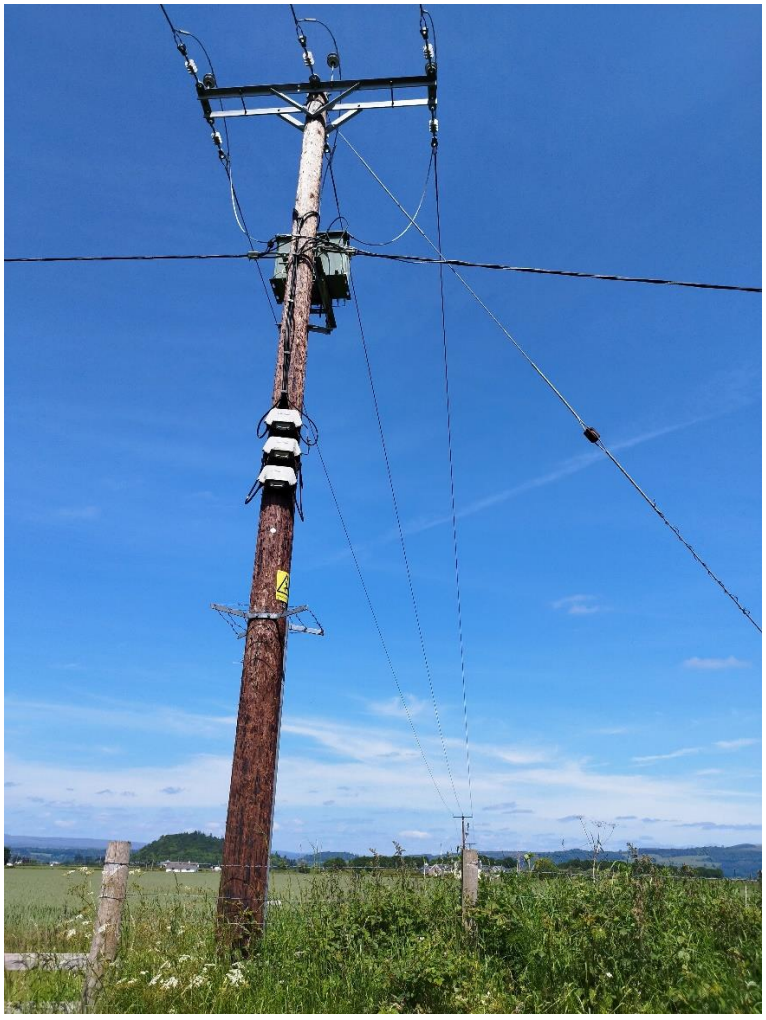
The University Of Queensland AUSTRALIA

ES Cornwall Memorial Scholarship

THIRD QUARTER REPORT

Alice Fleetwood



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SP Energy Networks

Acknowledgements

The third quarter of my experience undertaking the ES Cornwall Memorial Scholarship would not have been possible without the help of a number of people whose support I would like to acknowledge and thank here.

Firstly, I would like to express my gratitude to ScottishPower Energy Networks for being open to and enabling my second placement. I would like to specifically thank Iain Divers and Matthew Jones, for taking the time to meet with me to understand the scholarship and my interest and to welcome me into their team, as well as driving the internal requirements to bring me onboard. I would also like to thank Ailidh Meek and my team, Asset Management and Investment, as well as the wider Network Planning and Regulation department, for their support and inclusion.

In addition, I would like to give many thanks to both Stewart Bell and Keith Bell for their support and assistance in helping make my second placement a reality through their generous suggestions and introductions.

Undertaking the ES Cornwall Memorial Scholarship has meant taking extended leave from my role at Energy Queensland and as such I would like to acknowledge the support and flexibility of Energy Queensland in allowing me to step away from my role to participate in this once in a lifetime experience. I am also particularly appreciative of the efforts undertaken by Michelle Taylor, Sophie Allen, and Terese Milford in managing my absence from our Fringe of Grid work. I'm looking forward to sharing many learnings and stories upon my return.

This incredibly unique and extraordinary experience would not exist without the ES Cornwall Memorial Scholarship so I would like to once again express my gratitude and thank the scholarship and its Advisory Committee for providing this opportunity.

Disclaimer

This report provides a summary of the experiences and work undertaken by the author as part of an overseas ES Cornwall Memorial Scholarship placement. Statements and material contained within this report are the opinion of the author and do not reflect the opinion or positions of any other person or organisation. Reproduction or referencing of this report should also reflect this.

Executive Summary

The electricity industry is undergoing multifaceted change, driven by a number of diverse but interlinked factors including changing customer behaviours, changing climate and weather conditions, an increase in high impact events and the advent of new technologies. These changes have given rise to the need for an increased level of flexibility in our networks. Power system flexibility can be defined as the ability to respond to both expected and unexpected changes in demand and supply. Flexibility can also extend beyond this definition to encompass the overall fluidity of the electricity industry including the ability to facilitate greater participation and choice in the market for customers, the ability to shift load to mitigate maximum and minimum demand issues, and the ability to adapt to change. Flexibility is required in all parts of the electricity industry, spanning from generation to transmission and distribution networks, energy storage and demand. For this reason, my scholarship study plan is based around the theme of 'increasing network flexibility through technology innovation'.

