Scottish & Southern Electricity Networks

TRANSMISSION

Scottish Hydro Electric Transmission

Network Innovation Allowance Summary Report

Stakeholder-led strategy

Safe and secure network operation

Sector-leading efficiency

Leadership in sustainability

CONTENTS

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TRANSMISSION

FOREWORD

This report is a summary of progress made by Scottish and Southern Electricity Networks Transmission (SSEN Transmission) license: Scottish Hydro Electric Transmission plc, for the Network Innovation Allowance (NIA) funded projects during the period April 2021 and March 2022. The purpose of the NIA is to fund small innovation projects that are generally investigative in nature, with the outputs having the potential to deliver value and benefits to the business and consumer.

In 2019, we published our Innovation Strategy that focuses on delivering benefits for our customers and wider stakeholder groups. The strategy had been designed to enable the prioritisation of the most important innovations that can deliver the greatest benefits. However, embedded within this strategy is our overarching business priority of delivering a network for Net Zero. Innovation is a way of supporting this, and through the NIA we can de-risk a number of the uncertainties that the challenge of Net Zero presents. We want to ensure we get the most out of innovation, so that is why we have designed a five-stage process, that incorporates Cost Benefits Analysis (CBA) allowing a clear and consistent method of identifying and developing innovation with maximum benefit to our consumers.

The NIA is agile and creates great opportunity to explore new methods that would otherwise be deemed too risky. It helps discover new learnings, as ideas evolve through their levels or readiness, and our aim is to take these learnings and drive them forward to either identify new innovation opportunities or create Business as Usual (BaU) solutions.

This report covers the first full year of the RIIO-2 price control. In this time, our focus has been on creating the foundations of our RIIO-2 NIA portfolio. In alignment with our innovation strategy, we have taken a 'User Driven' approach to identifying new opportunities and continue to use the structure of the Innovation Framework as our principal guide. At the same time, we have concluded the final projects from our RIIO-1 portfolio, where learnings obtained will be used to inform our strategic direction and opportunities throughout RIIO-2.

We identify that the innovation landscape is continually changing and that is why our aim is to revise our innovation strategy over the coming year, to ensure we are strategically focused on the challenges that matter most. It is a truly exciting time within our industry. Our Network is seeing rapid growth, and as we build our network for Net Zero, innovation will sit as a cornerstone to support the energy system of the future.

Andrew Urquhart
Head of Whole System
SSEN Transmission

Scottish & Southern Electricity Networks
TRANSMISSION

1

SUMMARY OF PROGRESS

The SSEN Transmission Innovation Strategy sets out our plans and ambitions for getting the most from innovation before, during and after the RIIO-T2 price control period. This strategy aligns with the wider Electricity Network Innovation Strategy.

SSEN Transmission has four Innovation Focus Areas to support the SSEN Transmission Strategic Objective of enabling a transition to a lower carbon economy.

Each project accumulates knowledge and learning which aligns with one or more Innovation Focus Areas and underpins the SSEN Transmission Values: putting the needs of our stakeholders at the heart of our innovations, focusing on engaging the right people at the right time including partnerships to drive innovation and seek best value through continuous improvement, as we commit to a smart, sustainable energy future.

The relevant Innovation Focus Areas associated with the live NIA projects are represented via the icons below.

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1.1 NIA SHET 0026 REFASE

KEY ACTIVITIES

Refase is a new control product that allows measured values from up to 50 current transformers to be acquired using a single optical fibre core over distances up to 50km. By centralising current measurements, this method negates the need for multiple protection relays, complex time synchronisation systems at measurement points, and telecommunications equipment among the distributed protection and control devices. This project is sector-leading for a new technology, and will conduct a series of desktop trials, which if successful will progress into the field where the performance of the Refase system will be benchmarked against traditional protection methods.

BENEFITS

The approach demonstrated in this trial has the potential to save approximately £250,000-£350,000 in capital expenditure per installation, compared to conventional approaches to multi-ended circuit protection. The savings come from reduced need for equipment, space in the substation, the minimising of civil engineering work, less copper wiring, and the ability to leverage existing optical fibres OPGW which are a ready-made network for Refase passive sensors.

