Scottish and Southern Energy Power Distribution

Network Innovation Allowance

Summary Report

for period 1 April 2014 to 31 March 2015

Scottish Hydro Electric Transmission plc

Foreword

This report has been prepared by Scottish Hydro Electric Transmission plc (SHE Transmission) to summarise the progress achieved during 2014-2015 in our innovation projects funded through the Network Innovation Allowance (NIA). This allowance commenced in April 2013 as part of the RIIO-T1 Price Control and is aimed at promoting smaller innovation projects that will deliver benefits to customers.

Our core purpose within SHE Transmission is to provide the energy people need in a reliable and sustainable way. To deliver this core purpose in these challenging times, we recognise that innovation is a necessity which is driven by changes in the requirements placed on our extra high voltage networks largely due to the gradual shift towards lower carbon technologies in the electricity system as a whole and the significant increase in large scale renewable generation sources which are often located on the extremities of our legacy infrastructure.

In the year ending the 31st of March 2015, we have a portfolio of fourteen NIA projects at different stages in their lifecycles. All our NIA projects espouse at least one of the seven objectives which are outlined in this report and covered in greater detail in our Innovation Strategy. This approach ensures that our core purpose can be achieved whilst also helping to focus our attention on tackling the challenges faced by the entire UK electricity sector in its transition to a Low Carbon Economy.

Our experience of delivering NIA funded projects has evolved significantly since April 2013 as six of the earliest projects under the scheme have come to a close. The learning that has been gained from those projects as well as those in flight is very encouraging and likely to make a positive contribution towards addressing the challenges faced by all network licensees. Within SHE Transmission, we will continue to engage with our stakeholders and collaborate with other interested parties in the energy supply chain to ensure that our NIA projects can deliver the best possible value to our customers.

Stewart A Reid

Head of Asset Management and Innovation

Scottish and Southern Energy Power Distribution plc

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1. SHE Transmission Innovation Strategy

SHE Transmission's Innovation Strategy document sets out the priorities for innovation based on seven main objectives identified as part of the RIIO-T1 submission. Each SHE Transmission innovation project is derived from one of the seven objectives to meet our core purpose of providing the energy which people need in a reliable and sustainable way. The seven objectives which shape our innovation activities are shown below:

- **Accelerate network development and connections including the integration of increasing amounts of renewable generation**

Historically the priority of SHE Transmission has been to ensure that electricity supplies are available with minimal interruptions: to 'keep the lights on'. Over the years we have supported innovative practices in this area to improve our overall performance. In recent years the challenges faced by our networks have significantly changed, driven by the UK's move towards a low carbon economy. Our transmission network is evolving from delivering energy from a small number of large generation sources to a large number of customers, to a more complex situation where it must accommodate bidirectional power flows created by an influx of new renewable generators, both large and small. Such demand for new connections is unprecedented. The transmission network, mostly built 50 years ago, was not designed to accommodate the collection of energy from such geographically disparate locations.

- **Minimise the cost of providing network capacity**

Whilst it is clear we need to act swiftly and effectively to provide the capacity required by our customers, we must ensure that in meeting this demand we minimise the costs of the work required. Our ultimate stakeholder is the UK electricity consumer; people who pay electricity bills have a legitimate interest in how they are made up. Given that transmission costs are a contributor to energy bills, it is important that we minimise the cost of building and running our transmission network. Our electricity connections customers, and other stakeholders with an interest in the availability of grid capacity, have a direct interest in the costs associated with the development and operation of the transmission system. They wish to see costs minimised, but at the same time wish for the network to provide capacity quickly and easily to allow them to pursue their plans. The need for SHE Transmission to ensure the costs are kept to a minimum is illustrated in quotations from two stakeholder organisations with a direct interest in the matter. These and other quotations from our stakeholders can be seen in SHE Transmission's Innovation Strategy which can be accessed through a link in Section 5 towards the end of this report.

- **Maximise the use of existing assets to deliver capacity and speed connection**

Widely favoured by our stakeholders, one of the most efficient ways to swiftly provide capacity for new renewable energy developments is to 'make the most of what we have' – to maximise the efficiency with which we use current assets. Transmission networks have extra capacity which is traditionally reserved to provide security of supply. This is known as system redundancy, an as yet largely untapped resource which could provide capacity for generation connections, reduce waiting times, and lower costs.

- **Maintain and improve safety and environmental performance**

SHE Transmission's primary responsibility to its stakeholders – including employees, contractors and customers – is to ensure their safety. Safety is the number one value of our company where we pride ourselves on 'doing everything safely, or not at all'. In keeping with our commitment to sustainability, SHE Transmission's target every year is to achieve zero environmental incidents. These priorities are shared by our stakeholders, who have expressed their desire for safety and sustainability to be identified as priorities in a number of ways.

- **Maintain and improve network performance**

The past performance of our transmission network has been excellent. As the UK's energy infrastructure evolves to accommodate more widespread generation sources, we must adapt to ensure this high standard of performance is maintained. It is notable that customers appear to take this aspect of SHE Transmission's responsibilities as 'a given'. This is reflected in the infrequency that system reliability was mentioned as a priority by our stakeholders. In contrast we strongly believe that in line with our company's core purpose of providing the energy people need in a reliable and sustainable way, this should remain as a focal point for our future development. As such, maintaining and improving network performance is one of our innovation objectives.

