SP Electricity North West

QUEST

Final Project Closedown Report

Project Deliverable No: 8

Version History

Version	Date	Author	Status	Comments
V0.1	21/11/25	Andrew Howard	1st Draft	Internal Review
V0.2	28/11/25	Andrew Howard	2nd Draft	Internal Review
V0.3	02/12/25	Andrew Howard	3rd Draft	Internal review
V0.4	04/12/25	Andrew Howard	4th Draft	Internal review
V1.0	05/12/25	Andrew Howard	For external review	For external review
V1.2	09/01/26	Andrew Howard	Updated	Post series of DNO comments
V1.3	17/01/26	Andrew Howard	Final	

Review

Name	Role	Signature
Ben Ingham	Innovation Technical Manger	Ben Ingham
Geraldine Paterson	Innovation Development Manager	Geraldine Paterson
Neil McClymont	Head of Network Innovation	Neil McClymont

Approval

Name	Role	Signature & Date
Paul Killilea	Asset Management & Investment Director	28/01/2026

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GLOSSARY OF TERMS

Acronym	Description
ADMS	Advanced Distribution Management System
ANM	Active Network Management
ANM Decentralised	An ANM system used in project to reflect a connected customer with DER (Distributed Energy Resources) and their control
ANM Cloud	An ANM system reflecting an aggregator type approach, with a web hosted system.
AVC	Automatic Voltage Control – the systems that regulate system voltage at the transforming points on SP ENW network
BaU	Business as Usual – refers either to business-as-usual deployment of QUEST following successful trials or current process impacted by QUEST
BSP	Bulk Supply Point
BSP TS	Bulk Supply Point Tap Stagger (New QUEST function)
CAF	Cyber Assessment Framework
CB	Circuit Breaker
CI	Customer Interruptions
CLASS	Customer Load Active System Services (refers to Production system and QUEST element). CLASS actively controls HV network voltage to achieve several outcomes, including provision of system services to NESO (e.g., frequency services related to demand reduction)
CML	Customer Minutes Lost
CT	Current Transformer
CVR	Conservation Voltage Reduction
DBF DBH	Demand Boost Full (CLASS Function) Demand Boost Half (CLASS Function)
DER	Distributed Energy Resource
DERMS	Distributed Energy Resources Management System
DG	Distributed Generation
DMZ	Demilitarised Zone (IT secure design)
DNO	Distribution Network Operator
DNP3	Distributed Network Protocol 3
DRF	Demand Reduction Full (CLASS Function)
DRH	Demand Reduction Half (CLASS Function)

Acronym	Description
DROQ	Demand Reduction One Quarter (New QUEST function for CLASS element)
DRTQ	Demand Reduction Three Quarter (New QUEST function for CLASS element)
EHV	Extra High Voltage (132,000V & 33,000V nominal)
EMS	Energy Management System
ENWL	Electricity North West Ltd. Business name at commencement of project and current legal entity
ESQCR	Electricity Safety, Quality and Continuity Regulations within which GB nominal network voltages and voltage limits are defined.
FAT	Factory Acceptance Test
GSP	Grid Supply Point
HV	High Voltage (11,000V & 6.600V nominal)
ICCP	Inter-Control Centre Communications Protocol
ICCP (Secure)	An enhanced ICCP with additional security features
IEC	International Electrotechnical Commission standards
IED	Intelligent Electronic Device
IIS	Interruption Incentive Scheme - regulatory performance incentive scheme based on CI and CML
ISMS	Information Security Management System
IT	Information Technology (also SP ENW department)
LCT	Low Carbon Technologies (e.g. Heat Pumps, EV charging, solar panels)
LL	Load limiting (CLASS Function)
LOM	Loss of Mains
LV	Low Voltage (230V nominal)
MOL	Merit Order List
MOMS	Merit Order Management System
MyDMS	SE product that standalone QUEST software built on
NEM	Network Efficiency Mode (New 33kV control element within QUEST)
NIST	National Institute of Standards and Technology
NMS	Network Management System
OC6	Operating Code No.6 used for nationally for demand control
OLTC	On-load Tap Changing
OT	Operational Technology (also SP ENW department)
Primary SS	Primary Substation (33kV to either 11kV or 6.6kV)
PFR	Primary Frequency Response (CLASS Function)

Acronym	Description
PPR	Project Progress Report (Annual governance requirement)
RBAC	Role Based Access Control
RTS	Real Time Systems
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SE	Schneider Electric
SFR SGS	Secondary Frequency Response (CLASS Function) Smarter Grid Solutions
SIEM	Security and Information Event Management
SmSt	Smart Street (refers to Production system and QUEST element) Actively controls LV network voltage. The customer benefit (e.g., energy efficiency, also known as 'CVR'), is the primary benefit from Smart Street.
SP ENW	SP Electricity North West. Current business name (since August 2025)
SWBD	Switch Board
TSF	Tap Stagger Function (CLASS Function)
UI	User Interface
VT	Voltage Transformer

1. Project Background

For the purposes of this report, “the project” refers to the Network Innovation Competition (NIC) funded project, “QUEST” refers to the overarching system, and the “optimisation software” refers to the software used to enable QUEST.

The project officially started in April 2021 and was due to finish in April 2025, this has been formally extended to November 2025. It will identify and trial novel methods to holistically integrate multiple, concurrent system voltage control and optimisation techniques across the whole distribution system. The method will be integrated into the NMS (Network Management System), thus providing the full co-ordination needed to unlock the available benefits.

In addition, the new holistic voltage control methodology will:

- Ensure the network operates as efficiently as possible, optimising the system voltage to connected customers and minimising losses.
- Further boost the benefits available from existing voltage management techniques.
- Facilitate the increased connection and use of LCTs.
- Maximise benefits to all customers through demand reduction at High Voltage (HV) and Low Voltage (LV).

By providing a means of command arbitration, the optimisation software will ensure that potential clashes are avoided, and overall benefits are maximised through co-ordination of previously discrete techniques.

Furthermore, the project will provide a solid foundation upon which issues associated with conflict resolution, i.e. independent activation of Distributed Energy Resources (DERs), can be addressed. The project will explore the co-ordinated operation of voltage management techniques to enable a reduction of the built-in operating margins, creating capacity for our customers.

The project will also develop and introduce a distribution network-wide, fully co-ordinated, overarching system to manage voltages, with an appropriate balance between centralised and decentralised control hierarchy.

2. Executive summary

2.1. Project background

To cater for the subsequent increase in electricity demand and generation caused by decarbonisation targets, DNOs have investigated and deployed techniques such as Customer Load Active System Services (CLASS), Smart Street and Active Network Management (ANM). Whilst these systems have proven successful in helping DNOs to manage the network, they do have limitations. For example:

- They are often applied in isolation of one another and do not operate in a co-ordinated manner.
- It is possible that one technique could counteract another, resulting in reduced effectiveness and potentially failing to maintain operation within acceptable limits.
- They use worst-case planning assumptions, which build in large safety margins, resulting in operation below the theoretical maximum.
- They require a resilient communications infrastructure at all times and are set up to fail safe. Therefore, if there is a communications failure any voltage optimisation or ANM benefit is significantly reduced or removed.

The QUEST project aimed to build on the existing SP ENW voltage optimisation systems, at HV (CLASS) and LV (Smart Street), add EHV voltage control (NEM) and integrate all into one overarching, co-ordinated and optimised system, with appropriate balance between centralised (global) and decentralised (zone) control hierarchy. This will enable voltage optimisation for the whole distribution network. By viewing and controlling the whole network, QUEST will co-ordinate the often-competing objectives of these existing systems to ensure optimised operation whilst maximising benefits for customers. In addition, the QUEST software will allow demand and generation to automatically self-adjust in response to changing voltage requirements, creating an innovative, self-regulating distribution network.

QUEST optimisation software is the overarching software system that has the ability to control other individual systems on the network, i.e., Enhanced Automatic Voltage Control (AVC) including CLASS, Smart Street and ANM. These systems provide voltage control, thermal constraint management and demand control. Where appropriate, the QUEST voltage optimisation will optimise system voltages to provide additional benefits, for example, through reduction of system losses.

2.2. Scope of the Project.

The project deliverables, as defined in the project bid, are shown in the table below, including the formal adjustments made at two points in the project to reflect the documented delays in building the required project IT infrastructure.