This report provides an overview of the third quarter of my ES Cornwall Memorial Scholarship experience. During this quarter I commenced my second placement, at ScottishPower Energy Networks in Glasgow, United Kingdom, with the Asset Management and Investment (AM&I) team. As part of the AM&I team, my work has been focused on the initial phases of a 3D digital network performance proof-of-concept project and supporting asset management tasks, such as with distribution losses planning and reporting. During the third quarter of my scholarship experience I also had the opportunity to visit several network sites as well as a hydro power station, and attend two conferences, All Energy in Glasgow, and Utilities Week Live in Birmingham.

During the fourth and final quarter of my scholarship experience I will complete my placement at ScottishPower Energy Networks in Glasgow, Scotland. I will continue to work on several projects including the 3D network performance model proof-of-concept and am also planning to visit the transmission system operator Landsnet in Iceland during an upcoming trip.

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Glossary

AM&I	Asset Management & Investment (team at SPEN)
BAU	Business as Usual
C	Criticality Index
CBA	Condition Based Assessment
CI	Customer Interruptions
CML	Customer Minutes Lost
CNAIM	Common Network Asset Indices Methodology
DMA	District Metered Area (water industry)
DNO	Distribution Network Operator
DSO	Distribution System Operator
EHV	Extra High Voltage (33kV)
ENA	Energy Networks Association (industry body representing energy networks in the UK & Ireland)
EU	European Union
EV	Electric vehicle
GB	Great Britain
GIS	Geographic Information System
HI	Health Index
HV	High Voltage
LiDAR	Light Detection and Ranging
LV	Low Voltage
ML	Main Line
NCP	Network Controllable Point
NP&R	Network Planning & Regulation (department at SPEN)
OHL	Overhead Line
PCB	Polychlorinated Biphenyl (group of synthetic chemicals)
PMTx	Pole mounted transformer
PoC	Proof-of-Concept
QoS	Quality of Supply
RIIO-ED1	UK electricity distribution regulatory (price control) period from 2015 to 2023
RIIO-ED2	UK electricity distribution regulatory (price control) period from 2023 to 2028

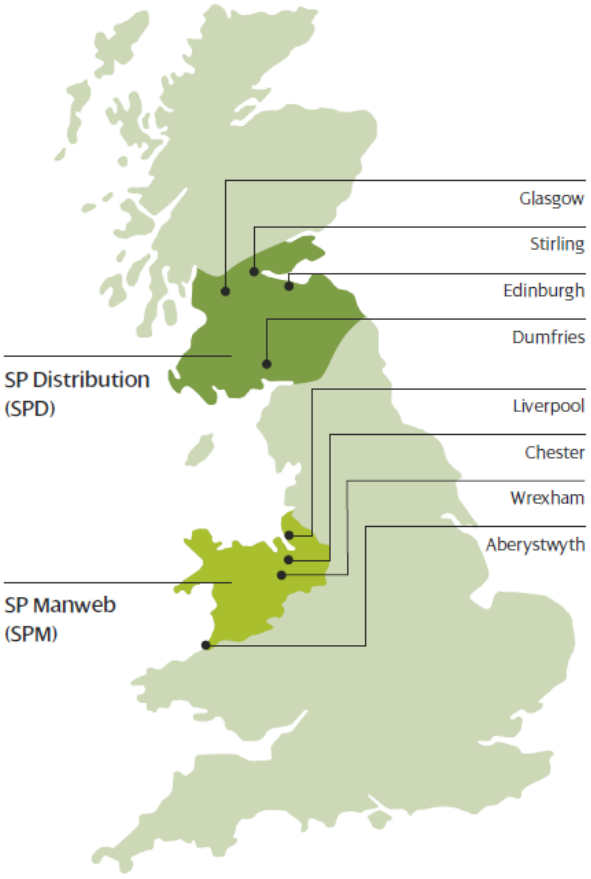
RML	Radial Main Line
SL	Spur Line
SP	ScottishPower
SPD	SP Distribution plc (distribution network in Scotland)
SPEN	ScottishPower Energy Networks
SPM	SP Manweb plc (distribution network in North Wales and Merseyside, England)
SPT	SP Transmission plc (transmission network in Scotland)
SS	Sub Spur
UK	United Kingdom
WSC	Worst Served Customers

Placement 2 – ScottishPower Energy Networks

Background

My second placement as part of the ES Cornwall Memorial Scholarship has been at ScottishPower Energy Networks with the Asset Management and Investment team.

ScottishPower Energy Networks (SPEN) owns and operates two regulated distribution networks, SP Distribution plc (SPD) and SP Manweb plc (SPM). SPEN is the only Distribution Network Operator (DNO) group to operate across all three nations of Great Britain (GB) – Scotland, England, and Wales. SPEN also owns and operates one transmission network in Central and Southern Scotland, SP Transmission plc (SPT).



SPEN is part of the ScottishPower Limited group and owned by the Iberdrola Group – a global energy leader, the number one producer of wind power, and one of the world's biggest utilities by market capitalisation.