- **Provide more accurate information on the short and long term asset condition information to allow more informed decision making**

There is a desire amongst stakeholders that SHE Transmission makes the best possible use of existing assets. A key way of doing that is to ensure that assets are maintained and replaced at the right time – before they fail, but at a time when they have contributed as much as possible to the network. Currently our assets are replaced in line with a standard methodology agreed jointly with National Grid (NG), Scottish Power Transmission (SPT) and SHE Transmission. We believe that to meet our customers' needs we must make the most of existing infrastructure to maximise security of supply and minimise costs. We must gain a better understanding of how our assets age and fail, and put in place a programme which best meets this. Similarly innovations and techniques can allow the re-use of existing assets in new roles, for example insulated crossarms allowing existing towers to carry higher voltages.

- **Remain at the forefront of innovation to maintain our record of providing the highest standards of service at the lowest possible cost**

New ideas, improvements to process and design, and innovation have been key to SHE Transmission's success to date and are fundamental to our ability to adapt to the challenges of the future. To deliver the changes and improvements our stakeholders desire, we must maintain a strong culture of innovation within SHETL, by actively promoting and supporting new idea generation to provide the feedstock for tomorrow's innovations. We are building on our underlying innovative flair and will utilise the Network Innovation Allowance (NIA) to push the boundaries and accelerate the rate and effectiveness of innovation on the network.

2. NIA Project Portfolio

In the year ending the 31 March 2015, SHE Transmission had 14 projects funded under the Network Innovation Allowance (NIA). Six of these projects were closed whilst three had been registered during the year. The three new projects have yet to provide significant learning which can be shared hence their initial progress reports will be published at the end of this year.

A crucial aspect of SHE Transmission's NIA projects is that each of them has to satisfy at least one of our Innovation Strategy objectives.

Table 1 below shows all the registered NIA projects for the last year and how each maps onto our Innovation Strategy objectives.

Table 1		Objective 1	Objective 2	Objective 3	Objective 4	Objective 5	Objective 6	Objective 7
Project Number	**Project Name**	Accelerate development and connections	Minimise new capacity costs	Maximise use of existing assets	Safety and environment	Network performance	Accurate asset performance	Leaders of innovation
NIA_SHET_001	**Sustainable Commercial Model for Networks**	*			●			●
NIA_SHET_002	**Prognostics and Health Monitoring of Grid Connected Assets**			●	●		*	●
NIA_SHET_0003	**Alternative Tower Construction**	●	●		*			●
NIA_SHET_0004	**Dynamic Line Rating – CAT1**	●	●	*	●	●	●	●
NIA_SHET_0005	**Transformer Intrascope**			●	●		*	●
NIA_SHET_0007	**Insulated Crossarms – 132kV Trials**	●	*	●				●
NIA_SHET_0008	**HVDC Nanocomposite Insulation**		●			*		●
NIA_SHET_0009	**DC/DC Converter**		●			*		●

Project Number	Project Name	Accelerate development and connections	Minimise new capacity costs	Maximise use of existing assets	Safety and environment	Network performance	Accurate asset performance	Leaders of innovation
NIA_SHET_0010	**New Suite of Transmission Structures**	*	●	●	●	●		●
NIA_SHET_0011	**Lightning Protection**		●			*		●
NIA_SHET_0012	**Magnetically Controlled Shunt Reactor (MCSR)**	●	*	●				●
NIA_SHET_0013	**Modular Approach to Substation Construction**	*	●					●
NIA_SHET_0014	**Partial Discharge Monitoring to Reduce Safety Criticality**			●	*		●	●
NIA_SHET_0015	**Controlled Backfill for Peatland**		●			*		●
NIA_SPT_1502	**Distributed Photonic Grid Instrumentation (DPGI)**		●			*		●

Key: **Primary Objective** * **Relevant Objective** ●

3. Progress Summary

Strategy Objective 1: Accelerate network development and connections

NIA_SHET_001 Sustainable Commercial Model for Networks

Start Date: June 2013

Duration: 22 months

Description:

Development of a Sustainable Commercial Model (SCM) to quantify the contribution of electricity transmission projects to the Scottish and UK economy through direct, indirect and induced expenditure, as well as a method for quantifying the social and environmental impact of electricity transmission projects. The SCM will also be trialled in a specific transmission project.

Expected Benefits:

This project is focused on enabling more informed and consistent decisions in transmission project development. This has the potential to provide cost savings for transmission customers in areas such as the planning process as well as early and informed engagement with stakeholders to identify the most cost effective options.

Progress:

Several methods and excel software models (Sustainable Commercial Models) have been developed using the Beauly-Denny project as a baseline case study of evidence. The NIA phase of the project has now completed and the models developed are available to guide future projects on the most sustainable impacts which need to be considered within commercial decisions made during project development. Further testing of the SCM methodology is ongoing as part of business as usual conversion and the methodology has already formed part of the evidence submitted to the Regulator in support of a new Transmission project.

The full closedown report and associated attachments can be accessed via the smarter networks portal link in Section 5.