Ref	Project Deliverable	Deadline	Evidence	Status / Revised Date
1	QUEST Initial Report - Use Cases	31/07/21	Document introducing the Project and detailing the use cases and scenarios.	Completed July 21
2	QUEST System Design and Architecture Lessons Learned	31/12/21	Document explaining Project progress including the following outputs: • Review of architecture options • Specification for the network models and modelling regime	Completed December 21
3	QUEST Trials, Design and Specification Report	30/06/22	Document explaining Project progress including the following outputs: • Functional specification for chosen architecture • Functional specification for voltage control methodology • Trial design • Detailed site design	Completed June 22
4	QUEST Interim Report - System Design and Technology Build Lessons Learned	30/06/23	Document detailing Project progress to date including lessons learned from: • QUEST software development and testing • Power system model development • Site installation for the voltage control and ANM equipment	Completed June 23
5	QUEST System Integration Lessons Learned Report	30/12/23 Revised Update: 30/04/24 Revised Additional IT update to be added	Document detailing the lessons learned from the installation and commissioning of the QUEST system including system integration and the results of site acceptance testing.	Completed Dec 23 Updated Apr 24 Last IT update Dec 24
6	Customer Research Findings Report	31/10/24 Revised: 26/09/25	Document detailing the outputs from the customer research.	Completed Sep 25
7	QUEST Trials and Analysis Report	30/12/24 Revised: 28/11/25	Document detailing: • Final results from network trials • Final results from modelling trials • Output from the voltage demand relationship research	Completed Nov 25

Ref	Project Deliverable	Deadline	Evidence	Status / Revised Date
			• Any adaptation required to voltage control methodology	
8	QUEST Final Report	30/04/25 Revised: 19/12/25	Report on the conclusion of the QUEST Project including all the lessons learned and detailing the next steps, including BaU transition.	This Report Dec 25

All the above deliverables are available on the SP ENW QUEST project website {QUEST}. These, and their associated documentation on the website, are a significant detailed resource and capture a level of supporting information to this final project report.

2.3. Outcomes of the Project.

QUEST has created an overarching control system by designing a holistic voltage control methodology to co-ordinate discrete techniques, optimising their use and facilitating the increased use of LCTs.

The system, built on SP ENW NMS platform, has proven to co-ordinate active voltage management techniques deployed across the DNO network.

QUEST has demonstrated the ability to optimise for a range of conflicting interests at different times of the day and in doing so further boost the benefits available from the existing voltage management techniques. And when appropriate, maximise benefits to all customers through demand reduction at differing voltage levels.

QUEST has explored how to unlock benefits for the National Grid Electricity System Operator (NESO) by providing improved visibility of real-time, embedded generation exporters and other forms of DER, and allowing "tuned" responses for demand control including OC6.

Throughout the project QUEST has engaged with customers, particularly those with voltage sensitive equipment, to understand how optimising voltage may affect their operations and to identify any special requirements they may need to consider.

The QUEST project has produced and published several project deliverables including technical reports. These are available at https://www.enwl.co.uk/future-energy/innovation/key-projects/quest/quest-library/

Changes in Cyber Security requirements during project delivery necessitated a change in how the QUEST system was configured and implemented within the SP ENW IT infrastructure. This led to delays in the build, configuration, commissioning and testing of the systems. It also continued to add delays as the QUEST system was updated further during the Trials and Analysis phase.

2.4. Objectives it met successfully, including Successful Delivery Reward Criteria (SDRC)/Project Deliverables.

The objectives (section 2.2) have been met in full, in line with agreed timescales.

2.5. Objectives it did not meet successfully, including Successful Delivery Reward Criteria (SDRC)/Project Deliverables.

As noted, deliverables 5 -9 have been met in full, in line with the revised timescales agreed with Ofgem. These changes had been updated in advance and communicated through the annual PPR (Project Progress Reports) and separate notification to Ofgem.

2.6. Main learning generated by the Project.

The learning from the project has proved and confirmed the project QUEST hypotheses laid out in the bid document (section 2.3).

- Using a novel application of proven technology, combined with the development of highly innovative control software, QUEST will remove voltage constraints and defer reinforcement, thereby reducing costs for customers and facilitating the connection of LCTs.
- Through innovatively managed network voltages, QUEST will reduce energy consumption and losses delivering financial and carbon benefits. The loss reduction benefits will be substantiated using modelling and bench testing.
- Customers will not discern the operation of QUEST.
- QUEST will support simultaneous and highly optimised operation of discrete voltage management techniques, ensuring each is used to its maximum at all times whilst avoiding conflicts.
- QUEST will deliver an improved demand response during emergency conditions by avoiding inadvertent disconnection of embedded generation and providing the ESO with improved visibility of available response.

The QUEST system has proven to be capable of remotely changing network voltages at all levels within a DNO network, using modifications to existing equipment and techniques.

The central system can optimise voltages, in full knowledge of system configuration and impact of its actions and will change that optimisation based on the outcome priorities at that time. The system will also re-optimise should these priorities change with time.

That QUEST allows the continuation of the benefits obtained from its component elements (e.g. CLASS and Smart Street), and where optimisation allows, for these benefits to be increased and supplemented from the additional NEM functionality.

The system will integrate with third party systems controlling assets connected to the electricity network and will be able to control and influence the output of these assets such that they do not mitigate or impact the desired QUEST outcomes. The project utilised two ANM systems (decentralised and cloud) to demonstrate this.

At times of wider system constraint or emergency, the system will reconfigure the voltage management from whatever BaU condition to a predetermined condition to best support the wider system constraint.

The project has also demonstrated the impact of BSP tap stagger, and its potential use for a future NESO reactive power service.

During the project a series of customer engagements confirmed the manipulation of network voltages remain unperceived. Engagement with EHV and HV customers provided learning on how better to engage with this customer base who may be most affected or able to engage with voltage matters, and who may be interested in voltage managed connections.

Future Innovation projects could be more aware to the potential of national and international events causing significant project consequences.

2.7. Main learning derived from the Method(s).

From applying the project's method, QUEST has proven that a central control system can be built to optimise (to achieve a desired outcome) and maximise (identify and utilise any additional outcomes), network voltages based on a whole system approach.

Using this system, we believe we have proven that we can push network voltages to the limits allowed under current ESQC regulations, measure the impact of these changes and correlate the measured impact with an independent modelled approach, and previous innovation and business as usual experience. Our belief is based on data retrieved from the SP ENW system measurements available to the project, the customer engagement work performed in the project (consistent with previous CLASS and Smart Street engagements) and the experience gained from operating CLASS and Smart Street.

The project did not include for any end point monitoring, and Smart Meter data was not available to the project. The project therefore cannot provide measurement data at customer premises to further support the engagement findings that customers continued to remain unaware of active voltage management on the SP ENW networks

We have proven we can integrate with different 3rd party systems involved with assets and services that may be impacted by or may mitigate the effects of active voltage management, and that the operation of these systems can be appropriately modified.

To apply the QUEST methodology, the project has utilised standard network equipment already in use, with some minor configuration to allow for additional control points.

3. Details of work carried out

3.1. Method trialled

The QUEST method builds on previous voltage management techniques developed through Innovation but implemented as Business as Usual; therefore, it is worthwhile to review the basics first.

3.1.1. How does voltage control work?

The majority of UK DNOs networks operate at nominal voltages of 132kV, EHV (33kV), HV (11/6.6kV) and LV (230V) with the DNO responsible for the transforming points 132/33kV and below. Voltages above these are the responsibility of NESO and NGET.

Traditionally the voltage output of all transformers, excluding HV/LV, has been designed to be automatically controllable on site using an Automatic Voltage Control (AVC) relay and a transformer tap changer which changes the transformer ratio in a series of fixed steps (usually between 1.25 and 1.5%). These devices then monitor the local voltage, which is constantly changing as the load on the network varies as customer turn on or turn up their electrical devices. Increasing demand, depresses voltage and when the voltage becomes lower than the preset AVC limit, usually for a set period of time, the AVC will instruct the transformer tap changer to tap, and the voltage to change. If the change restores the local voltage to a value within the bandwidth of the AVC setting, no further taps occur and the AVC continues to monitor. If the voltage is still outside range, the AVC will keep tapping the transformer until it is in range. Decreasing load, including increasing downstream distributed generation, results in a voltage rise to which the AVC relay will see and respond by tapping the transformer in the opposite direction.

3.1.2. Voltage Control in SP ENW

SP ENW nominal voltages are 132kV, EHV (33kV), HV (11kV or 6.6kV) and LV (230V). Certain local conditions or historic design decisions may result in some network sections running at a slightly different nominal target; up to 3% difference.

A hierarchy of voltage control exists where disturbances are first resolved at the highest voltages, with lower voltage devices responding slightly slower and for more local issues.

Voltage management away from nominal voltages has historically been considered. At the higher transmission voltages, a small increase in voltage causes a small decrease in current (for the same power) and this reduction in current causing a reduction in transmission losses incurred in moving the electricity from A to B.

At lower voltages on shorter more interconnected networks that directly supply end consumers, a voltage reduction can result in a change resulting in customer equipment consuming less energy resulting in a net demand reduction on the network. The voltage reduction approach (often referred to as conservation voltage reduction (CVR)) has long been embedded in the management of the GB electricity network when under emergency conditions.

