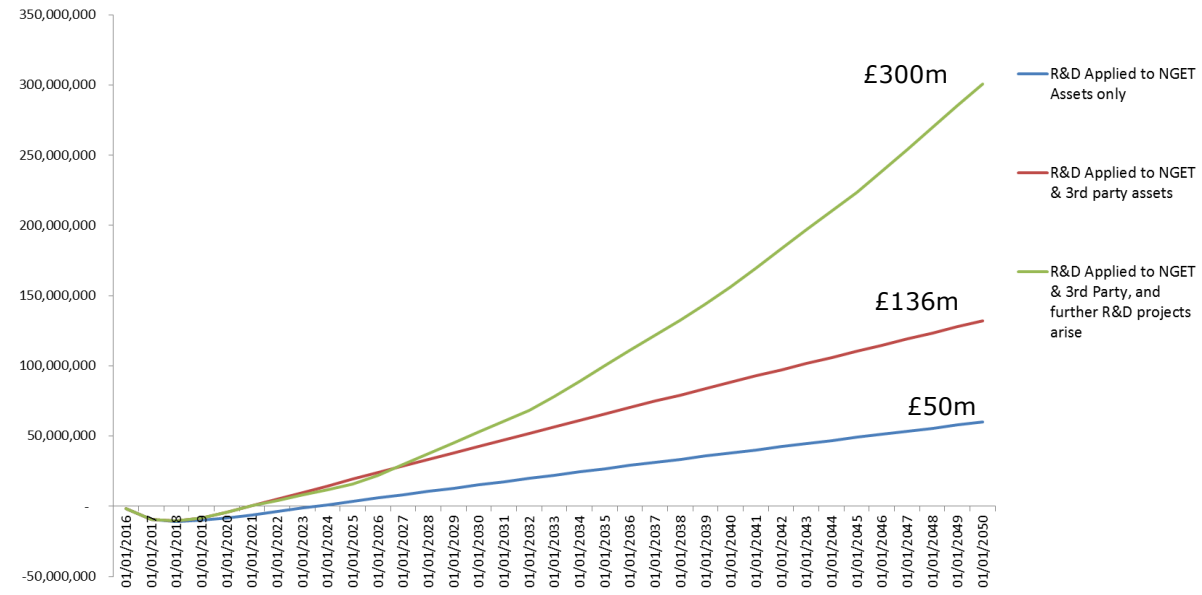


Figure X.2 Flowchart depicting flow of savings through to the consumer

We believe these scenarios are conservative since they assume only an approximate 30% utilisation of the facility and do not include any third party projects. We therefore expect the value to consumers to be higher than those projects in either case.

It is important to note that this list of project will be re-evaluated at the first Technical Advisory Board and so is subject to change should the priorities shift between now and the project commencing.

Carbon Benefits

Carbon Benefits for a significant part of many innovation project benefits. However, the assessment of carbon benefits has significant uncertainties associated with it, and this is equally true for this project.

In order to gain an idea of the scale of these potential savings, we carried out an assessment based on the projects within the innovation programme. Many of the projects have associated carbon benefits. The expected saving in carbon amounts to 1.1 million tonnes.

Other Benefits

This project has the potential to bring about significant benefits through the projects that it supports. The financial and carbon benefits are discussed above, but there are significant further benefits that may be achieved including the safety of network personnel and the general public, improved service to consumers including power quality and security of supply, and the creation of an innovation community for GB network licensees, suppliers, academia and research institutes.

Financial analysis of individual projects

1. Overhead line condition monitoring / evaluation			
Project enabled or accelerated by NIC funding?			Partially Accelerated, Partially Dependent
Description of how benefit materialises included key assumptions:			
Refer to Life extensions benefit methodology page			
Total Consumer Benefit:			[redacted]
Average annual reduction in spend against maintenance allowance:			[redacted]
Average annual reduction in spend against Capex investment allowance:			[redacted]
Confidence level behind benefit:			High
How we will track this:			
Once research has been completed, NGET asset policies will be updated to reflect the extended life where appropriate. Once the policy has been updated, NGET will randomly sample replaced assets and review what would have happened under the previous policy. The life extension (or otherwise) attributable to the change in policy will then be recorded.			
Delivered	Phase 2	**Completion Date**	August 2019