PROGRESS

The project is now closed. As a result of the project the Technical Readiness Level (TRL) of the Refase has increased to TRL8 and upon completion of compliance with SHE Transmission's General Requirements for Protection IED's document and ENA certification, Refase will be suitable for use in BAU.

COLLABORATORS

Synaptec / ABB / GE / Evolution Systems Ltd.

INNOVATION FOCUS AREAS

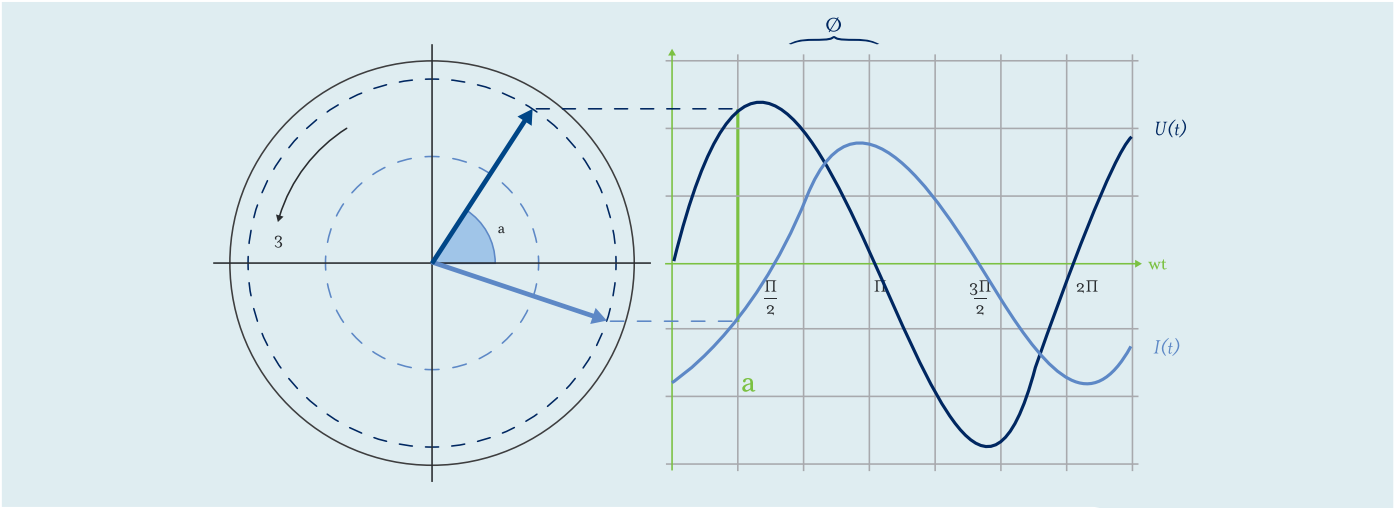
- Stakeholder-led strategy
- **Safe and secure network operation**
- **Sector-leading efficiency**
- Leadership in sustainability

Funded
£388,360

Start/end date
June 2019 / March 2022

Website
https://www.smarternetworks.org/project/nia_shet_0026

1.2 NIA SHET 0029 PHASOR BASED MONITORING



KEY ACTIVITIES

The GB Electrical Transmission Network is expanding, with an increase in the number of High Voltage Direct Current (HVDC) connection applications. This project aims to build upon learnings from the VISOR and MIGRATE projects and explores the potential of phasor wide area network monitoring and its application in controlling the incoming power from HVDC connections..

BENEFITS

The project seeks to identify potential benefits of controlling HVDC link power flows based on phasor-based monitoring to connected AC networks.

PROGRESS

The project is now closed. The application has successfully provided GE with remote access to their servers in the National HVDC Centre via a wireless VPN connection.

In the safe environment which mimics the transmission system it was possible for GE to develop and positively prove the operation and functionality of their wide-area phasor-based monitoring solution for HVDC control.

The results suggest this means that HVDC control is efficient in certain system situations such as electrically weak networks. However, it is recognised that there are research limitations and more testing on different network configurations is required to progress solution development.