AVC relays were traditionally electromechanical, however the majority installed today are digital electronic relays that provide increased functionality and configurability resulting in improved voltage management performance, especially with high levels of local embedded generation, and they also allow a degree of remote control and configuration via the DNO SCADA communication systems. The configuration of AVC relays includes timers (to affect the speed of response), and deadbands (to limit continuous operation). The settings applied take cognisance of the network topology of the relay location.

CLASS

An innovation project, completed in 2016, developed and proved a range of functions adjusting network voltage at the Primary (EHV/HV) transformers to elicit a predetermined network load response. From 2019 SP ENW has offered one of these functions, demand reduction, commercially to NESO which is in daily use. This function provides a specified demand reduction for a period of up to 30 minutes.

3.1.3. LV Voltage control

The Low Voltage network constitutes the largest element of a DNO network (by Asset Volumes) and is traditionally designed in a “fit and forget” manner. LV voltage design assumes the output of the distribution (HV/LV) transformer is stable at a nominal voltage and is maintained there by active voltage control at the Primary (EHV/HV) interface. An assessment is made of the load to be attached to this network by looking at the volume and type of customer connections required and then the network (the length and cross sectional area of the LV conductors) is designed to ensure that on a worst case basis (after some diversity applied) the voltage at the most extreme end of the network will remain with statutory voltage limits under all load conditions. Historically end of network voltages are not monitored, unless queried by a customer, when temporary monitoring would be installed as part of an investigation. This tried and tested approach ensures very few voltage issues exist, however for much of the year the voltage measured at a customer’s premises are well within limits. It is worth noting that recent and on ongoing changes to equipment purchased by customers including high load devices (such as power showers, EV chargers and Heat Pumps) and generation (such as solar PV) will impact historic LV design assumptions, and those networks built to historic norms.

Smart Street

An innovation project, completed in 2018, that applies the Conservation Voltage Reduction (CVR) approach to the LV network which identified a longer term 1% voltage reduction resulted in approximately a 1% reduction in energy usage as measured by the customer’s meter. Smart Street is now applied as BAU in SP ENW using the central network management system which holds a real time model of the LV network. Periodically (normally every 30 min) the system analyses the LV network to determine how low the voltage at a distribution substation can be reduced whilst the extreme of the network is held within limits. That minimum voltage is then sent to the AVC on site via the SCADA comms system, and the AVC then monitors and controls the on-site voltage, using the on-load tap changer, to maintain the reduced voltage setting, until the next recalculation.

3.1.4. QUEST

The QUEST methodology incorporates the CLASS and Smart Street approaches, extends this across the whole DNO voltage range and adds some additional functionality.

As system demand changes, network voltage fluctuates with the occasional step change as a control system intervenes to correct or do something different. Any change at the highest voltage (e.g. a voltage depression caused by a fault on the NGET network) is seen immediately at all lower voltage levels, and if that condition continues, the control systems would respond in an orchestrated manner to restore system to a nominal voltage with the higher voltages resolved first.

The ESQCR requires a DNO to maintain network voltages to within +-6% on nominal voltage at all levels except LV which is 230V +10%, -6% reflecting an EU harmonisation and change from the historic 240V nominal.

Amongst the possible voltage management techniques and strategies, a number are complimentary (can be applied at the same time) while others are not and if applied together could cause noncompliance to the ESQCR.

The QUEST method extended central voltage management to our 132kV/EHV BSP sites, then for an area of the SP ENW network fed from Whitegate GSP, provide an end-to-end holistic voltage management system. The system would apply all the currently available techniques with the foreknowledge of the impacts on the whole network.

Interfaces to this central management system would then be tested to demonstrate the interoperability with third party and ANM systems that may also respond to active voltage management and network voltage changes.

3.2. Methodology used

The project identified the Whitegate GSP group to be an appropriate network to trial the QUEST methodology due to its mix of network types and customers. This was validated early in the project.

QUEST required existing network equipment to be upgraded, or additional equipment installed such that network voltages could be set remotely. It also applied a process to define what QUEST was required to do via the development of use cases, how QUEST was to be implemented via an architectural design and a software functional specification. A customer engagement methodology was also implemented. These have been specific project deliverables and are available on the SP ENW website.

AVC schemes at four 132kV/33kV BSP substations were upgraded to Fundamentals SuperTAPP relays, with QUEST specific software installed. The key new functionality included was the ability to change the voltage set point remotely (via values configurable in QUEST software) and to provide tap stagger functionality. Tap stagger functionality would allow QUEST to stagger tap positions at BSP sites (noting that CLASS had previously tested this at primary sites), to create additional reactive power flow to investigate the impact and potential use at the NESO boundary, AVC schemes at twenty-one 33kV/HV primary substations were upgraded to Fundamental's Supertapp relays, with QUEST specific software installed. The majority of these were simple software upgrades to existing equipment, with a small number of sites requiring a full installation. The key new functionality on the primary AVC was the addition of extra demand reduction steps, providing increased granularity of response. The granularity of each step being a relay setting and not a software function to align with the existing CLASS functionality.

HV/LV transformers were changed at seven sites to new units with on-load tap changers identical to those used for Smart Street. These complimented a further 16 OLTC units installed across the Whitegate group as part of the wider Smart Street programme that were also utilised in the trials.

The first phase of QUEST was to develop a series of use cases of what QUEST needed to deliver and how it should do that. The outcome of this work was the project's first deliverable: QUEST Initial Report - Use Cases (July 2021). {Deliverable 1} The eight use cases developed refined the QUEST objectives using a common methodology and structure. They are a higher-level description of what scenarios are likely to be faced and how an optimisation solution should be expected to respond appropriately. This document then formed the basis for the remaining deliverables.

The project then developed two workstreams, architecture options and modelling regime:

- The architecture stream reflected on the software architecture to deliver QUEST, including refinements to the use cases, plus the IT architecture required to deliver the solution.
- The modelling workstream looked at independent network modelling that could be used to estimate QUEST benefits and be used as a benchmark for the QUEST system benefit outputs.

The deliverable, QUEST System Design and Architecture Lessons Learned {Deliverable 2} was published in December 2021.

The QUEST solution was then defined in further detail via four workstreams: Functional Specification for chosen Architecture, Functional Specification for Voltage Control Methodology, Trial Design and Detailed Site Design. The output of this was published as deliverable QUEST Trials, Design and Specification Report {Deliverable 3}, including associated detail reports in June 2022. The associated documents are a series of specifications and designs against which QUEST would be built.

During 2022, there was a significant shift in national concern regarding cyber security and critical national infrastructure because of world and European events. The project was impacted with delays from this point due to the increased IT support infrastructure required to address these new requirements. The depth and ongoing nature of this impact was initially underestimated. The impact of this challenge has been regularly communicated to Ofgem and reported publicly in the annually published project progress reports.

The next (4th) project deliverable, QUEST Interim Report - System Design and Technology Build Lessons Learned was published in June 2023. {Deliverable 4}. The report, and associated documents, described the functional specification developed for the QUEST software design and the development progress through the initial factory acceptance tests (FAT) and lessons therein. It touched on the modelling input to the software design and provided an update on installation progress and lessons learnt to date. Key in here had been the cyber / risk decision to further separate QUEST (as an innovation trial system that needed to be capable of decommissioning) from the core enduring NMS. This whilst still allowing the required interaction between the systems through cyber defences that are under constant review and selective enhancement.

The QUEST System Integration Lessons Learned Report, that was to detail the lessons learnt from the installation and commissioning of the QUEST system, was originally due December 2023 but was heavily impacted by delays with the IT design and build. The deliverable was ultimately delivered in three parts. An interim report was delivered in December 2023, which was updated in April 2024. As many of the issues were IT related, a further IT specific update was made in December 2024. {Deliverable 5}. Whilst there were delays with integrating the software with SP ENW systems, other elements were being delivered including site installations, AVC relay software (enhancement, testing and roll out to site with Fundamentals), development and testing of the QUEST overarching software (albeit on partner IT infrastructure), customer engagement & learning and dissemination. The QUEST System Integration Lessons Learned report did focus on the IT support design and delivery issues that continued to impact the delivery and testing of both the QUEST core system and the build of partner ANM systems.

By June 2024, the IT support systems had been put into place to allow communication between all the elements of QUEST infrastructure. This allowed the final build and commissioning of QUEST subsystems, ready for initials system testing and any debugging / enhancements found to be required for production trials.

Final element build, testing and revisions took place between July 2024 and May 2025, with minor changes continuing post the start of formal trials.