2. Circuit Breaker Monitoring			
Project enabled or accelerated by NIC funding?			Partially Accelerated, Partially Dependent
Description of how benefit materialises included key assumptions:			
Refer to Life extensions benefit methodology page			
Total Consumer Benefit:			[redacted]
Average annual reduction in spend against maintenance allowance:			[redacted]
Average annual reduction in spend against Capex investment allowance:			[redacted]
Confidence level behind benefit:			High
How we will track this:			
Once research has been completed, NGET asset policies will be updated to reflect the extended life where appropriate. Once the policy has been updated, NGET will randomly sample replaced assets and review what would have happened under the previous policy. The life extension (or otherwise) attributable to the change in policy will then be recorded.			
Delivered	Phase 2	**Completion Date**	August 2019

3. Low and medium voltage switchgear panel monitoring			
Project enabled or accelerated by NIC funding?			Partially Accelerated, Partially Dependent
Description of how benefit materialises included key assumptions:			
Refer to Life extensions benefit methodology page			
Total Consumer Benefit:			[redacted]
Average annual reduction in spend against maintenance allowance:			[redacted]
Average annual reduction in spend against Capex investment allowance:			[redacted]
Confidence level behind benefit:			High
How we will track this:			
Once research has been completed, NGET asset policies will be updated to reflect the extended life where appropriate. Once the policy has been updated, NGET will randomly sample replaced assets and review what would have happened under the previous policy. The life extension (or otherwise) attributable to the change in policy will then be recorded.			
Delivered	Phase 2	**Completion Date**	September 2019

4. Insulation defect monitoring in gas insulated switchgear			
Project enabled or accelerated by NIC funding?			Partially Accelerated, Partially Dependent
Description of how benefit materialises included key assumptions:			
Refer to Life extensions benefit methodology page			
Total Consumer Benefit in 2015/16:			[redacted]
Average annual reduction in spend against maintenance allowance:			[redacted]
Average annual reduction in spend against Capex investment allowance:			[redacted]
Confidence level behind benefit:			Medium
How we will track this:			
Once research has been completed, NGET asset policies will be updated to reflect the extended life where appropriate. Once the policy has been updated, NGET will randomly sample replaced assets and review what would have happened under the previous policy. The life extension (or otherwise) attributable to the change in policy will then be recorded.			
Delivered	Phase 3	**Completion Date**	October 2020

5. HV harmonic impact on transformers			
Project enabled or accelerated by NIC funding?			Wholly Dependent
Description of how benefit materialises included key assumptions:			
Refer to Life extensions benefit methodology page			
Total Consumer Benefit:			[redacted]
Average annual reduction in spend against maintenance allowance:			[redacted]
Average annual reduction in spend against Capex investment allowance:			[redacted]
Confidence level behind benefit:			Low
How we will track this:			
Once research has been completed, NGET asset policies will be updated to reflect the extended life where appropriate. Once the policy has been updated, NGET will randomly sample replaced assets and review what would have happened under the previous policy. The life extension (or otherwise) attributable to the change in policy will then be recorded.			
Delivered	Phase 3	**Completion Date**	October 2020

6. Tap changer monitoring			
Project enabled or accelerated by NIC funding?			Partially Accelerated, Partially Dependent
Description of how benefit materialises included key assumptions:			
Refer to Life extensions benefit methodology page			
Total Consumer Benefit:			[redacted]
Average annual reduction in spend against maintenance allowance:			[redacted]
Average annual reduction in spend against Capex investment allowance:			[redacted]
Confidence level behind benefit:			High
How we will track this:			
Once research has been completed, NGET asset policies will be updated to reflect the extended life where appropriate. Once the policy has been updated, NGET will randomly sample replaced assets and review what would have happened under the previous policy. The life extension (or otherwise) attributable to the change in policy will then be recorded.			
Delivered	Phase 3	**Completion Date**	October 2020

7. SF_6 Leak Management & Repair Techniques			
Project enabled or accelerated by NIC funding?		Partially Accelerated, Partially Dependent	
Description of how benefit materialises included key assumptions:			
Benefit from reduced SF_6: [redacted] SF_6 Leakage reduced from [redacted] to [redacted]. SF_6 becomes cash benefit in two ways, reduced maintenance cost and reduced cost of purchase of SF_6 • SF6: Top up [redacted] tonnes per year @[redacted] per Kilogram is [redacted] • Each top up is around 10kg, therefore it was assumed that [redacted] less visits would be required, saving [redacted] hours of labour per annum, resulting in savings of [redacted] per annum			
Total Consumer Benefit in 2015/16:		[redacted]	
Average annual reduction in spend against maintenance allowance:		[redacted]	
Average annual reduction in spend against Capex investment allowance:		[redacted]	
Confidence level behind benefit:		High	
How we will track this:			
NGET will be able to establish the benefits achieved here easily through the quantities ofSF_6 being purchased, and the number of work orders being raised to top up SF6			
Delivered	Phase 1	**Completion Date**	March 2018