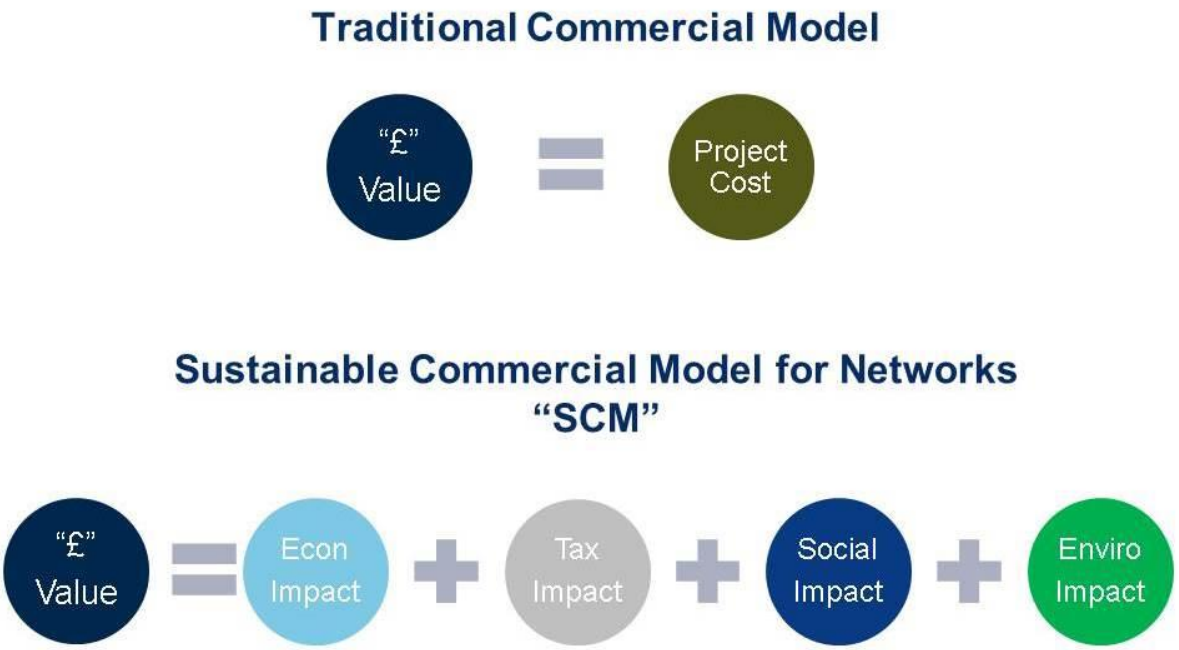

Figure 1: Traditional Commercial Model versus Sustainable Commercial Model

NIA_SHET_0013 Modular Approach to Substation Construction (MASC)

Start Date: April 2014

Duration: 24 months

Description:

This project is aimed at researching the potential market, developing a functional specification and engaging with manufacturers for the design development of a permanent substation using a Modular Approach to Substation Construction.

Expected Benefits:

The project will be successful if it delivers a recommendation from which a Modular Approach to Substation Construction policy can be developed by December 2015. This will allow more informed decisions to be made when considering design and construction options for future substation projects

Progress:

A functional specification for modular substation has been developed based on SHE Transmission standards for substations. This stage led to the tendering of the MASC project on the European market. Interviews of suppliers have been held and the proposals submitted have now been passed on to relevant internal specialists who will rank them. It is expected that this will be followed by the selection of ideas and possibilities which will bring out further efficiencies and also highlight the internal procedures and processes which need addressing.

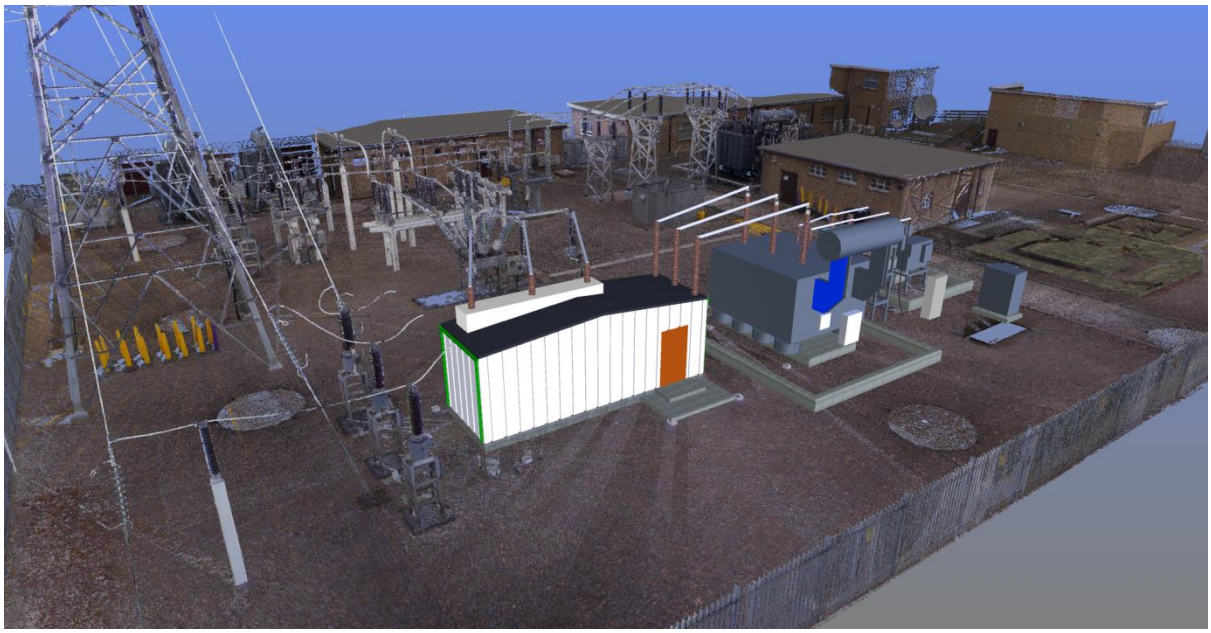

Figure 2: Artistic impression of a modular substation showing footprint reduction

NIA_SHET_0010 New Suite of Transmission Structures

Start Date: December 2013

Duration: 22 months

Description:

This project leverages existing innovations to design a suite of conductor support systems for transmission at 275kV. The aim of the project is to take advantage of new materials and products that will allow us to design a support and foundation that has a reduced impact on the environment.