During this period significant items included:

- Formal FAT and SAT testing of ANM systems
- Connectivity enhancements for ANM subsystems and outstations
- Additions and revisions to devices within the SCADA system
- Increasing computer memory in the IT system infrastructure supporting QUEST
- Addition of a layer of QUEST user authorisation, to ensure real time control of live assets only by authorised control staff was maintained
- Availability of authorised control staff
- Additions and revisions to data points within the multiple ICCP links
- Additions and revisions to relay configuration and relay software
- Failure of hardware within the IT support system, resulting in part replacement and a full system rebuild
- Review and enhancement of IT support and system back up routines
- Expiry and renewal of multiple IT certifications & licenses
- Expiry and renewal of multiple system accounts and passwords, including an enhanced processes for Non-SP ENW and Non-UK based resources
- General availability of environment
- Upgrade of common IT systems, partially used for QUEST project
- Enhanced maintenance of QUEST subsystems and databases, additional requirements resulting from final IT infrastructure

Any change to or impacting the IT infrastructure was subject to the formal IT change control process, which can take 4-6 weeks for a full cycle of the QUEST Test and Production systems. Availability of limited specialist resource, especially where a chain of experts were needed to pinpoint and resolve an issue, also added time to several required changes.

The developed QUEST software has 4 key functions, set out below, that can be arranged in a priority order and can be set at different function levels against which the QUEST system will optimise the network voltages. These functions are labelled:

1. Network Efficiency Mode (NEM) – 33kV control
    - This allows EHV voltages to be raised, causing a reduced current in the 33kV network, reducing the network losses
2. CLASS – HV control
    - This includes:
        - Standard Demand Boost function, which allows HV volts to be raised eliciting a demand boost from connected customer equipment
        - Enhanced Demand Reduction (DR), which allows HV volts to be lowered eliciting a demand reduction. The QUEST enhancement introduced an additional two DR levels (one quarter and three quarters), to allow an increase refinement of control for coordination and optimisation.
3. Smart St – LV control
    - Standard functionality allows LV network volts to be calculated (using the load flow based methodology described in the Smart Street project) and maintained as low as possible, to elicit a demand reduction ensuring end customers reduce their energy consumption.
    - QUEST functionality allows pre-determined partial Smart Street response, allowing the benefit of demand reduction to be optimised between CLASS DR and Smart Steet voltage levels.
4. BSP Tap Stagger (BSP TS) – Control to change reactive power at NESO boundary
    - This taps SP ENW BSP transformers apart, which causes a circulating current to flow in the 132kV network. This generates a change to the reactive power flow across the grid boundary (EHV/132kV transformers) but would increase network losses. (Modelling within CLASS (Primary) and QUEST (BSP) tap stagger logic includes loss calculation)

Several of these functions if applied together with no co-ordination could cause conflicts resulting in exceedance of ESQCR voltage limits, or exceedance of technical network capabilities (e.g. tap changer range).

The QUEST software also contained functionality to automatically re-optimise against a future schedule, and to re-optimise to an ideal state should several anticipated network system emergencies occur (SYSCON). After a sustained period of testing, formal trials commenced May 2025 and continued into September 2025. The trial period being constrained due to the delays in building the QUEST test infrastructure, but sufficient to test the functionality of the system developed. Trials and Analysis are covered in more detail in the following sections and in the published QUEST Trials and Analysis Report {Deliverable 7}

Customer engagement occurred throughout the project using a mix of communication techniques with Domestic, HV and EHV commercial customers. Section 3.5 and the published Customer Research Findings Report {Deliverable 6} cover this in more detail.

3.3. Trials and Result Analysis

The QUEST overarching optimisation software is complex. Section 2.1 of the QUEST bid defined the trials as: "The trials, illustrated diagrammatically below, will be carried out to determine how the command arbitration in QUEST will work for the 13 potential combinations of the following voltage management techniques:

- Passive voltage control: traditional methods of voltage control either responding to local measurements or fixed at the time of commissioning. No centralised overview.
- Active LV voltage optimisation: the use of centrally controlled devices to actively optimise the voltage profile on the LV network.
- Active EHV/HV voltage optimisation: the use of centrally controlled devices to actively optimise the Extra High Voltage (EHV) and HV parts of the network.
- ANM/flexible services: the controlled use of DERs to alleviate constraints on the network."

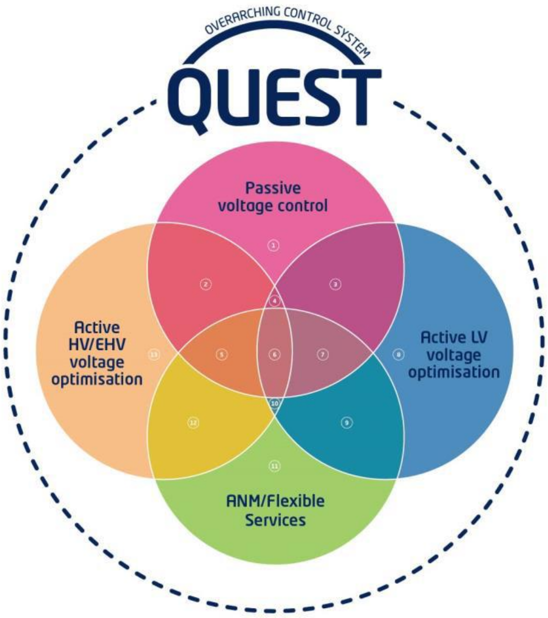

Figure1: QUEST Bid Image (2020) showing the anticipated testing requirement for the project.

This bid approach was refined as the project developed. The active HV/EHV optimisation was split into separate software functions, BSP tap stagger was added as an additional function and the ANM/Flexible services was refined to provide the appropriate controls based on the resultant QUEST optimisation.

The 13 potential bid combinations therefore changed to 16 base function combinations (NEM/CLASS/Smart Street/BSP TS) including a do nothing (passive voltage control) and a do all. However, each of the base functions allowed for multiple levels of response to be requested (e.g. for CLASS a full (100%), partial (¼, ½, ¾) or none) significantly increasing the number of combinations that could be tested. The testing also required the ANM/Flexible services interaction to be proven, the scheduled re-optimisation over time and the system abnormal (SYSCON) functionality to be tested. The actual range of possible tests were well over one hundred and with that testing being performed on a production system where load is constantly in flux and routine daily activity impacting network connectivity (asset replacement, maintenance, faults etc) is occurring, all of which can impact the output of optimisation, meant there was and would always be some test combinations that couldn't or haven't been tested.

The approach taken was therefore start simple and build complexity. Where issues were identified, we would step back and resolve. Where response was not as expected, we reviewed against the use cases, functional specification and overarching intention to improve understanding and/or resolve the issue. As learning, and techniques to improve the trial process occurred, we embedded them for future testing.

Initial testing ensured existing and new functionality was all fully commissioned and available ready for testing, noting that some of the new command chains could be quite long. This process flushed out several issues, with different paths to resolution by different partners and SP ENW teams. This also applied for connectivity between QUEST and the SGS ANM systems used in the project.

A standalone QUEST machine required a separate model of the Whitegate network to be created for QUEST, rather than using the real time model in the production NMS. A model extract process, used routinely to keep the NMS test system in step, was modified to create a Whitegate only model for the QUEST machine which could be updated either as a full rebuild or by network element using a modified version of the production update process.

The core functionality of each project element was then tested. So, where systems could be turned off or blocked such that a single system, e.g. CLASS, could be run to generate an output that could be compared with and be consistent to that being achieved by the production system on the same network. Again, this flushed out some issues, it also highlighted that QUEST is designed to optimise AND maximise. By this the system will optimise to achieve the priority and targets within the system, however if all targets are met but a capacity for more is available the system will add that extra. This was crucial learning for understanding the quality of optimisation the system was performing.

Different combinations of two elements were then tested (priority and scale) eventually moving through until all functions were available. Combination tests also started to generate controls and data to the ANM systems. This then allowed final set up, test and trialling on those ANM systems. Ensuring test access was available, data was being received, processed and stored, and that the ANM were responding as anticipated. Again, this flushed out additional issues and learning for the trials to continue.

A key focus on these early stages was to ensure that the logical optimisation being performed appeared to be correct, before an analysis of the scale of the benefits and outcomes was started.

This period also allowed the differences between Test and Production systems to be understood, for SP ENW control engineers to become familiar with the production systems, for SP ENW innovation engineers to become familiar with the NMS production system with an exchange of ideas on how best to deliver and record trials in a consistent repeatable manner.

The period also allowed the sharing and testing of the associated data collection systems in place, to support the delivery of real-world changes and their associated benefits.

Further detail on trial issues encountered and resolved are covered in the full Trials and Analysis report, with key learning point also captured in section 11.

3.4. Trial Process

From a master programme of trials to be delivered, a session plan would be prepared and test structure pre-populated where possible

Trials were run from within the SP ENW Control room, by both control and innovation team members working together. A trial would usually contain several individual tests.

Production systems (e.g. CLASS & Smart Street) were isolated or blocked in the production system, prior to QUEST being enabled. This prevented one device being managed by multiple control systems.

Current network issues and outages were considered, and both QUEST and production NMS systems were set up to perform and record planned tests.