SPEN serves over 7 million people across 3.5 million homes and businesses. SPEN's assets include 30,000 distribution substations across its SPD and SPM networks, and over 100,000km of cables and overhead lines.

Distribution Networks Planning & Development – Asset Management & Investment

The Asset Management and Investment (AM&I) team sits within the Distribution Networks Planning and Development (NP&D) part of the Network Planning and Regulation (NP&R) department at SPEN. NP&D leads on asset management, system planning and strategic network design for SPEN's two distribution networks areas. As well as the AM&I team, NP&D includes teams for Distribution Networks, Distribution Network Connections, and Distribution Network Planning.

AM&I is a newly formed team responsible for overseeing asset expenditure programmes and delivery of key outputs. This includes engineering investment plans and optimisation, such as end-to-end, holistic asset management strategy e.g., asset/civil/other programmes. The team is also responsible for modelling network asset risk and performance with a focus on improving current engineering capabilities. The AM&I team drives strategy for network resilience, performance, and reliability. During the RIIO-ED2 price control period (overview provided

below), AM&I plans for asset modernisation and network resilience to achieve ED2 outputs, as well as managing emerging risks and supporting RIIO-ED3 control period development.

As part of NP&R, the AM&I team helps to deliver SPEN's RIIO-ED2 Business Plan.

Overview of RIIO-ED2

Network companies in GB are regulated by Ofgem. As part of this process, companies submit business plans for set periods of time known as 'price controls'. RIIO-ED2 is the price control period from 1 April 2023 to 31 March 2028. This is a key time in the UK, with the challenge to achieve legislated Net Zero targets impacting all parts of society, with electricity at the heart of the solution. With the rapid decarbonisation of generation, transport, and heat systems, it is forecasted that by 2030 up to 1.8M electric vehicles (EVs), 1.1M heat pumps, and three times the amount of distributed generation will be connected to SPEN's networks. This is radical change and presents many issues and opportunities for the networks. As SPEN spans three government regions with their own Net Zero targets, SPEN has set its own target to achieve Net Zero Carbon by 2035.

SPEN's RIIO-ED2 Strategy is divided into three pillars to:

- Develop a network that's ready for Net Zero,
- Be the trusted partner for customers, communities, and stakeholders, and
- Ready the business for a digital and sustainable future.

Project Work

During the third quarter of my ES Cornwall Memorial Scholarship Experience, I have worked on several projects and team tasks at SPEN. These have included the initial phases of a 3D digital network performance model proof-of-concept project and contributing to the Losses Section of SPEN's Distribution Environment and Innovation Report 2022/23 as detailed below.

3D Digital Network Performance Model Proof-of-Concept

Project Background

Traditional overhead line (OHL) modernisation design and risk management typically relies on rules of thumb and sometimes dated standards. SPEN is looking to enhance OHL modernisation design and risk management, and better integrate existing datasets such as collected LiDAR data. Consequently, SPEN is undertaking a Proof-of-Concept (PoC) project to develop a pilot 3D digital network performance model and to assess the potential feasibility and benefits of a wider scale roll-out and integration of a non-load 3D digital model for SPEN's HV OHL network.

The initial phases of the project have involved formulating a project scope including understanding the potential benefits and capabilities of the software platform and identifying objectives, measures of success, and use cases. Procurement and approval processes were also undertaken and include activities such as presenting the proposed project plan to senior management and project specification development in order to kick off the project with the platform provider. Once the use cases were formulated, work was undertaken to shortlist appropriate network circuits for the proof-of-concept project and determine the required data inputs.

Project Overview

The PoC project involves the development and analysis of a pilot scale 3D digital network performance model for selected HV circuits in the SPD and SPM networks through the layering of existing datasets such as LiDAR data, asset data, risk data, policies, Customer Interruptions (CI)/Customer Minutes Lost (CML), and weather and operating parameters. The PoC will cover a network area of approximately 100km of OHL and include approximately 1200 poles.

The PoC project utilises the enterprise software platform of an external OHL design and modelling company. The platform has been developed for transmission and distribution utilities and offers both design and analytics capabilities. Available solutions offered by the platform include network design and construction; vegetation management; clearance analysis; storm, flood, and wildfire management; line rerating; and transmission design and optimisation.

The potential benefits of the platform include:

- Physics enabled – interactive model can simulate environmental changes (such as high winds, different operating temperatures, flooding) on assets such as poles and conductors to see both normal and abnormal operation in real world conditions.
- Finite element analysis – engineering analysis at the individual asset level to simulate dynamic stresses on all network assets and understand precise loading, stress, and tension.
- Predictive failure analysis and simulated conditions – improved risk identification, weather and critical event insights for enhanced safety and resilience.

Additional capabilities of the platform include:

- Allows simulated environmental conditions – high winds, different operating temperatures, flooding – all in real time.
- Incorporates vegetation management capability from LiDAR.
- Supports digital OHL design (allowing rapid Condition Based Assessment (CBA) comparison etc).

The project delivery has an expected duration of approximately five months and will be broken into three phases for model creation by the eternal software platform company:

- Phase 1 – data unification and classification,
- Phase 2 – 3D network model development, and
- Phase 3 – analysis using platform solutions.

