NIA Progress Report

Programme Summary

31 July 2021

VERSION HISTORY

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REVIEW

Name	Role	Date
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APPROVAL

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1 EXECUTIVE SUMMARY

Electricity North West is delighted to present this fifth summary of activities and learning from the projects funded under Ofgem's Network Innovation Allowance (NIA).

This summary highlights key findings and important learning from projects currently in flight, of which full information can be found in the associated annual reports on the ENA Smarter Networks Portal.

During this sixth year of NIA-funded projects, Electricity North West has closed two projects and registered no new projects. Currently, there are 8 projects in-flight, each reflecting the aims of the innovation strategy, which was updated in February 2021.

Highlighted below is a synopsis of what Electricity North West considers to be important for dissemination.

2 INNOVATION STRATEGY

Electricity North West updated its innovation strategy in February 2021.

Whether it be in response to external trends, the needs and expectations of our customers, or changes in regulatory and government policy, the need for innovation has never been greater. The UK became the first major economy in the world to pass laws to end its contribution to global warming and bring carbon emissions to net zero by 2050. Here in the North West, we are supporting our stakeholders' desires to go further and faster than the national target and deliver net zero even sooner. These changes bring with them uncertainty. Uncertainty as to the energy system and the composition and volume of generation and demand, and uncertainty of technology with continued introduction of innovations that have the potential to transform much of what we do. As the distribution network operator (DNO) for the North West of England, it is our responsibility to help meet this challenge by managing uncertainty and leading the way in the energy revolution in the North West.

This is a significant challenge, and it is through targeted and effective use of innovation and subsequent investment in energy needs that we will help the North West to decarbonise, pave the way for the growth of renewable energy and support the transition to distribution system operation (DSO) – an industry-wide initiative to drive the changes needed to achieve net zero carbon emissions in the UK. But it does not stop there, we must also continue to improve the ways we operate and maintain our network, improve our efficiency and protect the environment and the needs of our consumers in vulnerable circumstances.

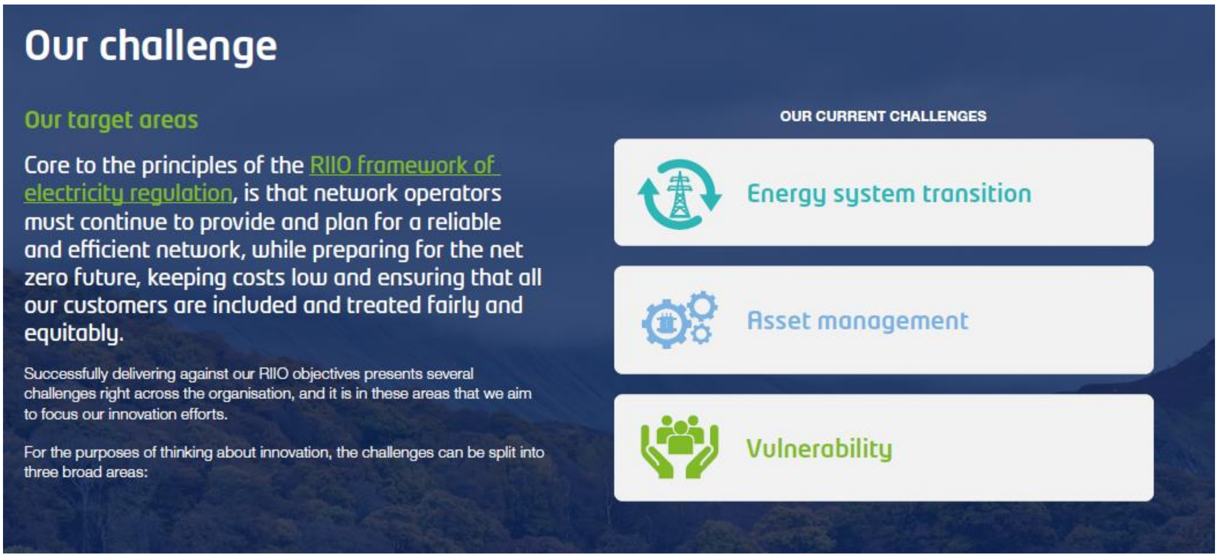
Innovation extends across all areas of our business and this strategy looks to facilitate our delivery of many of our other key strategies, thus forming an integral part of our overarching business plan.