COLLABORATORS

GE Digital / Ametek

INNOVATION FOCUS AREAS

- Stakeholder-led strategy
- Safe and secure network operation
- Sector-leading efficiency
- Leadership in sustainability

Funded
£321,000

Start/end date
October 2019 / April 2021

Website
https://www.smarternetworks.org/project/nia_shet_0029

1.3 NIA SHET 0031 WAKE INDUCED VIBRATION MONITORING

KEY ACTIVITIES

Some wind generation schemes may encroach or come close to existing infrastructure such as Transmission Overhead Lines. This project has been established to address the question "What effect and at what proximity do wind generators introduce an undesirable consequence on the existing conductor configurations and conductor types used on transmission overhead lines?".

BENEFITS

The project develops the ability to accurately simulate and model the effect of wind turbine turbulence on overhead line conductors, replicating actual conditions and effects from the field. This will provide the basis for conducting various scenarios to form appropriate recommendations and guidance for future similar proposed installations.

PROGRESS

The project is now closed and has successfully produced an extensive literature review into the different ways of investigating the impact of a wind turbine on an overhead line, with recommendations on how to approach this project and generate guidance material or to create a tool to help assess the impact of a turbine on an overhead line.

The project also produced a 'Tool' based upon the wind flow modelling effects of a wind turbine in close proximity to an overhead line conductor, which can be used to provide a basis for appropriate recommendations and guidance for future proposed wind turbine installations.

COLLABORATORS

PLP / ESB International / Wilde Analysis

INNOVATION FOCUS AREAS

- Stakeholder-led strategy
- Safe and secure network operation
- Sector-leading efficiency
- Leadership in sustainability

Funded
£310,000

Start/end date
April 2020 / June 2021

Website
https://www.smarternetworks.org/project/nia_shet_0031

1.4 NIA SHET 0032 TOTEM

KEY ACTIVITIES

Conventional phasor-based simulation tools have limitations in studying weak, low inertia systems due to the level of detail that is represented.

In conjunction with National Grid Electricity Transmission, National Grid Electricity System Operator and Scottish Power Transmission, there is a move to develop more detailed electromagnetic transient (EMT) based models which will address the present system modelling concerns.

BENEFITS

If successful, the new EMT power system model will help all of the Transmission Owners in GB to de-risk the integration of many of the technologies associated with the move towards the energy system transition, and may reduce system inertia and contribute to unplanned system outages.

PROGRESS

The TOTEM project is now closed. The project has been successful in developing a multi-Party Agreement which enables the GB Transmission Owners to work together to acquire and validate a new system model that will enhance, as well as de-risk, the integration of technologies that lower the system inertia.

COLLABORATORS

National Grid Electricity System Operator / National Grid Electricity Transmission / Scottish Power Transmission

INNOVATION FOCUS AREAS

- Stakeholder-led strategy
- Safe and secure network operation
- Sector-leading efficiency
- Leadership in sustainability

Funded
£580,000

Start/end date
May 2020 / April 2021

Website
https://www.smarternetworks.org/project/nia_shet_0032

1.5 NIA SHET 0033 PSL-FC

KEY ACTIVITIES

This project aims to investigate how effective and reliable new Protection and Control equipment is on a future electricity network, which has even more renewable generation and power electronic equipment, via a combination of network simulation and open-loop device trials.

BENEFITS

This project is testing new Protection & Control (P&C) products designed to respond to a future electrical network where the fault current spike is low but prolonged.

The present mitigation measure for areas of the network that may be exposed to lower levels of fault current is a device called a Synchronous Condenser. A Synchronous Condenser can replicate a traditional fossil fuel power source and in the event of a fault it will respond with a very large, sudden, single bolt of current enabling currently deployed P&C devices to respond but would cost around £15m per installation on the network.

If this project can evidence that new P&C products, with costs of c£200k per installation, have the potential to respond effectively in a lower-level fault current environment and identify any changes needed in P&C policies and procedures then the costs of Synchronous Condenser deployment may be avoided.

PROGRESS

The project has identified a number of protection and control devices being developed by different manufacturers to operate at low fault current and has commenced a test program to assess their capabilities.