Objectives & Measures of Success

The objectives and measures of success for the project support SPEN's RIIO-ED2 Strategy and Commitments and include:

- Design efficiencies, targeted modernisation, coordinated load interventions to 'touch the network once' and optimise risk outputs.
- Greater identification of risks and predictive analysis for asset insights and vegetation management.

- Targeted investments for network reliability, Worst Served Customers (WSC), CI/CML.
- Combined visibility of network performance, risk, and resilience metrics.
- Reductions in manual inspection requirements for assets and vegetation management.
- Creation of non-load 3D digital network environment, improved data insights, and enhanced utilisation of existing datasets e.g., LiDAR.

Use Cases

The Proof-of-Concept project will explore two use cases to identify the potential security, resilience, financial and safety benefits of a 3D digital network performance model to improve management of OHL risk and performance investment, planning and design. The two use cases are:

1) Circuit risk management analysis, and
2) Overhead line modernisation design

The outputs of Use Case 1 align with the inputs required to inform Use Case 2 and therefore a single set of data requirements are considered for the proof-of-concept project.

Overhead Line (OHL) Modernisation Design

OHL Modernisation encompasses all OHL rebuild and refurbishment activity. This is part of SPEN's long-term strategy to improve network storm resilience, customer performance and asset condition. Condition-based modernisation is currently achieved through an 18-year cycle for Extra High Voltage (EHV) (33kV) circuits and a 12-year cycle for High Voltage (HV) and Low Voltage (LV) circuits.

Circuit Risk Management Analysis

Existing asset risk management within SPEN is done mostly at an individual risk level, and there is no way to easily incorporate multiple risk types in one view/platform to support decision making.

Data Requirements

The 3D digital network performance model is delivered by layering multiple datasets together to provide insights and analysis modules. Required datasets include:

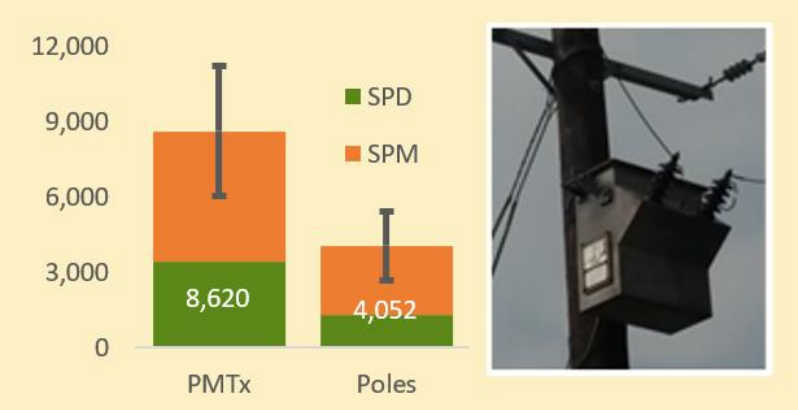
- LiDAR data for the PoC area and associated temperature data at time of LiDAR capture.
- GIS data including shapefiles and asset types and subtypes.
- Policies and procedures related to OHL Modernisation Design:
    - Library and technical specification for conductors
    - Library and technical specification for poles
    - Library and technical specification for pole-top constructions
    - Outline of current state workflow to perform OHL modernisation design works.
- Data related to Circuit Risk Management Analysis:
    - Vegetation fall-in and grow-in zone rules.
    - Conductor clearance to ground rules.
    - Asset condition data for poles and adjacent assets such as transformers.

- Circuit interruptions data such as Customer Interruptions and Customer Minutes Lost (CI/CML).
- Network configuration including Network Controllable Points (NCPs), Protection Zones and Connected Customers.

As well as these standard network data requirements, several enriching data layers were also collated for the PoC circuits and included in the 3D digital network model to provide further insights for the chosen use cases. An overview of the enriching data layers is included below.

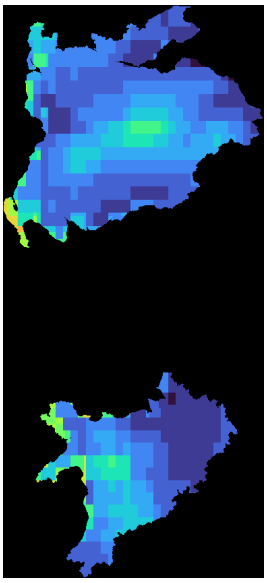
Polychlorinated Biphenyl (PCB) Contaminated Assets

- In the latter part of RIIO-ED1, changes in EU and UK environmental legislation introduced the requirement to replace all PCB contaminated assets by 31 December 2025. This mostly affects pole mounted transformers (PMTx)



- Removal of PCB Contamination:
  - PCBs are a group of synthetic chemicals with good dielectric properties and had been widely used in electrical apparatus until the 1970s.
  - In the latter part of RIIO-ED1, changes in EU and UK environmental legislation have introduced the requirement to replace assets that have trace levels of PCB contamination due to its toxic nature.
  - SPEN's PCB Programme will involve the removal of over 8,600 HV PMTx and over 4,000 supporting wood poles.