The strategy describes how innovation will help to address the challenges of energy system transition, while maintaining a safe and reliable network and ensuring that the most vulnerable in our communities can benefit from changes we make elsewhere in the energy industry. We outline the five principles that support our innovation decision-making; our innovation themes, which ensure our plans are aligned with those across the energy industry and supported by stakeholders; and our innovation life cycle, which ensures we take a fit-for-purpose approach to delivering our projects and ensuring their rapid transition to business as usual.

An important driver for us is to understand and respond to the needs of our customers and wider energy stakeholders. Working together is the core of our company purpose – engaging with our stakeholders on innovation, collaborating, sharing learning and listening and acting on what we hear is vital to our success. We know that we can only be successful when we deliver outcomes that are valued by the communities we serve.

To ensure we target our innovation resources appropriately across the full range of current and future challenges, and our stakeholders have visibility of the areas on which we are focused, we have forged our innovation strategy and associated plan around three core challenges facing distribution network operators: the energy system transition (where passive networks become increasingly active), asset management (further optimising our use of existing assets), and vulnerability (ensuring everyone benefits from our innovation and that
no one is left behind).

Each of our innovation projects seek to explore a range of technological and commercial issues and trial solutions to one or more of the problems associated with each of the three key challenges as below.



The strategy is easily accessible to stakeholders and demonstrates a clear and logical link from high level objectives to individual projects. The innovation strategy, this summary, the NIA project reports and many other supporting documents are easily accessible on the innovation pages of Electricity North West's website.

Electricity North West was also involved in the formation and production of the National Innovation Strategy which was completely updated and published by the ENA in March 2020.

3 PROGRAMME OVERVIEW AND PROGRESS APRIL 2015 TO MARCH 2021

The individual project progress and completion reports reflect the depth of work completed and can be found on the Portal and our website. The table below shows the percentage progress made on our portfolio of projects.

NIA PROJECTS							
No	Description	Collaborative	Start Date	Completion Date	Status	Period	% completed
NIA-ENWL001	Demand Scenarios with Electri Heat & Commercial Capacity Options	No	Apr-15	Oct-16	Closed	18 months	100%
NIA-ENWL002	Distribution Asset Thermal Modelling	No	Jul-15	Jan-17	Closed	18 months	100%
NIA-ENWL003	Review of Engineering Recommendation P2/6	Yes (ENW lead)	Jan-15	Mar-16	Closed	14 months	100%
NIA-ENWL004	Combined Online Transformer Monitoring	No	Sep-14	Sep-22	Live	8 years	75%
NIA-ENWL005	Asset Risk Optimisation	No	Jul-15	Jul-17	Closed	2 years	100%
NIA-ENWL006	Sentinel	No	Sep-15	Dec-22	Live	7 years 3 months	62%
NIA-ENWL007	Reliable Low Cost Earth Fault Detection for Radial OHL Systems	No	Oct-15	Oct-17	Closed	2 years	100%
NIA-ENWL008	ATLAS - Architecture of tools for load scenarios	No	Oct-15	Nov-17	Closed	2 years 1 month	100%
NIA-ENWL009	Cable Health Assessment - Low Voltage	No	Nov-15	Aug-21	Closed	5 years 9 months	100%
NIA-ENWL0010	Value of Lost Load to Customers	No	Oct-15	Oct-18	Closed	3 years	100%
NIA-ENWL0011	Enhanced Voltage Control (CLASS 2)	No	Nov-15	Nov-18	Closed	3 years	100%
NIA-ENWL0012	Investgation of Switchgear Ratings	No	Dec-15	Dec-16	Closed	1 year	100%
NIA-ENWL0013	Detection & prevention of formation of Islands via SCADA	No	Dec-15	Jun-18	Closed	2 years 6 months	100%
NIA-ENWL0014	Optimising Oil Regeneration for Transformers	No	Feb-16	Feb-22	Live	6 years	68%
NIA-ENWL0015	Tap Changer Monitoring	No	Feb-16	May-22	Live	6 years 3 months	85%