RESEARCH PARTNER

Strathclyde University

INNOVATION FOCUS AREAS

Stakeholder-led strategy

Safe and secure network operation

Sector-leading efficiency

Leadership in sustainability

Funded
£671,000

Start/end date
July 2021 / October 2024

Website
https://smarter.energynetworks.org/projects/nia_shet_0033

1.6 NIA SHET 0034 LOW PROFILE 132KV STEEL POLES

KEY ACTIVITIES

The project objective is to create a low-profile design which replicates the visual consenting envelope, reliability levels, insulation level, and construction methods associated with wood poles, significantly reducing future construction costs. Application of the low-profile design within the existing design suite as a substitute for current steel structures could provide a significant reduction in construction costs. Lower construction costs will provide customers with lower cost connections and support energy system transition.

BENEFITS

The learnings from the project have the potential to facilitate energy system transition by providing a lower cost OHL compared to current approved designs (lattice towers/NeSTS), enabling lower cost connections for renewable generation. The project aims to provide an alternative supply chain to address the long lead times and creosote obsolescence risk associated with wood poles.

PROGRESS

The project is in early-stage development with concept designs delivered. Several workshops with project partners to focus on the design stage have been undertaken to date with positive outcomes for the project.

COLLABORATORS

Energy Line / PLPC / NorPower

INNOVATION FOCUS AREAS

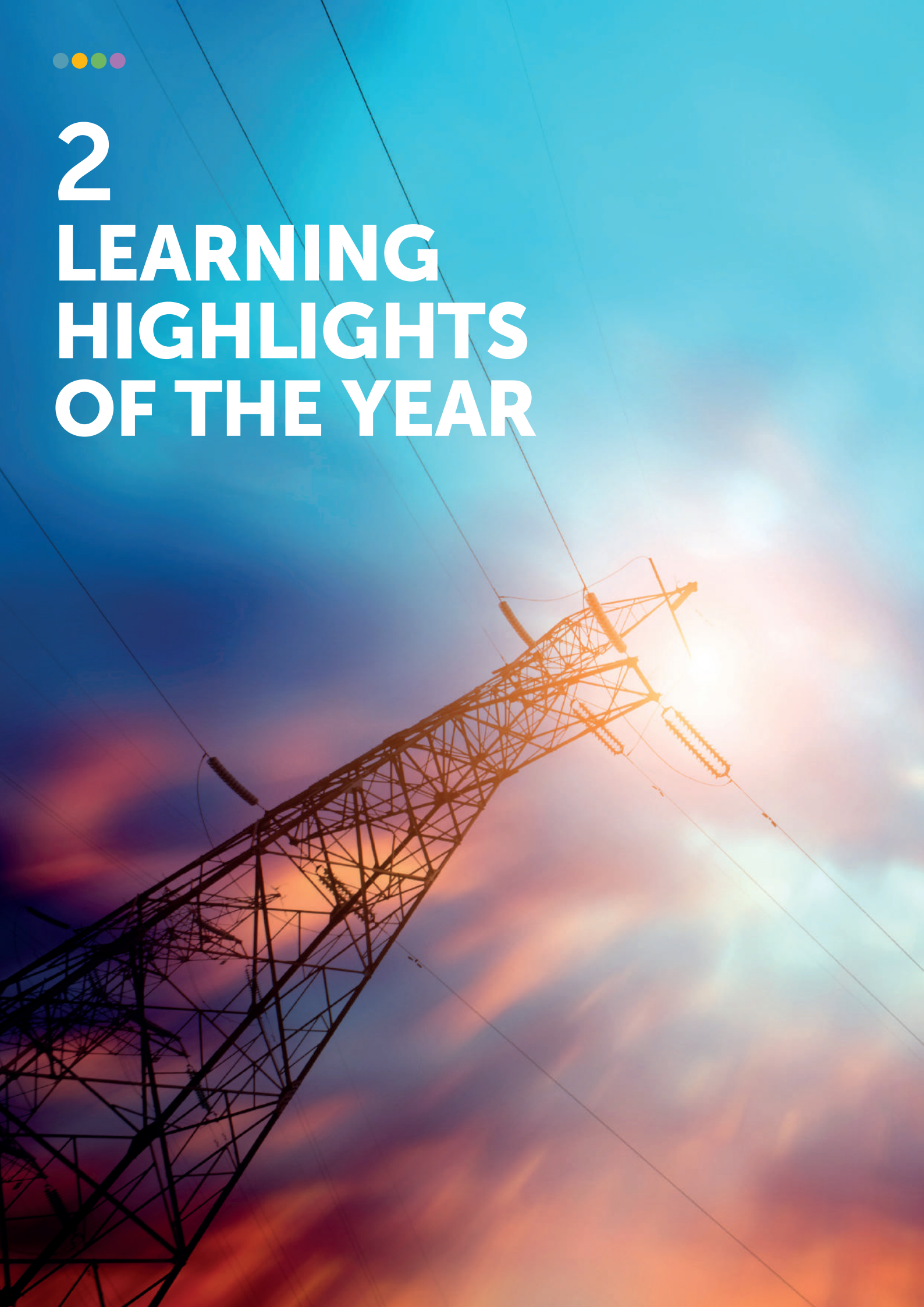
- Stakeholder-led strategy
- Safe and secure network operation
- Sector-leading efficiency
- Leadership in sustainability