Severe Weather Areas

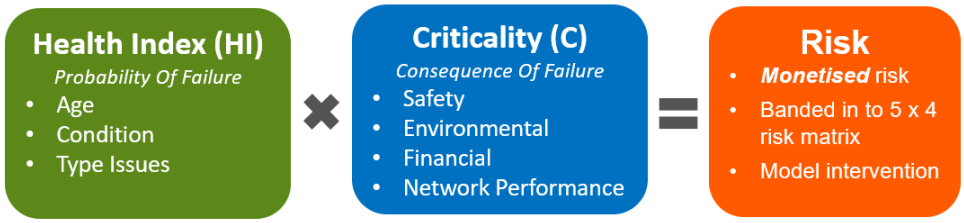


- The Severe Weather Index maps have been created as part of a project to update existing severe weather maps (from ENA TS 43-40) using satellite data collection and analysis.
- The Cumulative Severe Weather Index was calculated across multiple years. The time interval of years 2016-2021 has been mapped and selected for use in the network model PoC.
- The Severe Weather Index is defined based on a weighted average of the following three factors:
  - number of hours with average wind speed above 15 m/s,
  - number of hours with wind gusts above 23 m/s, and
  - number of hours with icing type1/type2/type3.

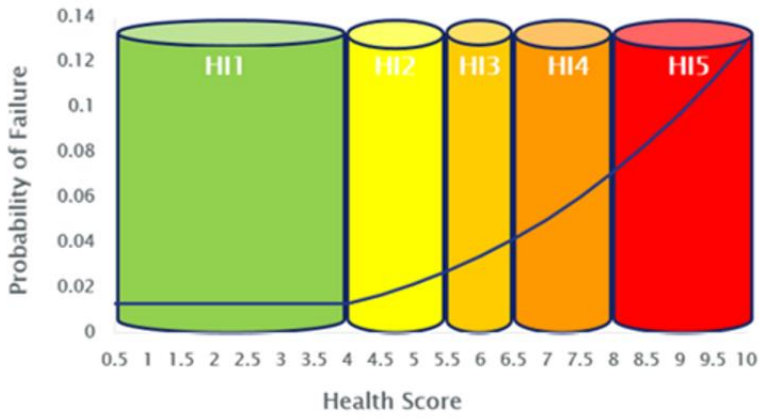
Asset Health

- Common Network Asset Indices Methodology (CNAIM):
  - The CNAIM is a common framework between all GB DNOs for assessment, forecasting and regulatory reporting of asset risk.
- Network Asset Indices:
  - Health Index (HI) – provides information about the health of the asset and can be related to its probability of failure.
  - Criticality Index (C) – provides information about the consequences of an asset failure. These are quantified in terms of the impact upon the environment, network performance, safety, and financial implications (e.g., repair costs).
- Current and Future Asset Health:
  - Current asset health – determined from observed and measured condition factors.
  - Future asset health – determined from age-based factors and assumptions regarding the likely future deterioration of the asset.

CNAIM calculates Asset Risk as the product of Probability and Consequence of Failure



Risk for each individual asset is calculated using specific asset condition information.



Quality of Supply (QoS) – Customer Interruptions / Customer Minutes Lost

- Customer Interruptions (CI) and Customer Minutes Lost (CML) are key indicators used in quantifying Quality of Supply to measure the performance of the distribution network.

- CI and CML are reported nationally in the UK and used by the regulator Ofgem and customers as a consistent measure of how well the network performs against targets.
- CI – is the proportion of customers whose supplies have been interrupted in a year. Calculated by summing the number of customers with an interruption of supply that lasted for 3 minutes or longer (excluding re-interruptions to the supply of customers previously interrupted during the same incident), multiplying by 100 and dividing by total number of customers.
- CML – a measure of the duration of interruptions to supply per year. It is the average customer minutes lost per customer per year, where an interruption of supply to customer(s) lasts for three minutes or longer.

Protection Zone Methodology

- SPEN's current OHL naming convention has only two distinct types of OHL, being main lines and spur lines. A new protection zone naming convention is currently being developed which will provide new insights for asset management and OHL modernisation.

- As part of the PoC project, the new protection zone naming convention was included to provide an example of how circuit risk management analysis can be achieved on a per protection zone basis.

- The proposed new protection zone naming convention will have four distinct types of OHL, that can be applied to HV (as well as EHV and 132kV) OHL networks. The four types are:

    - Main Line (ML) – an interconnected (solid or split ring) that is between a primary circuit breaker (CB), pole mounted (PM) auto recloser, or a normally open point, and capable of being back-fed from another primary CB (or source).

    - Radial Main Line (RML) – a non-interconnected OHL that starts from a primary CB, PM switch, auto-recloser or ground mounted secondary fuse switch or CB and is not capable of being back-fed from another source. It has a minimum of 3 automatic protective devices in series including the protective device at the start of the RML.

    - Spur Line (SL) – a non-interconnected OHL that is tee-d off a ML or RML from the automatic protective device, controlling the OHL to the next automatic protective device or the terminal pole(s) of the OHL.