NIA-ENWL0016	Future Network Modelling Functions	No	Mar-16	Sep-17	Closed	18 months	100%
NIA-ENW0017	Electricity & Heat (Futurebay)	No	Aug-16	Jun-19	Closed	2 years 10 months	100%
NIA-ENW0018	Project Avatar	No	Oct-16	Dec-21	Live	5 years 2 months	85%
NIA-ENW0019	Interface	No	Oct-18	Oct-21	Live	3 years	81%
NIA-ENW0020	Machine Learning	No	Oct-18	Oct-21	Live	3 years	81%
NIA-ENW0021	VOLL 2	No	Nov-18	May-20	Closed	18 months	100%
NIA-ENW0022	Reflect Uncertainties around E-Vehicle Charging to Optimise Network Forecasting	No	Mar-19	Mar-21	Closed	2 years	100%
NIA-ENW0023	Intelligent Network Meshing Switch	No	Apr-19	Apr-20	Closed	1 year	100%
NIA-ENW0024	Smart Heat	No	Apr-21	Apr-22	Live	1 year	0%
NIA-ENW0025	Online Netural Assessment (Broken Neutral)	No	Apr-21	Mar-23	Live	1 year 11 months	0%
NIA-ENW0027	Enhanced LFDD	No	Jun-21	Jan-23	Live	1 year 7 months	0%
NIA-NGET0100	Reative Power Exchange Application Capability Transfer (REACT)	Yes (NGC lead)	May-15	May-17	Closed	2 years	100%
NIA-NGET0154	Smart Grid Forun workstream 7 DS2030	Yes (NGC lead)	Jul-14	Sep-15	Closed	14 months	100%
WPD-NIA-008	Improved Satistical Ratings for Distribution Overhead Lines	Yes (WPD lead)	Jul-15	Jan-18	Closed	2.5 years	100%
NIA_SPEN0008	Environmentally Acceptable Wood Pole Pre-treatment Alternatives to Creosote (APPEAL)	Yes (SP Energy Networks lead)	Mar-16	Sep-18	Closed	2.5 years	100%
NIA_SSEPD0026	Management of plug in vehicle uptake on distribution networks	YES (SSE lead)	Mar-16	Jan-18	Closed	22 months	100%

4 AREAS OF SIGNIFICANT NEW LEARNING

Further areas of new learning have been observed during 2019/20.

The learning gained is shared at dissemination events and on our website and includes all projects that Electricity North West is involved in.

The areas of significant new learning identified this financial year relate to the Reflect, Cable Health Assessment and Intelligent Network Meshing Switch projects and a summary of the findings are as below.

REFLECT

REFLECT closed in March 2021. Although planned developments to electrify bus fleets and taxis provide some certainty to distribution network planners on where ultra-fast chargers (i.e. >20kW up to 450kW) could be connected in the future, it is still uncertain when EVs will charge, where other ultra-fast chargers will appear to facilitate en route charging and how much of the EV charging will take place at work/destination or at home/on street.

The aim of REFLECT was to:

- develop credible methodologies that introduce probabilistic assessments, use best available EV profile information (e.g. from other NIA projects) and consider traffic/travel information together with other local data to frame the uncertainties around the effects of the location and capacity of EV chargers;
- develop prototype tools that will implement the developed methodology for all BSP and primary substations (whole 132 to 33kV network) of our license area;
- provides specifications on how the uncertainties modelling in the developed methodology can enhance decision making CBA processes.

A key part of the methodology was the use of local data to frame local uncertainties around the location and capacity of charging. These datasets include information around the access to off-street parking, rural vs urban classification of EV registrations, volumes of vehicles commuting to work, data on travel patterns and potential locations for fast EV chargers including car parks beyond petrol and service stations.

All this local data is used to define the type and parameters of probability distributions that describe the likelihood of specific levels of EV charging per location/capacity type per primary substation feeding area. For example, an area with customers having high levels of access to off street parking has an associated probability distribution for home charging that exhibits high probability levels for overnight smart home charging. This is different from another area with limited access to off street parking, but with high traffic flows and high volumes of service stations that correspond to higher probabilities for en route rapid charging.

The developed methodology introduced the concept of micro-scenarios. These could be seen as variations around the core DFES scenarios, taking into account the probabilistic analysis around the location and capacity of charging. Each micro-scenario has an associated probability assigned that expresses its likelihood to occur. Importantly, these probabilities can be used to inform risk assessments in decision making tools, such as the Real Options CBA developed under our Demand Scenarios NIA project.