Expected Benefits:

The project will provide new designs that take account of the wide ranging challenges that are faced by the industry, namely a new conductor support system that:

- Is a more efficient design for supports and foundations;
- Reduces the impacts on Statutory Authorities and Stakeholders so that it is easier to gain consents;
- Is easier, cheaper and quicker to build;
- Reduces the whole life impact on the environment by assessing the overall impact of the materials we select by considering how we harvest, manufacture, transport, process and build the structure.

Progress:

The project is nearing completion. In its final stage, models of eight proposed designs of potential new structures have been made and two of those have now been selected for further development. The outcomes of this project's progress have provided sufficient confidence that several of the designs warrant further development. To do this, an application has been made for funding under the Network Innovation Competition (NIC). The Initial Screening Process (ISP) submission for the project has been approved by Ofgem to enable a full submission to be prepared. The link to the ISP and questions related to the submission can be found in Section 5 of this document.

Figure 3: Photo montage of new tower structure series Source: Energyline Ltd

Strategy Objective 2: Minimise the cost of providing network capacity

NIA_SHET_0007 132kV Crossarm Trial

Start Date: April 2013

Duration: 24 months

Description:

This project is a follow-up to the completion of mechanical and electrical testing of insulated crossarms in another NIA project NIA_SHET_0006 Insulated Crossarms - Lecht and St Fergus Trial which was performed in a simulated non-operational environment. This project involves the manufacture and installation of crossarms on the towers of an operational 132kV circuit and monitoring them for their performance as well as evaluating their longevity.

Expected Benefits:

The use of insulated cross arms has the potential to uprate transmission lines, without requiring a full line to be rebuilt. Environmental benefits could be significant if existing towers could be used, as significant ground disturbances could be avoided. Financial savings could potentially be achieved by the use of insulated cross arms in line rebuild projects.

Progress:

The six crossarms manufactured for the project have been installed on adjacent towers of the 132kV Kintore-Craigiebuckler circuit since August 2013. So far, the crossarms have been in service without any problems. The NIA phase of the project ended on the 31 March 2015. As part of Engineering Policy acceptance of the crossarms for business as usual operation beyond the NIA trial, a non-crane method of installation and removal has been identified as necessary. The methodology for this has been already been designed and approved with only the fabrication and demonstration still remaining.

The full closedown report and associated attachments can be accessed via the smarter networks portal link in Section 5.

Figure 4: Installation of six insulated crossarms on the 132kV line

NIA_SHET_0012 Magnetically Controlled Shunt Reactor (MCSR)

Start Date: December 2013

Duration: 15 months

Description:

This project aimed at instituting a study to establish the feasibility of installing a trial MCSR on the SHE Transmission network. An MCSR uses controllable core saturation to continuously regulate inductive reactance to provide a smooth range of reactive output thereby maintaining voltage within required limits. An MCSR is able to provide fast dynamic response at a lower cost than Static Var Compensators (SVC).

Expected Benefits:

The feasibility study established the best locations for a trial MCSR and its specification. A risk analysis of the technology was performed, and an analysis of the installation, training, operation and maintenance requirements. As a result of the study, the characteristics of this technology are known to the company and the basis has been provided for a future decision whether to proceed with a trial.

Progress:

The project has now completed and a technical report of the feasibility has been produced and shared with relevant stakeholders. System studies were also completed as part of assessing the need for the device and its potential to mitigate the voltage issues on the transmission network. The recommendations made in the project will be reviewed once the political situation in Ukraine has changed. The full closedown report and associated attachments can be accessed via the smarter networks portal link in Section 5.

Figure 5: Magnetically Controlled Shunt Reactor (MCSR)

Source: ZAPOROZHTRANSFORMATOR PJSC

Strategy Objective 3: Maximise the use of existing assets

NIA_SHET_0004 Dynamic Line Rating CAT1

Start Date: April 2013

Duration: 60 months

Description:

The project is aimed at evaluating an innovative system with potential to provide real time monitoring of overhead line networks. The method involves measuring tension and sag on the line in conjunction with known line characteristics to obtain accurate rating values for the line at any moment.

Expected Benefits:

- Securement of Transmission line outages, given increased confidence in current carrying ability of the rest of the network under fault conditions
- Increased generation output hence allowing further generation connections to the 132kV network
- Advance warning of impending clearance violations through sag monitoring
- Matching of line ratings to load and weather conditions.

Progress:

Confidence has grown in the viability of the CAT-1 system to provide information on conductor conditions based on evaluation of data from units installed on a 132kV line on the Kintyre peninsula. A new batch of devices has now been installed on another line and the integration of the proprietary communication system with SHE Transmission SCADA is progressing. The next stage of the project will involve establishing the correlation between the theoretical model and practical observations.

Fig 6: CAT1 system installation

Strategy Objective 4: Safety and environmental performance

NIA_SHET_0003 Alternative Tower Construction

Start Date: April 2013

Duration: 24 months

Description:

This project investigates the use of a modified SBB Emergency Restoration System (ERS) as a Lightweight Tower Crane (LTC) in the trial construction and dismantlement of transmission towers in SHE Transmission's license area to establish if it is technically feasible, economical, minimises environmental impact and mitigates safety issues inherent in existing construction methods.

Expected Benefits:

Use of an LTC as a construction method reduces costs by removing the need for temporary access roads when constructing tower lines. Further costs attributed to associated cranage for use with the temporary roads are also avoided. In addition, there are benefits derived from minimising environmental impact from constructing temporary roads.

Progress:

The NIA phase of this project has been closed and a site demonstration of the construction and use of the LTC is being organised as part of converting the methodology into business as usual.

The full closedown report and associated attachments can be accessed via the smarter networks portal link in Section 5.