A test would be run with the QUEST Contention Management Process “scenario mode” where the optimisation would occur and a result generated based on the system targets and actual system readings. On occasions, targets would be adjusted to refine the optimisation. (Note: QUEST optimises and maximises benefits, e.g. optimisation achieves the requested priorities, maximisation allocates any additional benefits available to the system including for lowest 0% priorities). On occasions this maximisation function would obfuscate the contention being tested for)

The test would then be run in QUEST Control where the QUEST optimisation would result in a series of controls being delivered to site, and the site equipment responding to these controls. CLASS core demand response is a two-stage function where the system (and on site AVCs) is first “enabled” to provide a response, and the response is then “activated” usually via an instruction from NESO. Therefore, several tests would need a secondary “activation” stage, which would send a further set of controls and responses to and from site.

After a suitable period, for data collection, the operation stages would be stepped back towards the known starting position, ready for the next test.

The operation of the QUEST machine was captured mainly via a series of screen shots, the impact on the production system was captured real time in the NMS trending functions (time stamped changes in network values), which were exported after each session. Each EHV and primary substation has high accuracy one second data recording, with each

QUEST distribution substation having 10min average LV monitoring. This remote data was automatically uploaded the day after to SP ENW to complement the NMS recorded data. Ad hoc access to a much wider range of LV sites was also available to complement analysis which involved a multitude of different network combinations across the Whitegate group.

At the end of each trial session, site equipment would be restored to normal, QUEST would be isolated and production systems restored to the Whitegate network area.

The full Trials and Analysis report and the associated Digital twin report are published on the SP ENW website {Deliverable 7}

3.5. Customer Engagement

Key project deliverables included detailing our engagement with customers, including:

- Customer feedback to revalidate the hypothesis that customers will not discern any changes in their electricity supply when operating across the permissible voltage range. (This focussed on predominately LV domestic and SME customers)
- Guidance for customers with voltage sensitive equipment connecting to networks with highly optimised control of system voltages. (focused on I&C organisations)
- Customer feedback on the appetite and acceptability of voltage-managed connections.

Engagement was performed by Impact, supported by SP ENW for the more technical aspects of the engagement.

The findings of this work are summarised in section 4, but more detail can be found in the published report Customer Research Findings (deliverable 6). Initially this was due to be published 31/10/24, but to align with the project delays and real-life trials the work was published on the 26/09/25.

4. Outcomes of project (with detail for DNO adoption)

Proactive optimisation and maximisation of voltage levels to achieve a mix of priorities whilst maintain statutory voltages and being imperceptible to end customers has been proven.

This has been achieved by building upon previous innovation projects that have been transitioned to BaU corporate systems and bespoke enhancement of on-site equipment. All this is built on a physical network of electrical equipment developed over several decades to SP ENW specific policy and standards.

SP ENW believe the functionality provided by SP ENW's network and the voltage management philosophies developed over many years through CLASS, Smart Street and now QUEST could be applied by other DNOs, and that the learning to do so is available via all the innovation detail published to date.

SP ENW are aware that UK DNOs do have several differences in the specification of key network elements, network design policy, operation policy and investment policy which could impact the scale and speed of any adoption and may limit some of the benefits achievable by SP ENW. SP ENW are not in the position to comment on the scale of any such detailed impacts, but as with all innovation learning, are happy to engage with other DNOs to explore and hopefully resolve any queries that arise.

The QUEST software has been delivered using the Schneider Electric DMS system, which may not be the NMS in use with other GB DNOs. However, the published project use cases, and functional specifications are anticipated to be sufficient should the QUEST solution be adopted by others for development within their core systems.

As the proven solution requires physical control devices at each voltage level, DNOs will need similar equipment installed. This may include enhanced software or configuration being applied within existing AVC relays.

Active control of the Low Voltage network can be achieved. In this circumstance continuing to use equipment developed and rolled out as part of Smart Street including on load tap changing distribution transformers. The ability to control voltages locally may also prove beneficial in several future scenarios as customer equipment changes with decarbonisation.

Active control of the EHV and HV networks can be achieved using industry standard equipment. AVC software modifications for enhanced control have been proven to be deliverable across several projects. Adoption details have been included in previous reports, including those related to CLASS.

In summary QUEST requires the following core technical elements:

- An ability to change voltage at every voltage level Usually provided by an on-load tap changer mounted on each network transformer. (Note: Smart Street can only be applied at sites with a distribution OLTC transformer, but QUEST will optimise the remaining network in the knowledge of sites that are available for Smart Street)
- An ability to control network voltage remotely. Usually provided via an AVC relay.
- An ability to collect data from site, and issue and receive commands. Usually provided via a SCADA system
- A whole network model, against which site data can be mapped, electrical analysis performed, and optimisation calculated. Usually provided within the network management system.
- A control system within which the real time calculations to perform the functionality described by QUEST (and previous projects) can be performed and enacted. Usually provided within the network management system.

Customers did not perceive the operation of QUEST which pushed voltage at all levels towards statutory limits. The customer engagement work in relation to voltage sensitivity and voltage managed connections again highlighted issues in identifying and getting customers engaged in what for many are technical issues and concepts that can be difficult to comprehend. The material provided from the project may be useful for other DNOs to consider and adopt.

During the life of the project the level of debate regarding network voltage control has increased significantly. The QUEST project has contributed to this debate in several ways at several forums. QUEST has shown how network voltages can be controlled away from historic practise in an overarching manner, with the ability to prioritise different needs at different times. It does not provide any comment on what these priorities should be, whether existing statutory limits are still appropriate, and should they be changed what benefits should be prioritised from any such change.

4.1. Quantitative data to describe outcomes

Quantitative data underpins the learning from the Trials and Analysis phase described in Deliverable 7: QUEST Trials and Analysis Report and the associated SGS modelling using the QUEST digital twin. The data was extracted from the core NMS system and from monitoring units installed at key nodes in the network. The data processed into graphical form, is utilised to demonstrate and support the trial findings.

The key findings described within these reports are:

- QUEST can control voltage at all Network Levels
- QUEST can optimise voltage across all levels based on priorities set
- QUEST will maximise benefits, once all priorities have been met
- QUEST can integrate with 3rd party customer systems and modify their operation
- QUEST benefits can be verified against modelling with an external digital twin model
- QUEST can do this using standard SP ENW network equipment

Deliverable 7 explains in detail how benefits available via the different QUEST elements can be prioritised, how the QUEST system can analyse the network and ascertain where and how much benefit can be obtained, how it uses this information to select the specific equipment required to achieve the immediate priority set, and should additional benefits be available from other network assets, how these benefits be utilised against the remaining set priorities. It does this in the knowledge of the real time system configuration and network component availability and can modify the behaviour of third-party systems to prevent conflict with its set benefit prioritisation.

The QUEST system can identify potential network conflicts from active voltage management at differing voltage levels and adapt its response before releasing network controls. Such conflicts can include setting voltages at different voltage levels that act cumulatively and result in a network excursion from ESQCR limits or applying functions that result in a tap changer conflict, or a tap changer exceeding its physical tap range.

QUEST has been delivered through new overarching control software. This software is looking at the Whitegate GSP area, and it has knowledge via an ICCP of the network's switch status and analogues at key network nodes. The software is set its priorities (via a profile which is a defined set techniques (functions) in a priority order with a desired level of function response per technique) against which it will firstly optimise (to achieve the desired response) and then maximise (to utilise any remaining response) the expected benefits by adjustment of voltage control equipment at all levels.

The result of this optimisation is displayed on the QUEST control and monitoring dashboard (network view), and a benefit summary is shown on the Output dashboard.

Screenshots, from deliverable 7, of the various stages are included for information:

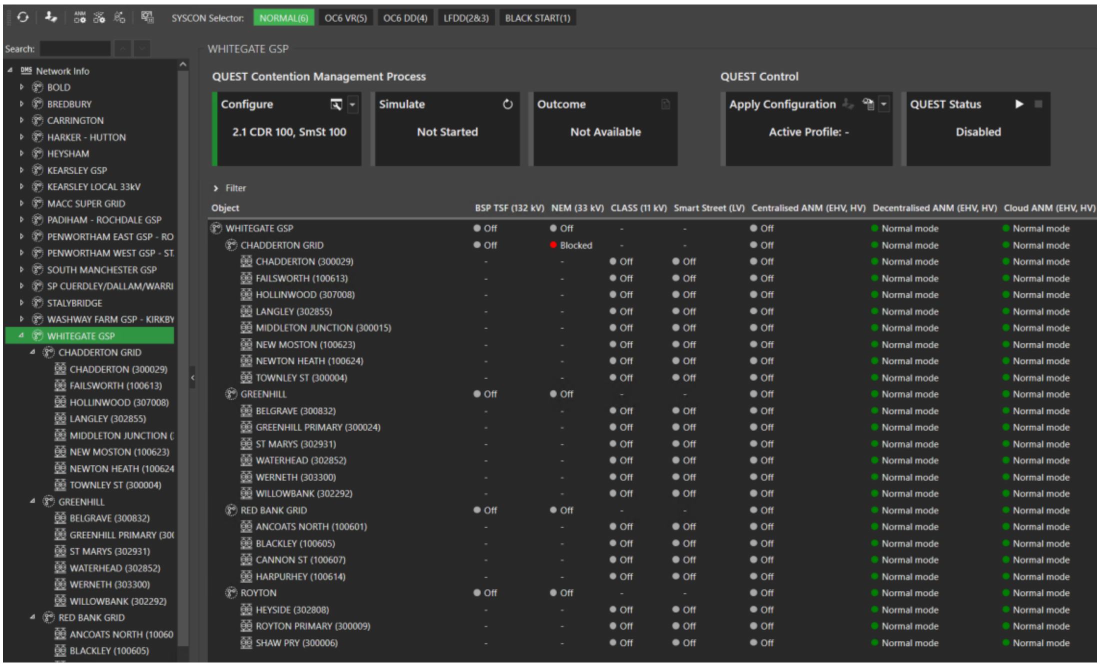

Figure2: QUEST Control & Monitoring Pre-Activation

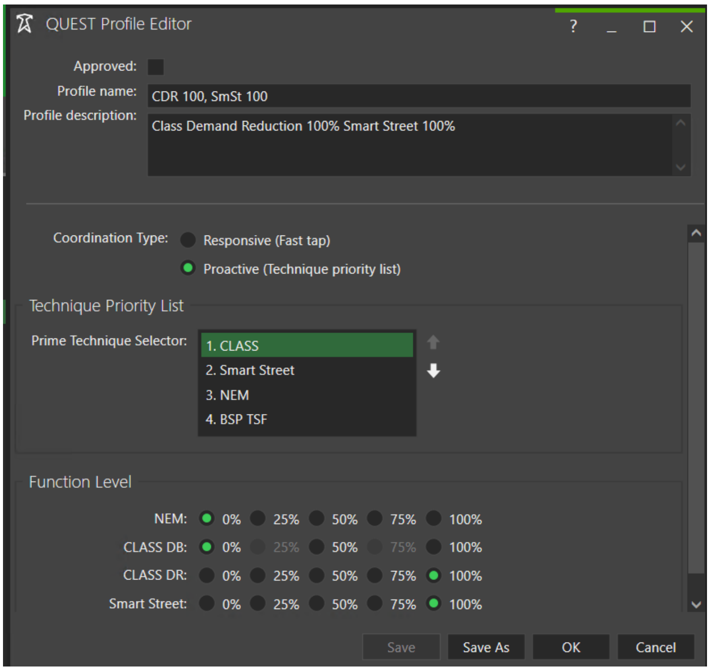

Figure3: QUEST Profile Editor / Creator

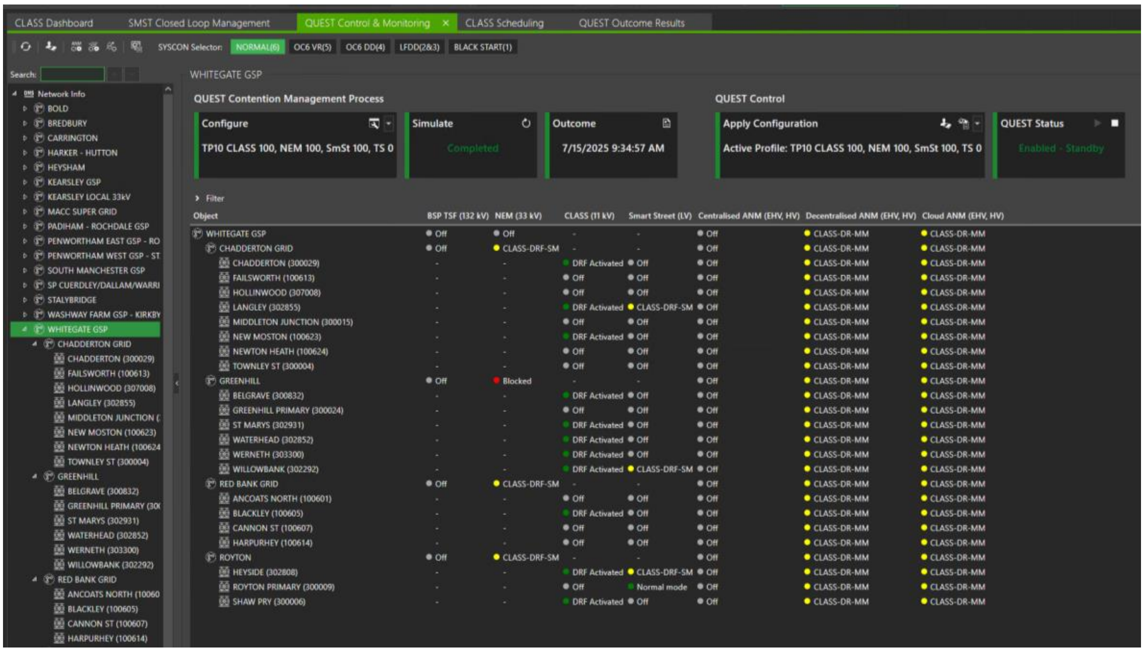

Figure4: Control & Monitoring Dashboard Post Activation

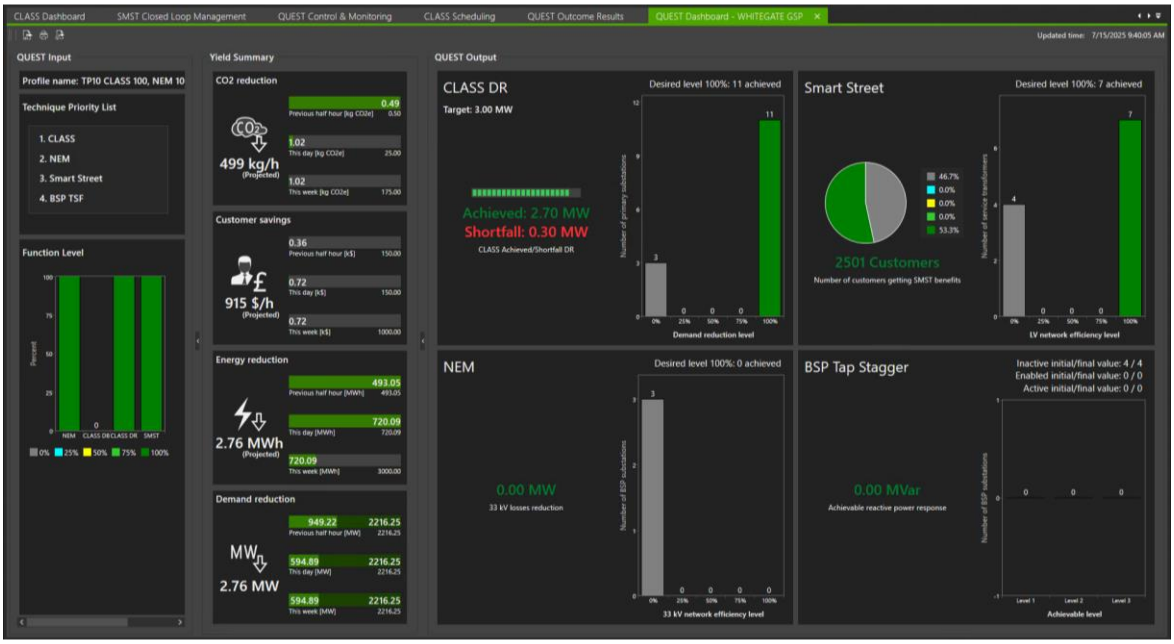

Figure5: QUEST Real-Time Output Dashboard Results

QUEST is sending control signals across all voltages to all control equipment, each of which is responding and providing its element of the cumulative benefits being obtained. To reinforce the confidence that the QUEST system was providing an accurate result, a series of trials were replicated in the "Digital twin" developed by SGS. A trial test results and analysis report https://www.enwl.co.uk/globalassets/innovation/quest/deliverable-7-documents/200952-63b---spenw-quest---trial-test-results--analysis-report.pdf published alongside deliverable 7 provides the detail for this work and confirms a consistency of results between both processes.

The QUEST BSP Tap Stagger function investigated whether generating a significant reactive power flow across the four BSP transformers would result in a reactive power effect at the transmission boundary, sufficient for a potential future service. Deliverable 7 details the specific tests performed and verified against the external digital twin. The trial tap stagger generated a circulating current in each of the four BSP transformer pairs. Typically, one transformer injected between 12 and 14 MVAr of reactive power while its paired transformer absorbed 10 to 12 MVAr, resulting in a net reactive power absorption of approximately 2 to 4 MVAr per BSP. Across the four BSP sites within the Whitegate GSP group, the cumulative effect was clearly visible at the GSP level. Analysis of reactive power data at Whitegate confirmed an increase of 8 to 10 MVAr during the periods of manual tap staggering, which aligns with the combined net absorption observed at the individual BSPs.

This value was however small compared to the daily fluctuation measured at Whitegate and is an area for discussion with NESO to understand if it is sufficient for a potential future service.