Funded
£1,650,000

Start/end date
January 2022 / July 2023

Website
https://smarter.energynetworks.org/projects/nia_shet_0034

2 LEARNING HIGHLIGHTS OF THE YEAR



2.1 REFASE

Refase is Synaptec's multi-zone protection instrumentation product. It is designed to enable robust protection of complex, wide-area, or distributed power networks and assets. The ability of Refase to access many measurements over a wide geographical area, or traverse multiple feeder sections within a substation, can enable convenient centralised protection and control functions, including multi-zone protection (up to 16 zones per fibre) and highly-selective auto-reclose blocking for hybrid lines.

The system can make protection-class measurements over distances of up to 50km (depending on the health of existing fibre infrastructure), which permits efficient unit protection of lines, cables, and other assets placed at very remote locations where it would be challenging and costly to install conventional monitoring equipment.

By centralising current measurements, this method eliminates the need to have multiple protection relays at each line end, complex time synchronisation systems at measurement points, and complex telecommunications equipment among the distributed devices, potentially resulting in significant operational and infrastructure savings.

SSEN Transmission has undertaken significant factory acceptance testing of the Refase product to demonstrate its performance before progressing to a live field trial. The system has been installed on the Inverarnan/Killin circuit to shadow the existing protection scheme and has performed satisfactorily to date. The field trial is continuing beyond the end of the NIA project where SSEN Transmission engineers will monitor the performance of the Refase system over an extended period.

2.2 PHASOR-BASED MONITORING FOR HVDC APPLICATIONS

GE were appointed in 2019 to undertake this research project, as they had conducted several wide area network monitoring trials using PMUs, including VISOR which was a Scottish Power Transmission NIC project.