8. Asset thermal model for remote operations			
Project enabled or accelerated by NIC funding?		Wholly Dependent	
Description of how benefit materialises included key assumptions:			
With improved calibration of thermal surveys false readings can be reduced. This will reduce unnecessary load restrictions and maintenances, as well as reduce the level of avoidable catastrophic failures. Financial savings will result from eliminated maintenances, and increased failure prevention. The benefits included here are only from eliminated maintenances as there is insufficient data to calculate avoided failures. • There are [redacted] false positive thermal readings per annum. Each of these results in further surveys by an experienced engineer in order to establish that the reading was inaccurate. • Avoiding this will save [redacted] hours of labour per annum, resulting in savings of [redacted] per annum			
Total Consumer Benefit:		[redacted]	
Average annual reduction in spend against maintenance allowance:		[redacted]	
Average annual reduction in spend against Capex investment allowance:		[redacted]	
Confidence level behind benefit:		High	
How we will track this:			
NGET will track the number of false positive hot joint call outs, with a target of 0.			
Delivered	Phase 1	**Completion Date**	March 2018

9. RFI Sensitivity and Characterisation			
Project enabled or accelerated by NIC funding?	Wholly Dependent		
Description of how benefit materialises included key assumptions:			
This is very similar to the hot joint model. With improved understanding of sensitivity and signal characterisation false readings can be reduced. This will reduce unnecessary load restrictions and maintenances, as well as reduce the level of avoidable catastrophic failures. Financial savings will result from eliminated maintenances, and increased failure prevention. The benefits included here are only from eliminated maintenances as there is insufficient data to calculate avoided failures. • There are [redacted] false positive RFI readings per annum in a trial zone. When RFI condition monitoring is rolled out across all [redacted] zones this is expected to become [redacted] per annum. • Each of these results in further surveys by an experienced engineer in order to establish that the reading was inaccurate. • Avoiding this will save [redacted] hours of labour per annum, resulting in savings of [redacted] per annum.			
Total Consumer Benefit:	[redacted]		
Average annual reduction in spend against maintenance allowance:	[redacted]		
Average annual reduction in spend against Capex investment allowance:	0		
Confidence level behind benefit:	Medium		
How we will track this:			
In this instance, the cost is an avoidance of extra resource that would be required once the RFI technology is rolled out nationally. Therefore, this benefit can be validated by confirming that the team performing the investigations form positive readings does not increase in size.			
Delivered	Phase 1	**Completion Date**	March 2018

10. Digital Data and Visualisation	
Project enabled or accelerated by NIC funding?	Wholly Dependent
Description of how benefit materialises included key assumptions:	
This project provides the capability to analyse diverse sets of data in parallel, providing better visualisation of the location and condition of assets. The benefits of this result from a greater ability to plan major projects prior to execution. Examples include; • Smoother entry and exit of large equipment from sites; spatial issues can be better considered prior to deployment of cranes and lifting platforms. • Civil assets are more likely to be re-usable as it will be easier to consider whether replacement assets can fit on the existing support structures during project planning. The information will also support better prioritisation of maintenance plans. At this stage, it has not been determined exactly how many schemes the benefits will arise on, and the scale of the benefits is highly variable on a case by case basis. Benefits would arise in a number of large projects and the financial impact of these is considered significant (the overall spend affected is approximately [redacted] per annum). However, it is difficult to separately identify the relevant costs from the overall overheads of the projects. As such the financial value attributed to the benefits has a significant level of uncertainty attached Using a factor of 0.05% of the affected cost base gives a benefit of £600k per annum.	
Total Consumer Benefit:	[redacted]
Average annual reduction in spend against maintenance allowance:	[redacted]
Average annual reduction in spend against Capex investment allowance:	[redacted]
Confidence level behind benefit:	Low
How we will track this:	
The benefits of this project arise in multiple places, and as such are hard to design a tracking mechanism for at present. As the research progressed, potential tracking mechanisms would become more apparent and would be designed prior to implementation.	