Figure 7: Light Tower Crane assembly

NIA_SHET_0014 Partial Discharge Monitoring to Reduce Safety Criticality

Start Date: January 2015

Duration: 36 months

Description:

The scope of this project is to install online trial Partial Discharge (PD) monitoring systems incorporating alternative technologies and suppliers at selected sites and integrate with SHE Transmission's SCADA system in order to collect, store and analyse output PD event data to establish if this can be used to improve the management of safety critical plant. Learning from this project will also be used for further work to incorporate PD failure precursors into control and protection schemes.

Expected Benefits:

The most significant benefit from this project is safety. If equipment is isolated from the network prior to disruptive failure then the risk to safety will be minimised. Furthermore, where assets have been earmarked for replacement just as a result of their being identified as having high safety criticality, deferring their replacement through the continuous monitoring method proposed in this project will have a financial benefit.

Progress:

The project has successfully been registered as an NIA project and the tender process for the suppliers of the alternative systems has been completed. Installation work at one site is in progress and upon completion another tender will be held for the second site where another trial will be held.

Figure 8: Partial Discharge sensors installed on a cable sealing end

Source: HVPD

Strategy Objective 5: Improve network performance

NIA_SHET_0008 HVDC Nanocomposite Insulation

Start Date: April 2013

Duration: 30 months

Description:

This project is concerned with investigating the development and scaling of nanocomposite electrical insulation materials for HVDC power transmission applications. Insulation represents a major cost of network assets and use of nanocomposite materials is expected to bring the costs down.

Expected Benefits:

It has the potential to address the need for advanced electrical insulation materials dedicated to high performance next generation HVDC power transmission applications. It is expected to demonstrate improved HVDC performance of materials compared to traditional thermoset micro-composite insulation. The overall benefit is that if this technology is successful, it will significantly lower the cost of HVDC insulation.

Progress:

Investigation has been done into production/development of insulator including challenges of controlled nano-dispersion, matrix nano-filler interfacial control and reliable reaction behaviour. The current phase of the project has just completed and the learning from it has been positive. Since the technology is still at an early stage, the scope of a follow-on project is currently under discussion by relevant stakeholders.

NIA_SHET_0009 DC / DC Converter

Start Date: September 2013

Duration: 42 months

Description:

The scope of the project comprises:

- Design and develop the software models of high power DC/DC converter
- Study DC/DC converters, DC hubs and their integration with HVDC systems
- Optimise the design of a DC/DC converter.
- Produce conclusions and recommendations on the design of DC/DC converters and their use integrating HVDC systems.

Expected Benefits:

There are about between 20 and 45 new HVDC links anticipated in GB according to NG's Ten Year statement of 2012. If this project is successful and the technology becomes commercially available, it may offer alternative approaches to the integration of HVDC schemes with the potential for significant cost savings. This is possible through connection of HVDC systems at different voltages thereby enabling multi-terminal HVDC schemes.

Progress:

The PhD student doing research on this project is progressing with studies. The first task has been completed and the associated report has been produced: Task 1. Design of high power Modular Multilevel Converter (MMC) bridge operating at 1-2kHz. A detailed PSCAD model for 1GW MMC has been developed and the impact of higher switching frequency has been studied.

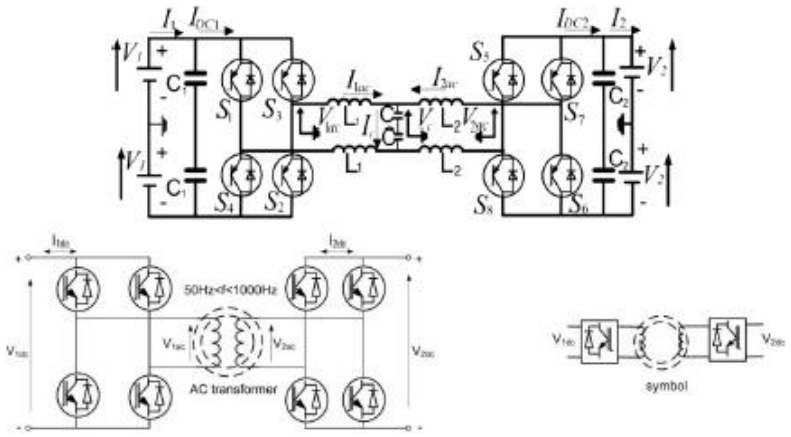

Figure 9: DC/DC Converter

Source: University of Aberdeen, PhD research project

NIA_SHET_0011 Lightning Protection

Start Date: December 2013

Duration: 36 months

Description:

This project involves building and verifying simulation models of lightning strikes on lines at 132kV and above with towers that have high footing resistances. This will enable investigation of protection options which will inform decisions on lightning protection approaches.

Expected Benefits:

This project's aim is to optimise the design of lightning protection for towers with high footing resistance in order to cut costs. At the moment, the choices are limited and the process is largely based on trial and error until the resistance is acceptable. This project, if successful, might avail alternative options and the ability of informed decision making. It is therefore envisaged that savings of up to £30k may be made per tower with high footing resistance.

Progress:

A PhD student is doing research on this project. So far, an evolving technical project report has been provided at each quarter detailing work to date. Literature reviews of lightning source, overhead line, tower structure and insulators have been completed. Modelling, simulation and laboratory work on the lightning source has been completed and the same process will follow for the aforesaid components.