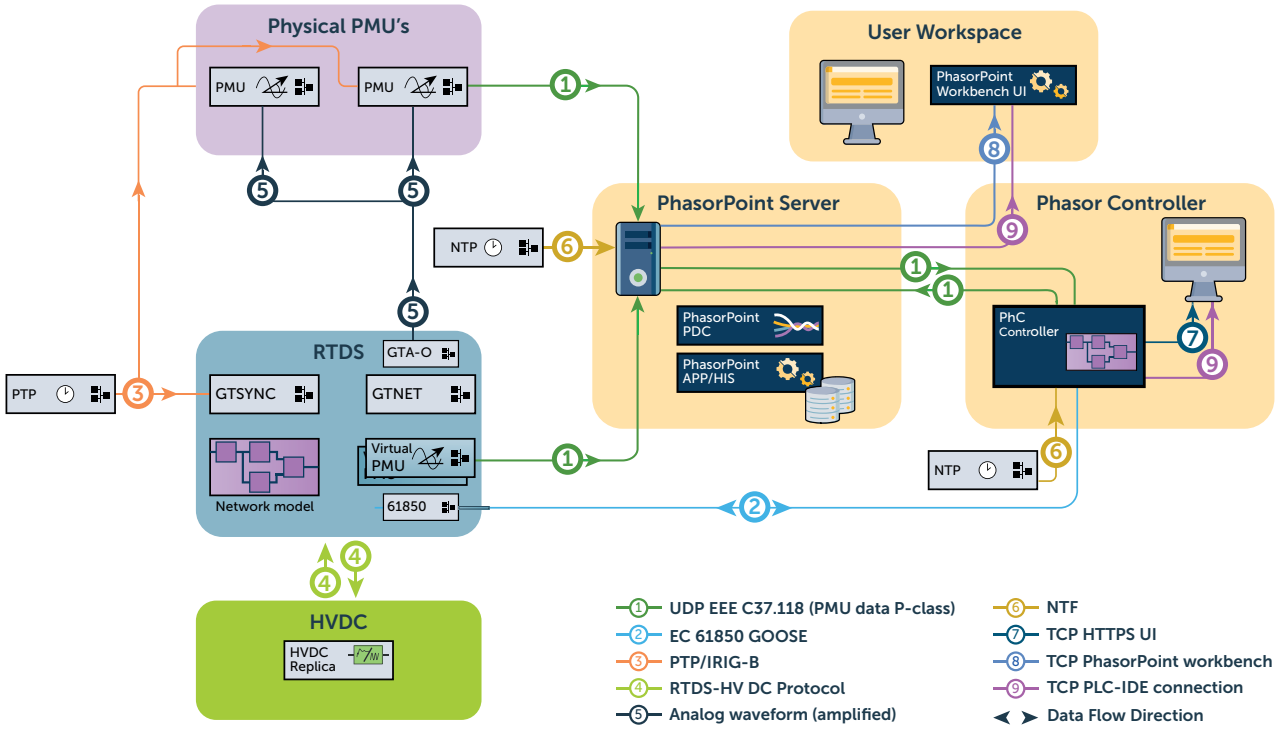
GE started the project by placing their server, which houses a PMU data concentrator, within the National HVDC Centre. Following on from this, a test environment was created using the inbuilt virtual PMUs within the Real Time Digital System (RTDS) model and two physical Ametek PMUs (which are identical to the actual PMUs on the SSEN transmission system). The uniqueness of the PMUs in their ability to provide high resolution grid measurements with accurate time-stamp in real-time.

GE this year have conducted a broad range of real-time simulations to:

- Determine the most effective set of indicators for applying HVDC control
- Tune the application thresholds for appropriate triggering
- Review the performance of the triggering in terms of latency, false triggers, missed triggers etc.
- Review the round-trip response from a system event to issuing a control instruction and its effect on stability of the HVDC link.

In the safe environment which mimics the transmission system it was possible for GE to develop and positively prove the operation and functionality of their wide-area phasor-based monitoring solution for HVDC control. The results highlight as beneficial this means of HVDC control in certain system situations such as an electrically weak network. However, it is recognised that there are research limitations and more testing on different network configurations is required to progress solution development.

Figure 1. Test setup with PhasorController and PhasorPoint in HVDC environment



2.3 WAKE VIBRATION-BASED MONITORING

The Wake Vibration-based Monitoring project was introduced to address the question: "What effect and at what proximity do wind generators introduce an undesirable consequence on the existing conductor configurations and conductor types used on transmission overhead lines?" The project was able to measure, simulate and model the effect of wind turbine turbulence on overhead line conductors and evaluate associated wear and tear on the conductors. The project learnings support our existing policy of requiring 3 rotor diameter separation between overhead line assets and wind turbine rotors, have produced a prototype evaluation tool, and have suggested further empirical research to refine the tool and increase understanding of this issue.

4 FURTHER INFORMATION

The new SHE Transmission Innovation Strategy, published in December 2019 can be found at the link below:

2019 SHE Transmission Innovation Strategy

https://ssen-innovation.co.uk/transmission/

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

ENA Smarter Networks Portal – SSEN Projects

http://www.smarternetworks.org/project-results/1

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