QUEST trials also looked at integrating its voltage management outcomes, with the impact on third party equipment that may also respond to voltage changes on the DNO network. The ability to mitigate 3rd party equipment was demonstrated using ICCPs and additional work was performed looking at the detailed response of a constrained Distributed Energy Resource (DER), in this case a generator.

In 2022 and related to the development of the digital twin load model, SGS performed a review of the Voltage Demand Relationship. (The report "Voltage Demand Relationship Research - Present, Future Load Modelling and Scenario Analysis" is published as an associated document to this report. The report covers improvements to load models originally developed through the CLASS innovation project, updates with more recent network data and predicts potential future load changes. It notes that whilst future devices may be less voltage dependent leading to a reduced response over time, suggested at 5% reduction by 2031, there will remain a healthy amount of CLASS demand reduction service provision). Within the trials and analysis phase, the project concentrated on the new QUEST optimisation functionality only confirming that the demand response being obtained through QUEST was equivalent to that being generated by the equivalent BaU systems (CLASS and Smart Street).

4.2. TRL levels

The QUEST submission expected that the Project would develop the overarching software and holistic voltage control methodology from Technology Readiness Level (TRL) 6, and progress it to a business-ready solution (TRL 8). The final stages of the Project will produce the case for transitioning the solution to Business as Usual (BaU).

Through this project QUEST has proven development to TRL 8 by demonstrating final integration and validation of the technology in its intended operational environment. The project has demonstrated that the technology is fully functional, reliable and compliant with the required regulations. A full commercial deployment will require the project software to be updated with the learning developed from this project and, as a commercial product, it would also require to be assimilated into the core production NMS product and environment and any intersystem arbitration resolved.

4.3. Customer

Deliverable 6: Customer Research Report details the methodologies applied and the results obtained in exploring the general Customer experience of QUEST and the specific needs and expectations of customers who could be impacted or benefit from enhanced voltage management.

Area 1 research among domestic and SME customers confirmed that the introduction of QUEST voltage control had no notable impact on electricity supply. Across both trial and control groups, there were no findings that suggested a decline in appliance performance. Satisfaction with supply remained consistently high, with no evidence that QUEST had influenced attitudes or increased contact with SP Electricity North West. Even among SMEs with specialist equipment, none reported any negative effects during the trial period. Power cuts were infrequent, generally short in duration, and unrelated to the trials, while behaviours and levels of satisfaction in trial areas closely mirrored those in the control areas. It therefore appears that QUEST operated as intended: delivering network efficiencies while remaining effectively invisible to end users. The research is based on a sample size of over 300, split approximately 2/3 within trial area and 1/3 outside trial area. A survey was conducted prior to any trials, to create a base line, and repeated during the trial period when any negative effects would be forefront in the customer's experience. Over 600 surveys were completed in total. As with previous customer engagement for CLASS and Smart Street the findings can only be based on what the customer reports as their experience, and the difference between their experience before and during trial activity. Smart meter data was not available to the project to confirm measured voltage changes.

Area 2 explored the views of I&C organisations, many of whom operate equipment highly sensitive to voltage fluctuations. Interviews and focus groups revealed the critical importance of a stable and reliable electricity supply, with over half of participants stating that even small deviations could shut down operations entirely, causing financial losses. Businesses described the severe operational, safety and reputational risks posed by interruptions, particularly in healthcare, manufacturing, and energy generation, where downtime or equipment damage could have financial and safety consequences. Despite this sensitivity, most organisations had little awareness of how network pressures are changing, and few had plans to manage future supply challenges. Once QUEST was explained, however, participants were able to recognise its potential to reduce risks and improve reliability. Feedback gathered across focus groups and follow-up depth interviews directly informed the development of new communication materials, which were generally well received for their tone, clarity and accessibility. Businesses emphasised the need for transparent information, practical examples, and sector-specific tailoring, alongside a preference for direct communication from named contacts, whether through in-person engagement, email or digital formats. Printed leaflets were considered less effective. Overall, the Area 2 research demonstrated both the vulnerability of this group to voltage issues and the importance of clear, proactive communication in ensuring positive engagement with QUEST. The research is based on a series of semi structured interviews, followed by Focus groups and in-depth interviews. The initial semi structured interviews consisted of representatives from 31 organisations.

Area 3 research engaged generators, developers, and large demand customers to explore their attitudes towards and experiences of connection agreements and the potential for bespoke managed voltage connections under QUEST. Across the in-depth interviews, most participants were familiar with the connections process but had limited direct experience with constrained or flexible agreements. Appetite for bespoke arrangements was mixed and often cautious. While some recognised the potential to secure connections that might otherwise be unavailable, others expressed concern about compliance requirements, monitoring, and the impact on long-term investment value or resale of sites. Capacity was the only constraint consistently seen as a clear benefit, with voltage management and fault level constraints less well understood. Businesses emphasised that any new model would need to be financially viable, transparent, and flexible enough to fit their existing operational patterns. Interest was strongest among generation developers and those with fluctuating import and export needs, particularly where QUEST could support expansion plans or hybrid solutions combining solar, wind and storage. Overall, while QUEST was viewed positively as a credible innovation that could enhance network efficiency, the case for widespread uptake of bespoke connection agreements remains uncertain, underlining the need for further communication, technical detail, and targeted engagement with the most relevant customer segments. The research is based on 17 in-depth interviews, targeting organisations that could potentially benefit from bespoke managed voltage connections.

Key findings

Area 1:

- The hypothesis that the introduction of QUEST voltage control had no notable impact on electricity supply experience was confirmed.
- Satisfaction with electricity supply remained consistently high, with no increase in customer contact or concerns.
- SMEs operating specialist equipment reported no negative effects during the trial.

Area 2:

- Businesses highlighted the critical importance of a stable supply, with over half noting that even small voltage deviations could halt operations, risking financial loss, safety, and reputation.
- Sectors such as healthcare, manufacturing, and energy generation are especially vulnerable to voltage fluctuations.
- Awareness of changing network pressures was low, and few organisations had plans to manage future supply challenges.
- Once explained, QUEST was recognised as a positive innovation to reduce risk and improve reliability.
- Communication materials developed from the research were well received for their tone, clarity, and accessibility.

Area 3:

- Participants were generally familiar with connection processes but had limited experience with constrained or flexible agreements.
- The existing pool of customers for whom this would be relevant was much smaller than anticipated. This created challenges in recruiting respondents for Area 3.

- Appetite for bespoke voltage-managed connections was mixed, with concerns about compliance, monitoring, and potential impacts on long-term investment or resale value.
- Interest was strongest among generation developers and organisations with fluctuating import/export needs, particularly where hybrid solutions (solar, wind, storage) could be supported.

5. Plan for transitioning the solution to Business as Usual

The QUEST software developed for the project is built on existing system functionality, by the same technical team providing BAU technical upgrades, in such a way that it could be integrated into the production system as an almost “lift and shift” software update. However, during the project certain changes have increased the complexity and cost for the transition to BAU phase. These are:

1. QUEST was built as overarching software utilising existing previous innovation. During the extended period of the project there have been routine updates to the core systems. A BaU QUEST system will need updates to embed these changes, and work to ensure appropriate arbitration required for a core product.
2. The project anticipated the SP ENW core ANM project would have delivered a BAU solution earlier, to allow full integration and testing. Due to delays in the ANM solution this was not possible
3. The QUEST project change, requiring QUEST to be built into a separate NMS instance, has increased the integration and arbitration work for the full BAU system
4. In 2025, NESO, updated the market requirements for Demand services, requiring the BAU CLASS functionality to be updated (test and delivery due early 2026). As CLASS was a fundamental building block for QUEST, the recent CLASS BAU changes would need to be embedded into a final QUEST BAU
5. During the QUEST project, SP ENW made the business decision to version upgrade the core NMS system. This is a significant upgrade to the latest NMS software and includes changes to system structure and supporting systems. Whilst some QUEST future planning has influenced the new system design, the software tested will require to be upgraded and modified for use in the new NMS.
6. Significant industry discussion is currently underway on potential changes to ESQCR limits, and the significant benefits this could unlock (including the potential for DNOs to facilitate the types of services trialled in QUEST via alternative means), alongside the potential issues low voltage could present to customers’ equipment.
7. There is also on-going discussion regarding the provision of CLASS services in ED3 (Ofgem Consultation - ED3 Sector Specific Methodology Consultation). The outcome of these potential changes may impact the business case for QUEST BaU adoption, especially if any particular benefit achievable from a

voltage managed service is prioritised such that the flexibility and optimisation offered by a QUEST like solution is significantly diminished or not required.

SP ENW are keen to embed QUEST into BaU adoption, and work has commenced with SE on the initial stages of a BaU adoption project. Partially due to the issues outlined above, this is currently anticipated for delivery some time in ED3.