    - Sub Spur (SS) – a non-interconnected OHL that is tee-d off a SL or another SS, from the automatic protective device to the terminal pole(s) of the OHL.

Shortlisting Circuits

As a proof-of-concept project, a small part of the actual network was chosen to be modelled in order to demonstrate the practical potential of the modelling platform for SPEN. The process of choosing *which* subset of the network could be avoided by modelling the whole network, but that is not feasible for a PoC project. For the PoC scale project, an area of about 100km was required, which could be split across a couple of separate smaller areas, providing the benefit of being able to model both SPD and SPM distribution license areas of SPEN's networks. Without wanting to cherry pick the 'ideal' part of the network, the following general parameters were considered in order to shortlist circuits for the PoC model:

- Circuit length – minimum length of 20km, maximum length of 50km.
- Length of main line vs span line within circuit.
- Customer numbers – with a preference given to a higher number of customers.
- Historical network performance – with consideration to CI/CML, QoS, and WSC data.
- Modernisation plans – as part of RIIO-ED2, in order to compare with Business as Usual (BAU) modernisation processes.
- Asset health – preference for a mix of asset health along the circuit (not wanting to have more than 50% of poles with worse health index (HI4 and HI5)).
- LiDAR data quality – preferable to use an area of the network with good quality LiDAR data, or at least part of the dataset to be of good quality to yield value in results.
- Vegetation presence on route.
- Region.

From this process, six circuits across both SPD and SPM were shortlisted for consideration in the PoC project, with the aim to then select two to three circuits from this list based on quality of data once ingested into the platform.

Distribution Environment and Innovation Report 2022/23 – Losses Section

During the first part of my placement at SPEN I also contributed to editing and updating the Losses Section for the 2022-2023 SP Distribution Environment and Innovation Report. The SP Distribution Environment & Innovation Report provides stakeholders with a transparent account of SPEN's commitment to environmental matters and a progress update on the delivery of these commitments. The report also updates stakeholders on the continuing development of SPEN's Sustainable Business Strategy and the other progressive changes that SPEN is making in pursuit of becoming a sustainable networks business. As part of the report, an update is provided on electricity distribution losses as they carry an environmental impact.

While SPEN's distribution networks are designed to avoid excessive losses through the principle of increasing voltage with increased load transfer, some loss is an inherent outcome of power flowing through our networks as components generate heat, noise, or both.

Technical losses can either be fixed or variable, with fixed losses occurring due to the necessary continuous energization of some parts of the system, the consumption of energy by system equipment for safe and reliable network operation, and other predetermined components losses. Variable losses on the other hand vary with the current that flows through any conductor due to electrical resistance causing heat loss to the environment.

The traditional industry approach for determining network losses is limited by challenges in visibility and quantifiability of losses, sensitivity to data quality and accuracy, and reliance on estimations (such as energy use from unmetered supplies and the apportionment of losses across customers). Therefore, over RIIO-ED1 SPEN has committed to improving their understanding of losses.

Based on SPEN's losses innovation investigations into contact voltage detection during RIIO-ED1 a plan has been developed for RIIO-ED2 to employ a purpose-built vehicle called the MAAV – or Mobile Asset Assessment Vehicle – that detects exposed voltages (called 'contact voltages') that can occur due to faults in electrical equipment. By providing early identification of faults, this vehicle can lead to a wide range of benefits through losses detection and

intervention. Work is now underway to develop a MAAV Policy to help set up new businesses processes and communication channels in preparation of vehicle use.

Losses are also an important consideration for the electricity supply industry in Australia, with AEMO estimating that losses through the Australian transmission and distribution networks are equivalent to approximately 10% of the total energy transported between power stations and market customers. Management of these losses should be balanced with customer benefit and include the use of cost benefit analysis. Work being undertaken by distribution utilities in Australia to trial Stand-Alone Power Systems (SAPS) and remove sections of long network serving small numbers of customers in fringe of grid areas may reduce losses while also improving reliability and quality of supply. In some cases, the pursuit of net zero targets in the electricity supply industry may lead to an increase in losses from a quantitative perspective, but at the same time the climate impact of these losses will be reduced.

During the second part of my placement at SPEN, I will also be helping to develop a Losses Strategy Delivery Plan based on the Losses Strategy that was submitted as part of the RIIO-ED2 Business Plan.

Additional Learnings

During my time with SPEN I have also sought out opportunities to learn about other projects, activities and concepts within the company and electrical power industry which has broadened my understanding not only of SPEN but of the wider UK and European electricity system. This section outlines some highlights from these additional learnings.