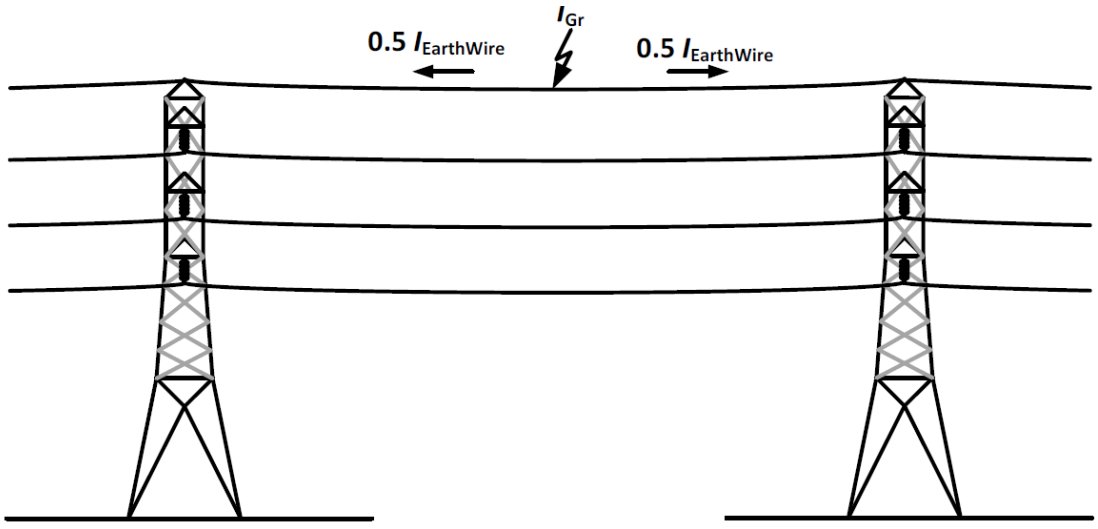

Figure 10: Simplified illustration of overhead line towers with conductors

Source: Heriot Watt University, PhD research project report

NIA_SPT_1502 Distributed Photonic Grid Instrumentation (DPGI)

Start Date: March 2015

Duration: 10 months

Description:

This project is a collaboration with Scottish Power Transmission and it involves the development of photonic sensors which can demonstrate the potential for faster, safer, more accurate and less expensive instrumentation for monitoring, control and protection.

Expected Benefits:

This project's method will provide technical benefits through enhanced system monitoring, protection and automation, reduced secondary wiring and complexity. It will also facilitate the 'smart grid' by provision of accurate information on system status. Through reduced material use as is currently the case for standard instrument transformers, this method is likely to lead to improvement in carbon footprint.

Progress:

The sensors for this project are under design and development. Technical specifications are also being reviewed and refined to enable Synaptec, the R&D provider to incorporate features which enable use within the substation environment.

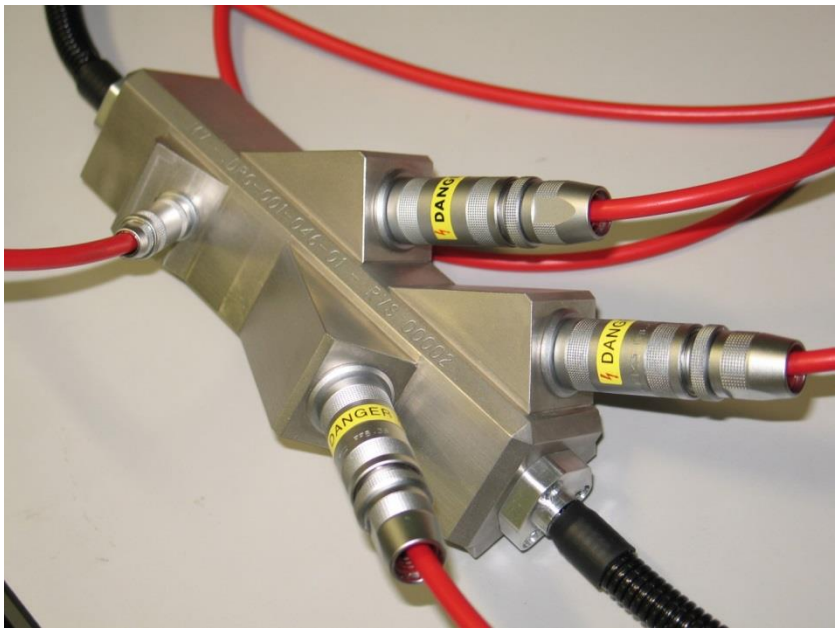

Figure 11: Three phase, 5kV Voltage sensor

Source: Synaptec

NIA_SHET_0015 Controlled Backfill for Peat Land

Start Date: March 2015

Duration: 18 months

Description:

To find suitable alternative backfill materials, conduct Thermal Resistivity (TR) tests in the lab and in close HV cable proximity in order to identify the material which is most technically suitable, environmentally friendly and cost-effective for use in peat land.

Expected Benefits:

The following are the benefits that are expected if this project is successful:

• Reduced cost through identifying a controlled backfill material which is more economical than Cement Based Sand (CBS)

• Reduced cost for cable installations in peat land by designing projects with appropriate cable ratings and economic use of cable sizes

• Improved power flows due to increased cable ampacity gained by lowering the backfilling TR

• Improved cable lifetime by lowering the risk of cable damage or faults due to overheating

• Improved environmental performance by using a solution that is friendly to the peat land habitat

Progress:

The project has recently been registered and kick-off activities are in progress.

Figure 12: Thermal Resistivity measurements Source: J Murphy and Sons Ltd

Strategy Objective 6: Accurate Asset Information

NIA_SHET_0002 Prognostics and Health Monitoring of Grid Connected Assets

Start date: July 2013 (NIA)

Duration: 42 months

Description:

The objectives of this project at inception were to:

- Review the literature on prognostics and health management;
- Build a small-scale prototype prognostics system for testing on electromechanical relays;
- Apply the prototype results to develop a cost-effective online transformer oil condition monitoring and prognostics system prototype for subsequent testing on a decommissioned SHE Transmission grid transformer

Expected Benefits:

Prognostics and health management (PHM) can potentially provide an improved assessment of the condition of an operational network asset. This can inform the network operator's asset management decisions. For example, the life of a transformer may be extended through an estimation of the transformer's remaining useful life using PHM tools. This would provide a financial benefit to our customers by minimising the cost of replacing ageing assets on our network.