Delivered	Phase 1	**Completion Date**	March 2018

11. Degradation cure of a hot joint			
Project enabled or accelerated by NIC funding?	Wholly Dependent		
Description of how benefit materialises included key assumptions:			
Establishing the degradation curve of a hot joint will provide greater insight into asset health. The financial benefits materialise from delaying asset replacements through more confident anticipation of failure point. Until developed, it is difficult to specifically quantify the effect of this. However, an initial estimation suggests that a minimum of [redacted] of our annual capital expenditure ([redacted]) may be delayed by one year. At an average asset life of [redacted] years, this would yield [redacted] per annum ([redacted]/[redacted] years). It is considered that this is a highly conservative estimate, and the research would need to progress in order to obtain a more robust figure.			
Total Consumer Benefit:	[redacted]		
Average annual reduction in spend against maintenance allowance:	[redacted]		
Average annual reduction in spend against Capex investment allowance:	[redacted]		
Confidence level behind benefit:	Low		
How we will track this:			
The benefits of this project arise in multiple places, and as such are hard to design a tracking mechanism for at present. As the research progressed, potential tracking mechanisms would become more apparent and would be designed prior to implementation.			
Delivered	Phase 1	**Completion Date**	March 2018

12. Conductor Audible Noise Evaluation			
Project enabled or accelerated by NIC funding?		Wholly Dependent	
Description of how benefit materialises included key assumptions:			
The main benefit arises from a reduction in public inconvenience from the noise generated by overhead lines. By understanding the conditions under which the conductors make noise, we can further develop mitigation methodology such as conductor coatings. However, NGET does occasionally install more expensive conductors in order to mitigate the noise in areas of close public proximity. Also, because new conductors cannot currently be tested under live conditions, it is possible that new conductor types are installed before NGET discovers they generate unacceptable noise. They must then be replaced at significant cost. Instances of this are rare, but expensive, with the cost running into millions .			
Total Consumer Benefit:		[redacted]	
Average annual reduction in spend against maintenance allowance:		[redacted]	
Average annual reduction in spend against Capex investment allowance:		[redacted]	
Confidence level behind benefit:		High	
How we will track this:			
NGET will track the number of instances of schemes re-placing recently installed conductors with a target of 0			
Delivered	Phase 2	**Completion Date**	August 2019

13. Architecture for substation secondary systems			
Project enabled or accelerated by NIC funding?			Partially Accelerated, Partially Dependent
Description of how benefit materialises included key assumptions:			
This initiative defines an optimum architecture and communication language for substation secondary systems. This will generate savings through: • Reduced outages (impossible to quantify) • Reduced time and complexity to deliver new or replacement substations. This is expected to reduce the cost of the protection and control systems with the substation by [redacted], or [redacted]. On the assumption that 10 substations are refurbished or built per annum, the annual saving is £500k.			
Total Consumer Benefit:			[redacted]
Average annual reduction in spend against maintenance allowance:			[redacted]
Average annual reduction in spend against Capex investment allowance:			[redacted]
Confidence level behind benefit:			High
How we will track this:			
NGET will track the delivery cost of secondary systems over time in order to identify a [redacted] reduction in costs targeted. Extra care must be taken as there may be multiple causes of price fluctuations.			
Delivered	Phase 3	**Completion Date**	October 2020

14. Backfilling of current GIS with alternative gases			
Project enabled or accelerated by NIC funding?			Wholly Dependent
Description of how benefit materialises included key assumptions:			
No financial benefits associated with this. This project drives CO_2 savings.			
Total Consumer Benefit:			[redacted]
Average annual reduction in spend against maintenance allowance:			[redacted]
Average annual reduction in spend against Capex investment allowance:			[redacted]
Confidence level behind benefit:			Medium
How we will track this:			
[refer to CO_2 document]			
Delivered	Phase 3	**Completion Date**	October 2020

Appendix XI – List of Figures and Tables

The following figures are displayed within the main submission document:

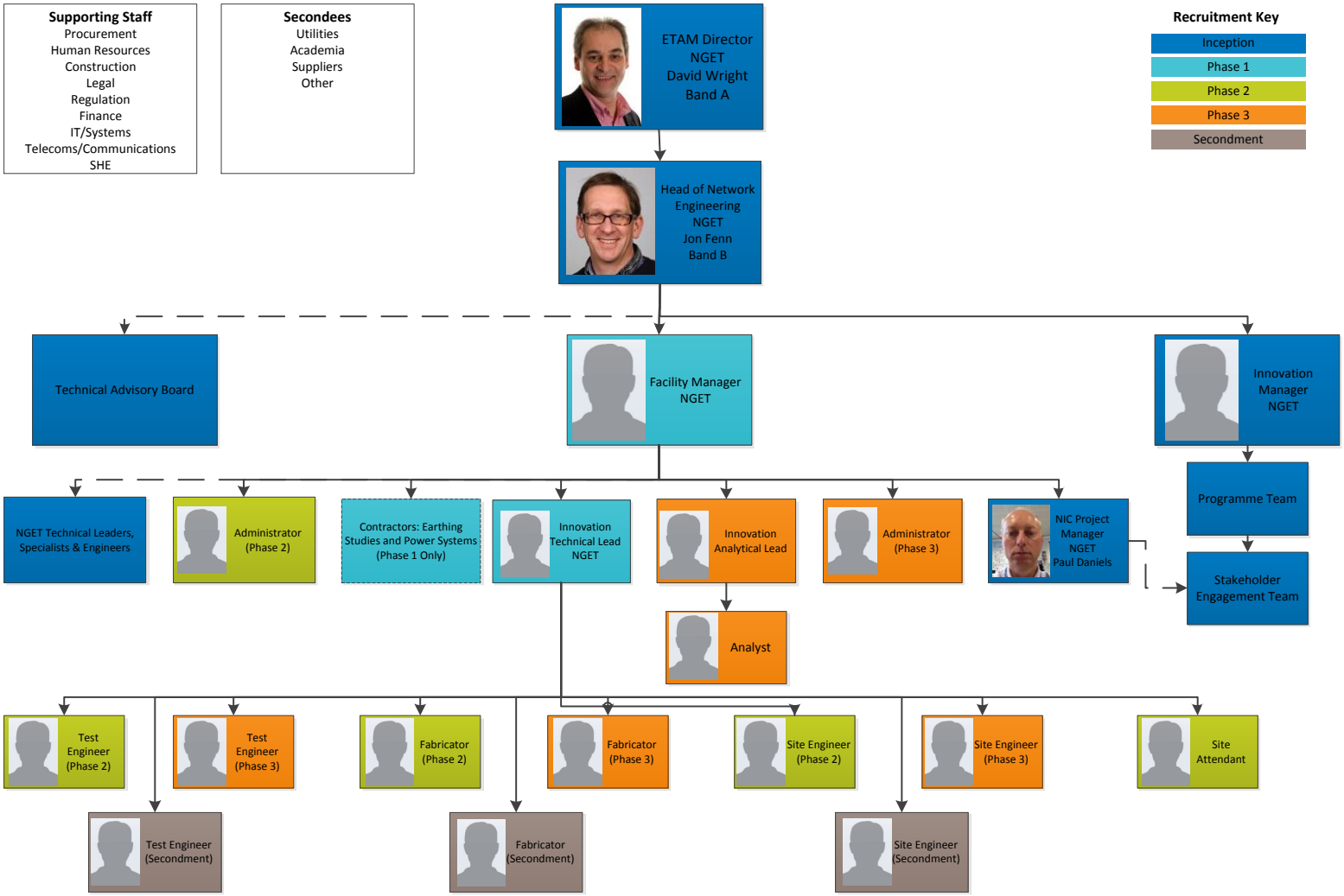
The following tables are displayed within the main submission document:

The following figures are displayed within the appendices:

The following tables are displayed within the appendices:

Appendix XII – Governance Framework

The organisational framework is displayed below:



Governance Framework

Clear governance arrangements are vital to the successful delivery of a complex project such as this. In order to achieve this, overall responsibility for the project will sit with the Electricity Transmission Asset Management Director, David Wright. In addition the Technical Advisory Board will be chaired by the Head of Network Engineering, Jon Fenn.

A challenge and review process will be implemented with stage gates at the end of each of the construction stages. These will determine whether to proceed to the next stage of construction or whether proceeding should be suspended. As part of this process a review of the risk register and contingency plan (Appendix IX) will take place.

Role of the Technical Advisory Board

As part of the governance framework for the facility a Technical Advisory Board ("the Board") will be created. The Board will comprise of representatives of the GB Network Licensees, Ofgem, a Health and Safety Representative and academic representatives.

The role of the Board during the initial phases of development will be to provide advice with regard to design and construction of the facility. Following this it will be to determine the prioritisation of work undertaken, and to provide investment advice regarding which equipment should be purchased to enable the continued benefit to stakeholders of a facility of this nature. In addition; once the centre is fully functional then the Board will be asked to assist in driving those standards and specifications which are required to implement the work undertaken into business as usual.

During the initial phases of development and construction (years 1 and 2) individuals will be asked to attend 4 face-to-face meetings over the course of a year. Post this period it is anticipated that there will be 2 face-to-face meetings and 2 teleconferences per annum.

General TAB key duties

- Provide strategic direction for the Network Innovation Competition (NIC) project and its deliverables;
- Challenge, review and approve/decline project proposals and associated deliverables;
- Terminate a project
- Approve any change in NIC project scope, direction or delivery;
- Approve the NIC Innovation Programme;
- Keep executive level stakeholders informed of the progress of the facility;
- Ensure adequate resources are committed to deliver the NIC Innovation Programme;
- Approve expenditure on facility alterations.
- Approve new TAB members.
- At the end of the NIC period, review the success of the facility and make a decision about its future and governance structure.