Site Visits

SPEN Network Sites

As part of the NP&R department I was able to join colleagues and visit several SPEN network sites around Stirling in Scotland. We visited a range of sites from the Grid Supply Point substation between transmission and distribution, then stepping down the voltage to primary and secondary substations. We also looked at several overhead lines and poles, and LV pillar and link boxes. During these visits I observed several interesting aspects of the electricity networks in Scotland, including the following:

- *Pole treatment*: many wooden poles have traditionally been treated by creosote, a well proven wood preservative, to combat wood rot. Creosote is derived from coal tar and as such has both an environmental and safety impact. Exposure to excess creosote or vapours can cause phototoxic dermatitis. SPEN is trialling alternative pole treatments, with two copper oil treatments currently under test alongside creosote and untreated control samples in an accelerated test chamber.
- *Heating requirements in buildings:* due to the colder climate in Scotland, particularly in the winter months, heating is installed in substation buildings to ensure the temperatures remain within manufacturer recommendations for installed equipment. This is similar to the cooling requirements required in many Queensland substations and network buildings.
- *Undergrounding of transmission*: as part of a network upgrade recently undertaken, it was agreed with stakeholders to underground a section of the transmission network for visual amenity reasons. Visual amenity is an important consideration in network developments in Scotland due to the precedent of National Scenic Areas and the protection of areas identified as having outstanding scenic value in a national context from inappropriate development.

SSE Renewables Pitlochry Dam and Hydro Power Station

During the third quarter of my scholarship experience I was able to visit the SSE Renewables operated Pitlochry dam and hydro power station, as a member of the public. The hydro power station, which has a capacity of 15MW, started generating in 1950 and is part of a nine-station scheme in the Tummel Valley. The dam also incorporates a 'fish ladder' which was integral to the design of the hydroelectricity scheme in the 1950s and is used by salmon to swim upstream to their breeding grounds.

Figure 1 Pitlochry dam fish ladder (left) and power station buildings (right)

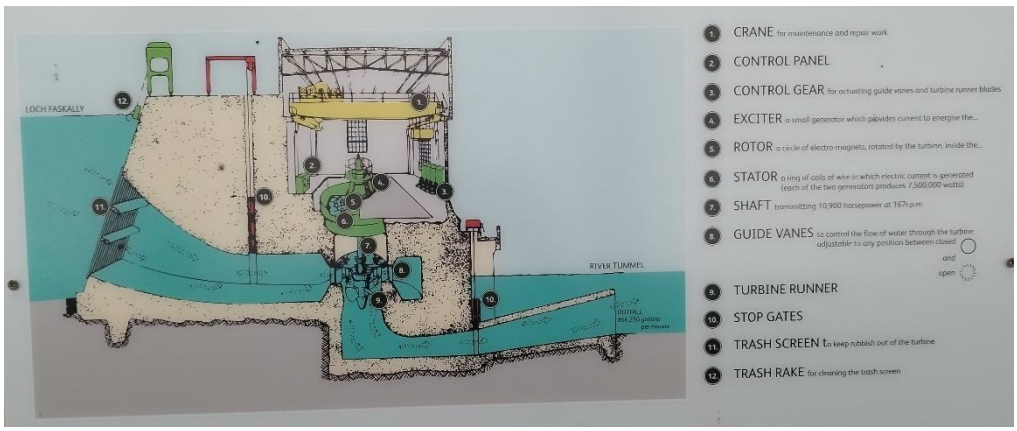


Figure 2 Cross section view of Pitlochry power station

All-Energy Exhibition and Conference – Electricity Supply Resilience

In May 2023 I attended part of the All-Energy Exhibition and Conference in Glasgow. All-Energy is a meeting place for the renewable and low carbon energy community, welcoming professionals from a variety of energy sectors and countries and showcasing 250 suppliers in the industry.

During the conference I attended a session of Electricity Supply Resilience with speakers from Ofgem (The UK electricity regulator), SPEN, the National Infrastructure Commission, the University of Strathclyde, the UK Climate Change Committee, and the Scottish Government.

This was a very informative session with good discussion and debate between representatives from across related but distinct parts of the electricity supply industry in the UK. The critical importance of electricity was emphasised, and with it the increasing reliance on electricity with the current and future electrification of energy systems such as transport and heating. The lack of a universal definition of resilience was highlighted, noting that currently the definition is subjective, and work is needed in the industry to agree on what is acceptable. The need to define and distinguish between reliability and resilience in an electrical supply context was also noted.

The question of whether 'net zero' is building 'fragility' into the electricity network was also raised, with speakers suggesting that systems are only likely to be more impacted in the future, and that system resilience will be possible but more complicated. Professor Keith Bell from the University of Strathclyde addressed several aspects of surviving disturbances, presenting a view of resilience as the prevention of, containment of, and recovery from, interruptions to electricity supply, introducing resilience as not just a response characteristic.

Cara Labuschagne from the UK Climate Change Committee's presentation discussed climate change impacts on the electricity system, which further compound the risk of future fragility in the electricity supply industry from increased electrification. This presentation reviewed both the projected changes in climate conditions, such as surface temperature and rainfall, and the project changes in electricity demand, including a 50% increase in electricity demand by 2035. The impacts on the supply side were also addressed, with the risk of extreme weather events increasing but also the fact that for some critical hazards such as wind strength and regimes and storminess/occurrence of storm events, the future impacts remain uncertain. Potential impacts include loss of transmission and distribution capacity due to damage from flooding, high winds or storm events, and restrictions of thermal ratings of assets due to increased temperatures and heatwaves.

Several solutions were presented by the Climate Change Committee to address the need to design and build the future energy system so that it can continue to operate under changing conditions. These included accounting for future changes in demand and climate impacts in site selection and design, and in the maintenance and extension of existing assets; introducing minimum resilience standards which cover regulated parties and relevant climate hazards; and researching further to improve understanding on how certain critical hazards will impact the energy system.