Progress:

As part of the initial phases of the project, a detailed review of the tools available for prognostics and health management (PHM) was completed. The conclusions from this review were then successfully applied in a lab-based prognostics prototype test bed to test the contacts of small electromechanical relays. The project was prematurely terminated after completing the first two objectives.

The full closedown report and associated attachments can be accessed via the smarter networks portal link in Section 5.

NIA_SHET_0005 Transformer Intrascope

Start Date: April 2013

Duration: 24 months

Description:

The transformer intrascope system has been developed as an asset management tool to assist with the condition assessment of internal paper winding insulation within electrical power transformers. It is in the form of a controllable probe which can be inserted through the hatch of a defective transformer to analyse the chemical composition of the Kraft paper insulation to assess the health of the asset in situ.

Expected Benefits:

- Correlation with and increased confidence in using existing methods such as dissolved gas analysis of insulation oil for condition assessment of power transformers
- Maximising the operation of existing transformer assets by delaying expensive asset replacement
- Collection and storage of retrievable, reliable and potentially improved condition information of our existing fleet of transformer assets.
- The system can be used as a lower cost tool for investigation of commissioned, faulted and decommissioned out-of-service transformer assets compared with conventional off-site transformer de-tanking
- Increased confidence in the condition of transformer assets connected to the network

Progress:

An intrascope system has been designed and developed with the practical functionality to allow in-situ transformer inspection within a site based environment. The fully assembled prototype system has been both mechanically and functionally tested in a number of field based trials on both primary and supergrid transformers. An inspection of a commissioned operational transformer on the SHE Transmission network has been completed.

The current phase of the project has completed and the device developed will continue to be used in SSEPD. Already, arrangements are underway for use of the device for inspecting transformers at another substation. The lessons obtained from the current phase of the device are being used to shape a follow-on project aimed at raising its technology readiness level (TRL) as well as improving technical issues identified as needing improvement.

The full closedown report and associated attachments can be accessed via the smarter networks portal link in Section 5.

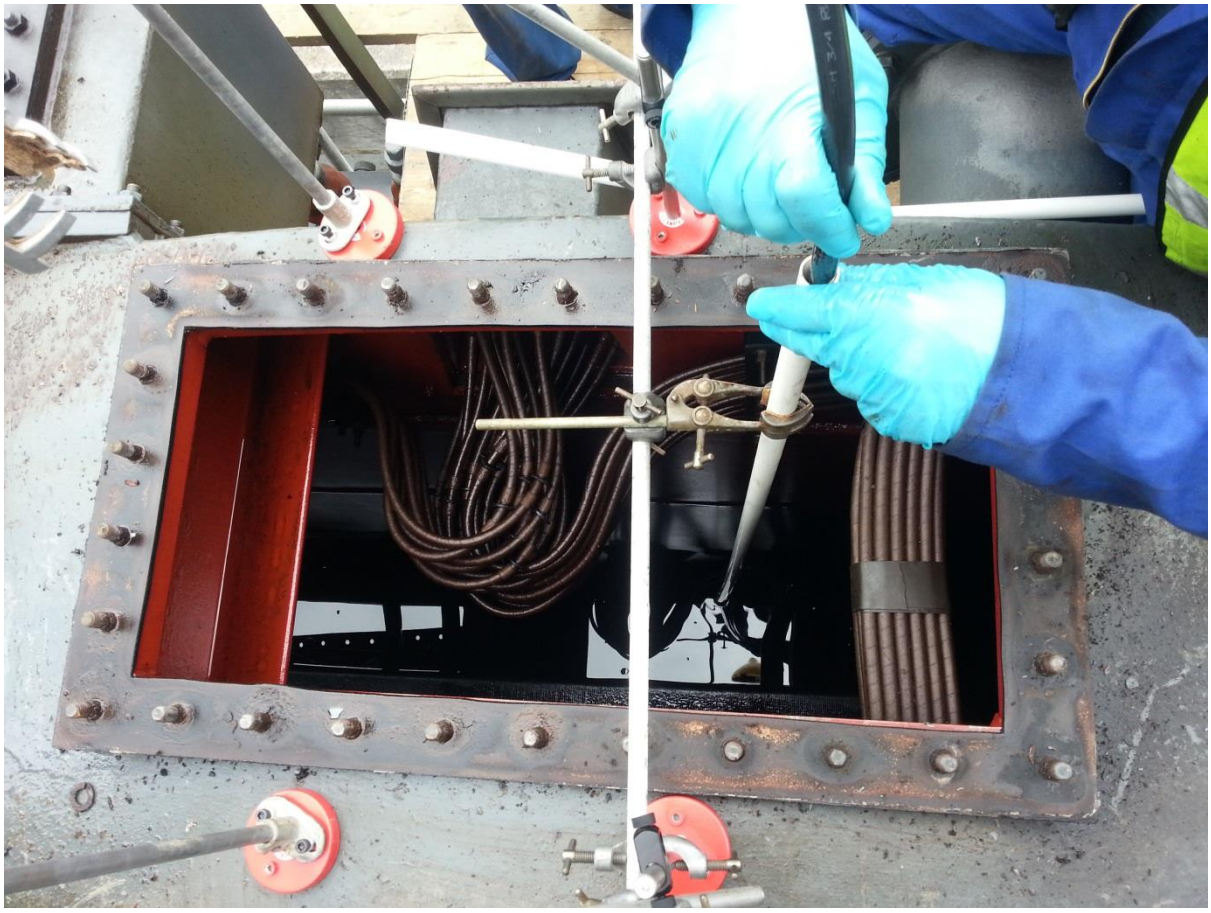

Figure 13: Intrascope inspection of transformer winding from top hatch

Strategy Objective 7: Remain at the forefront of innovation

All SHE Transmission NIA projects have to meet the test of keeping us at the forefront of innovation. This objective drives us to continue to seek improvements which can deliver value to our customers because we strongly believe that such improvements are only achievable if innovation continues to be embedded in the way we do things. Our projects summarised in this document are a reflection of this culture in SHE Transmission and SSEPD as a whole.