The REFLECT methodology actually enhanced the demand growth trends of the DFES scenario by showing how a user defined number of micro-scenarios with associated probabilities can exhibit different demand growth trends around the core scenario. These micro-scenario trends correspond to different levels of EV charging whilst all other demand components (eg, heat pumps, industrial demand etc) remained the same as the associated core DFES scenario.

A prototype tool in Python platform was delivered. The developed tool models the whole of our EHV network (all BSP and primary substations) and has a modular structure.

The probabilistic modelling module modelled the probability distributions of the different types of EV charging depending on the location / capacity, i.e. home; on-street residential; work; rapid en route; and destination. Using the local data per primary substation feeding area, the probability distributions per EHV substation were defined. The module results are individual combinations of the EV charging share of the different types of EV charging (per location/capacity type), as well as the associated probability of each combination. The tool user has the option to either consider each of these combinations as a micro-scenario or further process them to define manually the micro-scenarios, e.g. using a K-means clustering to reduce the number of micro-scenarios.

The time-series EV profile module combined the micro-scenario outputs from the probabilistic module, i.e. charging share per location/capacity type of EV charging, with EV profiles for the different charging and other modelling inputs/assumptions (e.g. EV volume uptake trends per vehicle type and smart charging assumptions used in DFES etc) to produce a half-hourly EV demand forecasts. These half-hourly forecasts were produced per micro-scenario.

We used the developed Python tool to carry out an analysis for all BSP and primary substations in our license area. The analysis has used 50 micro-scenarios and results are presented and discussed in the closedown report. Results revealed smaller or bigger differences across the different primary substation feeding areas than could be explained by the corresponding differences in their local characteristics.

Apart from the development and use of the Python tool, the closedown report describes how the tool outputs can enhance decision making CBA processes, such as the Real Options CBA tool developed in the Demand Scenarios NIA project.

Work in REFLECT project has led to a quantification of the min-to-max variation of EV charging demand using our Central Outlook from DFES 2020. The analysis revealed which areas should have a different EV charging profile adopted that would reflect the “local reality” in EV charging. This learning has highlighted that we need to enhance our EV charging profiles in DFES. Therefore, we will use the profiles produced by the analysis using the REFLECT tool to update BSP and primary substation EV charging profiles (400+ profiles) in our DFES 2021 to enhance our demand forecasts that will support our first Network Development Plan (NDP) in 2022.

Apart from the short-term implementation in our EHV network planning, REFLECT has importantly introduced a modelling framework that allows DNOs to use it in the future to model other critical uncertainties beyond EV charging to consider probabilities in planning and the use of micro-scenarios to enhance the use of scenarios in risk and cost assessments (e.g. using ENWL’s Real Options CBA tool).

Cable Health Assessment

Our Cable Health Assessment project was due to close in August 2021, however, it was deemed appropriate to close the project in March 2021. The project aimed to develop the technology, data processing, support services, business as usual (BAU) operating model and condition based risk management (CBRM) asset health modelling required to allow low voltage (LV) cable condition data to be included in the condition based risk model giving network operators the ability to assign health indices to its low voltage cables and associated networks.

This project provided learning outcomes that influence several other projects in the asset health and fault prediction fields. One of the key goals of the project was to identify substations that had faults developing and to provide information that will help give a CBRM score. At the outset of the project, the intent was to design and install at an LV substation a monitoring system with a very high bandwidth monitoring system, so as not to miss any vital data that could lead to scoring or fault identification very early in the process.

For the high bandwidth monitoring, a greater than 100 MHz sampling system was utilised, as well as a signal injection system to take advantage of impulse response analysis. However, this decision to include high bandwidth in the monitoring system had several repercussions:

- Each unit was much more expensive to manufacture, assemble and test – with a high number of units initially failing the testing stage, and having to be re-worked extensively, further increasing cost and time for many of the units.
- Limitations related to the decision of monitoring transformer tails only for current – this aggregated data meant that a substation with failing cable assets could easily be identified, but not individual feeders without further intervention. This is ok from a CBRM analysis for investment purposes, but not practical for individual feeder management.

When the benefits of high bandwidth sampling were reviewed, the benefit of it over decent ~ 200 kHz sampling that was synchronised was marginal.