Scott Mathieson from SPEN talked about the changing energy landscape, with decarbonisation, decentralisation, and digitalisation key aspects in the need for transmission and distribution networks to think and act differently in the face of net zero. With managing system resilience becoming more complex, the requirement for advanced planning, design and dynamic network operation was raised, with LV monitoring, flexibility and active network management, and significant battery connections given as key examples. The importance of

the underlying network asset infrastructure was also highlighted, with aging assets working harder than ever before to facilitate net zero.

Attending this conference session was highly impactful, as electricity supply resilience is equally critical in the Australian industry, with similar net zero and climate change impacts increasing the challenge, and the importance, of resilience in our networks.

Utility Week Live

Utility Week Live is Europe's only pan-utility exhibition. Utility Week Live 2023 took place in Birmingham in May and I attended the event with colleagues from SPEN. The two-day event was comprised of interspersed exhibition stands and multiple staged areas for conference panels and discussions.

One of the conference sessions I attended was on Establishing the Distribution System Operator (DSO) Function – Defining Business as Usual. This session included speakers from National Grid Electricity Distribution, Northern Power Grid, SSEN, and the Enzen Group. Key takeaways included:

- Flexibility is essential for the network of the future. To achieve flexibility, LV monitoring or data on LV is needed. The UK currently doesn't have complete coverage with smart metering, so at this stage gap filling extrapolation and modelling techniques are used for LV visibility. There is also a potential need to go beyond smart meters and look at actual/individual devices in order to have greater visibility and flexibility.
- The flexibility services market provides both a challenge and an opportunity, as there is a need for standardisation but also a need to keep innovating.
- The importance of data management was also emphasised. Inherited data has often been siloed, not integrated, and in the past, this may have not been such a problem, but better integration is now needed. With the existing and future quantities of data required for the DSO function, the massive amount of data also presents a challenge in terms of quality, handling, and integration of big data and its insights. Data cleansing, AI, and data gaps are just some aspects that need to be considered. Improved data integration and management can have benefits for both DSOs and external stakeholders, with more published data resulting in better informed stakeholders and market parties which can have a positive impact on the wider industry in enabling net zero. Data storage and its impact on climate change shouldn't be disregarded in the DSO discussion, and as the scale of data means that cloud storage is required, data lifecycle and data governance (including end of use) need to be looked at be the industry. While the solutions aren't necessarily already available or in practice, this is something that can be looked at by the industry to drive innovation and improvement in this space.

At Utility Week Live I also attended a session on Getting Ahead - Predictive and Condition-Based Asset Management. This session tackled the implementation of predictive asset management founded on condition-based monitoring, which although as a concept has been recognised for its merits, has sometimes proved challenging to achieve in the current regulatory reporting and risk management environment. Speakers from multiple utilities, from SES Water, SPEN, and National Grid addressed this topic and provided experiences and latest developments in predictive management and condition-based monitoring. Case studies from this session included:

- A District Metered Area (DMA) Asset Health project by SES Water, who supply water to 750,000 customers south of London. This project, which has adopted technology not previously utilised in the UK, undertakes non-destructive, in-site testing of SES' metal infrastructure to assess the residual thickness (and therefore indicative condition and

remaining useful life). The consequence of this has included a change in the way water mains are renewed resulting in a 28% efficiency increase, and a reduction in leakage mains repairs and supply interruptions. While this case study was presented by the water industry, its learnings can be applicable to the electricity industry both in asset management principles and in similar opportunities for underground electricity cables which are traditionally challenging to inspect. This also highlights the value in cross-utility communication and collaboration.

- A LV Network Evaluation case project by SPEN, where Pre-Fault Identification for LV cables has been trialled using network tracing and data analysis from installed LV monitors. In this project, heavily loaded circuits can be monitored and prioritised to complete proactive repairs and reduce customer disruptions. SPEN is installing 14,100 LV monitors, covering 80% of their customers to enable proactive and targeted interventions on the right assets, in the right way, at the right time.
- An Eye in the Sky project by National Grid to explore utilising satellite data to improve grid resilience. This project, with partners including DNV, spottitt, and Cranfield University, addresses the problem statement of current survey methods which cover limited areas and are labour intensive by investigating the use of satellite data to identify risks for assets in operation, provide ‘online’ information for emergency response managers, and assess damage after severe weather events. The project looked at utilising satellite data to improve grid resilience through change risk detection, land motion, and asset motion, and found a number of commercially available or open-source imagery and analysis techniques to address these applications which can be further investigated as satellite technology develops.

Plan for Next Quarter

For the fourth quarter of my ES Cornwall Memorial Scholarship experience I will continue my placement at ScottishPower Energy Networks. The 3D digital network model proof-of-concept project will continue, and I will also be supporting the development of a Losses Strategy delivery plan in continuation of the losses work I have undertaken in the first half of my placement. I am also looking forward to visiting the Icelandic TSO Landsnet during a trip to Iceland in this last quarter of my ES Cornwall Memorial Scholarship.