4. Highlights of the year: Areas of significant new learning

Valuable learning about the assessment of design aspects of new transmission structures

Our New Suite of Transmission structures project has produced examples of a range of support options which have led to the eventual selection of eight support structures which were taken through further design and review. As part of the subsequent review process, models of the eight supports as well as an existing representative lattice design were built to scale to enable a visual benchmarking exercise. A Support Assessment Matrix developed by Energyline Ltd provided a tool for use by the SHE Transmission Working group to make a qualitative assessment of the design aspects of each of the eight supports. This work culminated in the selection of the final two supports which will now be taken for further development and a trial build of components. A special innovation workshop will be announced later to all interested parties and during the next LCNI conference the models developed will be exhibited to share the learning that was gained at that stage of the project.

Gaining insight into the behaviour of lightning through modelling

As part of our NIA project 'Lightning Protection', we are beginning to gain a better understanding of the behaviour of transmission lines under lightning strike conditions through the creation of a suite of models. So far, two models have been prepared covering the following aspects of the project:

- Behaviour of lightning strikes in UK based on available data obtained from the lightning indicator tool installed in our control room as well from previous works
- Behaviour of transmission lines under lightning strikes.

The successful completion of these models is now being followed up with the development of models for the behaviour of towers, the corona as well the cost and impact of different lightning protection techniques.

The learning from the modelling work so far will initially be shared through the publication of a paper that is currently under review by project stakeholders. Overall project learning to date will be shared at the next LCNI conference.

Assessing GB's commercial environment against the external paradigm shift in substation construction

The NIA project 'Modular Approach to Substation Construction' has provided significant learning about the disparity between GB and the wider world in adoption of concepts such as modular substation construction. It has also shown how the commercial approach taken in getting proposals from potential suppliers has a direct impact on the breadth of innovation that suppliers are likely to propose. As is stated in the progress report of this project, provision of a functional specification closely coupled to internal policies potentially reduced the diversity and extent of solutions proposed by suppliers. Some of these observations were made as further engagement was made

with suppliers during the tender process. Although focus on a limited number of solutions is regarded as good practice, the potential further efficiencies achievable from exploring more innovations as demonstrated by suppliers suggest that there is value in doing further research in this area, albeit through a different project.

The foregoing lessons and others from this project will be shared at the forthcoming LCNI conference in November 2015.

Turning innovation concepts into techniques for everyday use

SHE Transmission has closed 6 NIA projects which completed in the last year. 4 of the projects have successfully delivered their objectives and success criteria. Where these were not completely achieved, the learning that was gained within the tasks which were completed is still valuable for use in future projects or business as usual activities of a similar nature. The closure reports and accompanying outputs on the online learning portal and on the SSEPD website provide detailed learning that enables replication, further assessment and development of the methodologies. Below is a summary of how the projects' learning is being applied in SSEPD and how the same methods can be replicated by other interested parties in the energy supply chain:

- The Sustainable Commercial Model (SCM) will now become the framework for quantification of sustainability impacts in evidence provided to support new projects. New projects have already started to use the SCM in SSEPD and it will continue to be used.
- The Insulated Crossarms installed and working on our Craigibuckler-Kintore circuit have provided further confidence about this technology and hence the technology has become part of the design considerations shaping support structures of the future.
- The Transformer Intrascope has proven its usefulness during trials. The current device will continue to be used through inspection service provision by the expert R&D providers on operational assets to reap the benefits and also develop further learning that can feed into further work aimed at refining the technology.
- The Alternative Tower Construction project has demonstrated that transmission overhead line projects can be delivered with minimal environmental impact associated with access routes. Once the outstanding demonstration is held to get final Engineering Policy approval, this method will become the de facto method of tower construction wherever it is suitable.
- The Magnetically Controlled Shunt Reactor (MSCR) feasibility study explored a technology that has not yet reached the UK. After the feasibility study delivered in this project, there is now a basis for introducing this technology and its benefits to the UK through a trial. This is expected to be revisited once the current shunt reactor installation program has been completed, and when the conflict in Ukraine (where the MCSR is manufactured) has been resolved.
- The Prognostics and Health Monitoring of Grid Connected Assets project was terminated due to unforeseen circumstances. However, by that time, there was adequate learning from some tasks within the project which serve to set the scene for potential future work or for replication in dealing with like for like work packages within other innovation projects.

5. Further Information

The complete SHE Transmission Innovation Strategy can be found on the link below:

SHE Transmission Innovation Strategy

The initial screening submission made by SHE Transmission to develop the NIA_SHET_0010 New Suite of Transmission Structures project into an NIC project can be accessed through the link below:

NeSTS ISP

Further details of all the NIA projects summarised above can be accessed through the following link:

ENA Smarter Networks Portal

Alternatively, all SHE Transmission NIA project documents can be accessed via our website on the link below:

SHE Transmission Innovation Library

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