Learning outcomes from the project included:

- Deployment experience of fitting monitoring for current and voltage in substations, showing that advanced triggering and monitoring could be successfully deployed,
- Tested the comms infrastructure by generating very large amounts of data.
- Limitations of only monitoring aggregate transformer tail data
- Requirements for PRESense device, regarding the sampling and individual feeder elements

PRESense has taken these requirements forward and provided an advanced LV monitoring platform with high performance in the LCT identification, asset and fault management and power quality areas. With a wide deployment of PRESense monitors, it is envisaged that the data coming from them will provide a basis for building of a CBRM model for LV cable assets.

Based on the challenges faced during the project additional time spent prototyping the devices to fully understand the complexities of design choices may have highlighted some of the issues at an earlier stage.

This project has shown the benefits of trials, even where the original plan does not quite come to fruition, the learning generated on this project has benefitted several other projects. This does, however, need to be balanced against the need to provide value for money for customers. This can be a difficult balance to strike, in this instance it is believed that it was struck.

The project as envisaged will not be implemented, as the solution was found to be not viable as originally proposed. The learning from the project will be taken and applied to other projects to help improve their performance. This has also refined the performance of the commercially available PRESense device, which Electricity North West is currently rolling out on the network.

Intelligent Network Meshing Switch

This project looked to further develop and improve the link box meshing device trialled on the Smart Street LCNF project (LYNX) to allow for deployment in all locations and environments. As part of the project, the improved design was trialled in a number of scenarios to demonstrate the benefits of the enhancements made. The scenarios were selected to cover the full range of environmental issues and location types identified.

There were three stages to the project:

1. Stage 1 – This concentrated on reviewing the LYNX that was used on the Smart Street project. Following a detailed review of the LYNX the set up the team elected to pursue a major conceptual redesign away from existing UDB switching technology in order to address the issues around heat dissipation/build up, and to improv water ingress IP protection rating.

   A number of communications protocols were investigated in depth, which included a new concept for GSM antenna installation, use of roaming SIM cards to be able to connect to the highest power GSM provider rather than a fixed GSM service provider, as well as Power Line Carrier (PLC) technology.

   It was discovered that If no or limited GSM coverage is available, PLC becomes a reduced functionality (lower bandwidth) alternative. This was tested on ENW's network, and the reduced bandwidth was evident, but was sufficient to enable basic switching control operation and voltage and current monitoring features.
   GSM, as a higher bandwidth technology was preferred, testing was carried out on antenna integration into the new ventilated UDB access cover. Results from the field showed that this approach worked in a majority of installations.

2. Stage 2 – Prior experience in Smart Street showed that good thermal management could prove critical in this application. Getting heat out of the underground cavity was key to the design from the outset, and improved heat management techniques concentrated on ventilation and maximising the use of that ventilation. Advanced computer simulation was used to test candidate concepts, followed by prototype testing on the Kelvatek LV test network in Lisburn, Northern Ireland.

   The final design used a newly installed ventilated pavement level cover, with associated frame that needs to be installed into the road level. This cover supported heat exchange with the outside environment and prevented excessive temperature rise in the UDB cavity itself. The design was optimised using the simulation data along with new heatsink designs to provide a decrease in the rise-over-ambient temperature in the region of 25 %. Work was undertaken to re-distribute power across the entire system to further assist with thermal management.

3. Stage 3 – Comprehensive testing was carried out on the new design – Physical design tests checked the fit to the UDB and how that design assisted in thermal management, and also tested the ventilated access cover and the overall system architecture.

The outcome from this project produced a completely new paradigm in UDB switching and Intelligent Network Meshing and will facilitate in the delivery of LV network automation projects and roll outs involving aspects of network meshing and automation. It is expected that this will be taken up by a number, if not all, of the UK DNO's.

The LV Underground Distribution Box is a harsh and challenging environment. As the technology for this area of the LV network automation is in a relative infancy compared to say the 20+ year experience with LV fuse way automation, there are still approaches to be investigated in the future. As the technology matures and the lifetime of devices and associated control electronics are better understood and very reliable, then consideration should be given to complete sealed and buried LV automation, monitoring and switching equipment. Without years of reliability data, currently this approach is high risk as it would require excavation if repair or maintenance were ever needed.

Implementation of the project outcomes will see many new INMS units being installed on Electricity North West's network from 2022 onwards, and Kelvatek will actively discuss with other DNO's the application of this technology to their networks and projects that actively manage the interconnection of LV networks.