6. Performance against Project Aims, Objective, SDRC/Project Deliverables

The project has delivered all its project aims and objective. All project deliverables have been delivered, however due to the documented delays with the supporting IT infrastructure several deliverables, pre notified to Ofgem, were revised then delivered to the revised dates. Where applicable, deliverables have been updated and additional associated supporting documentation published.

Ref	Project Deliverable	Deadline	Evidence	Status / Revised Date
1	QUEST Initial Report - Use Cases	31/07/21	Document introducing the Project and detailing the use cases and scenarios.	Completed July 21
2	QUEST System Design and Architecture Lessons Learned	31/12/21	Document explaining Project progress including the following outputs: • Review of architecture options • Specification for the network models and modelling regime	Completed December 21
3	QUEST Trials, Design and Specification Report	30/06/22	Document explaining Project progress including the following outputs: • Functional specification for chosen architecture • Functional specification for voltage control methodology • Trial design • Detailed site design	Completed June 22
4	QUEST Interim Report - System Design and Technology Build Lessons Learned	30/06/23	Document detailing Project progress to date including lessons learned from: • QUEST software development and testing • Power system model development	Completed June 23

Ref	Project Deliverable	Deadline	Evidence	Status / Revised Date
			• Site installation for the voltage control and ANM equipment	
5	QUEST System Integration Lessons Learned Report	30/12/23 Update: 30/04/24 An IT update to be added	Document detailing the lessons learned from the installation and commissioning of the QUEST system including system integration and the results of site acceptance testing.	Completed Dec 23 Updated Apr 24 Last IT update Dec 24
6	Customer Research Findings Report	31/10/24 Revised: 26/09/25	Document detailing the outputs from the customer research.	Completed Sep 25
7	QUEST Trials and Analysis Report	30/12/24 Revised: 28/11/25	Document detailing: • Final results from network trials • Final results from modelling trials • Output from the voltage demand relationship research • Any adaptation required to voltage control methodology	Completed Nov 25
8	QUEST Final Report	30/04/25 Revised: 19/12/25	Report on the conclusion of the QUEST Project including all the lessons learned and detailing the next steps, including BaU transition.	This Report Dec 25

Note: Formal Revisions were communicated to Ofgem in Dec 23 and Nov 24. These revisions, and the reasons for them, were published in the year end Project Progress Reports (also published & available on the SP ENW website)

6.1. How has project helped solve the issue in the full submission

The issues described in detail in the initial submission, regarded the transition of traditional basic voltage management to an overarching system better able to respond to changing customer adoption of LCT (both load and generation), the provision for active voltage control by the DNO for a range of benefits, and the increasing proliferation of discrete voltage management techniques.

The project has demonstrated a solution suitable to resolve the issues in the full submission. It has demonstrated an overarching voltage optimisation and maximisation approach that optimises across the whole network and interfaces with external systems that impact voltage management. The system demonstrated the resolution of conflicting priorities and different times, it has refined the degree of control a central system has on existing network assets, and how a system can move from normal operation should an GB network emergency develop. Whilst doing all of this, the project has reconfirmed GB customers are unaware of additional voltage control and provided further insight into how voltage sensitive customers can be engaged with and potentially take advantage of opportunities arising from improved voltage management.

7. How did project perform relative to its aims and objectives and success criteria

In terms of the core aims, objectives and success criteria the project has delivered. Throughout the project the significant issue has been Cyber Securities impact on the project. This has included a design change to underlying project IT support infrastructure, exposing the project to additional risks of resourcing, prioritisation and system access, leading to significant delay in the build process, and delays in delivering enhancements when identified once testing commenced. Combined this resulted in the original 12 month estimate for Trials and analysis to be delivered in 5 months. Whilst not ideal, this has proved sufficient to prove the projects hypothesis.

8. Required modifications to the planned approach during course of project

As stated, the cyber security driven change to IT support infrastructure, and the knock-on delays was the key modification.

However, the core planned approach of the project was delivered relatively as planned, excepting the impact on timing. The project delivered a series of enhancement and refinements to the project definition using a methodology of use cases, and design, leading to a formal software specification that was delivered and tested. The adoption, installation and enhancement to proven on site technologies was delivered with only minor timing and resource issue that would be anticipated working on the live network. Customer engagement was delivered, and the trials and analysis phase deliver results within the expect range.

8.1. The project modification can be summarised as:

- Diversion of focus and resources in response IT changes including
  - Change to IT support design and hardware
  - Change of scope for some partners to onboard IT activity originally to be delivered in house by SP ENW
  - Change of timing, resources and costs to reflect the delay of the project, and additional partner works for the changed IT and software licenses
  - Change of IT access arrangements for the build, support and operation of QUEST system and subsystems, including issues in providing and retaining remote access.
  - Reduction in industry liaison during IT extended build phase (project was not developing suitable learning for engagement)
- Delay to the customer engagement work, resulted in small modifications to mitigate the risk posed from extended period between pre- and post-trial surveys.
- Less time to fully explore the complex partner ANM systems over and above that needed for project deliverables
- Modifications to respond to changes in SP ENW systems being developed & upgraded on independent BAU timelines

8.2. Summarised changes to projects planned methodology

The significant change was the IT support design change, which required QUEST to operate outside the core production system and be interfaced into using an ICCP link. The resultant impact of this change direct relevant to the project methodology where:

- Loss of the seamless integration with core NMS functionality required for a production system, resulting in mixed benefits:
  - Integration with the SP ENW ANM system, which was anticipated to have been delivered for the QUEST project to use became significantly more difficult, however…
  - The SP ENW ANM system had been equally delayed and would not have been ready to fully utilise in the QUEST system
  - The core NMS is subject to regular patches, updates and enhancements. The reduction in integration reduced the need for QUEST compliance testing for each update.
  - The QUEST system required additional data updates, reflecting some sub systems would not be automatically updated and kept in step with production
  - IT responsibility for Project partners was revised to reflect changes in IT architecture, and availability of skilled, experienced resource.
- Revised remote access (for build, configuration and operation) resulted in additional delays, and full exploration of ANM capabilities.

- Minor changes to customer recruitment and engagement to reflect different trial period
- Loss of full 12-month trial period, reduced to testing across 5 months.

8.3. Reason and outcome of changes to project's planned methodology

An SP ENW IT review held early in the project and under a changed cyber security environment, identified delivering an Innovation project of new software code within a production real time system environment was high risk, with the associated requirements to interface with third party systems and the requirement to be able to fully decommission the project should it be unsuccessful was an unacceptable risk. A revised architecture with the QUEST system as a standalone system, integrated through ICCP links was approved and thought to be simpler to deliver. During detail design, hardware build, software build, configuration, integration, testing and trials a series of unforeseen IT related challenges arose causing the project to be significantly delayed. Both the IT changes, and the knock-on delays impacted QUEST project finances.

However, during the QUEST project, the core NMS BAU system has remained secure.

The project delays introduced by the creation and maintenance of the supporting IT infrastructure created additional pressures in the delivery of the subsequent project phases resulting in the timescales for certain items of work being constrained and reduced. However, the volume and quality of work performed within the reduced timeframe have not impacted the core deliverables or the output quality, nor were they a change to the underlying project methodology.

9. Significant variance in expected costs

Whilst the project incurred a significant time delay and a change in IT approach resulting work being delivered differently to plan, the project was delivered within total project approval including contingency (within 1%). With one exception each project bid categorisation was brought in within +/- 5% variation. The exception was Equipment Costs. During the project efficiencies were identified in the scope and number of interventions planned on the existing network to bring it to a state suitable to test the QUEST hypothesis against.

Significant efforts were made across the project to ensure the extended project remained within the approved project authorisation.

10. Updated Business Case and lessons learnt for the Method

The Business Cases, financial and carbon, developed for the bid submission have been reviewed and updated based upon the QUEST learning and to reflect any significant external changes during the life of the project.

The structure of the analysis remains consistent from bid to best reflect the impact of the project findings. Most of the quoted QUEST benefits are because of the established CLASS and Smart Street techniques that QUEST encompasses. Where QUEST can optimise these techniques, additional benefit can be obtained. The benefits are aligned to the impact of managing network voltage away from a nominal (historic) value, usually a reduction resulting in reduced energy consumption and network current/power flow.

The NPV calculations are based on the following benefit subclasses: Network Capacity Release, Consumption Reduction, Losses Reduction and Carbon Benefits.

- Capacity Release benefits are based on the estimated deferral years of the substation reinforcement costs from the release of capacity by considering the peak demand values for selected DFES scenario over the time period of the study, which is 2024-2050.
- Consumption Reduction benefits are based on load reduction due to voltage reduction based on the voltage demand relationships, electricity consumption reduction and corresponding bill reduction for low voltage customers.
- Losses Reduction benefits are calculated by the monetary values of the losses reduced in the network.
- Carbon Benefits due to carbon emission reduction are calculated based on the electricity demand related carbon reduction and corresponding carbon prices forecast over the time period of the study (2025 to 2050).

10.1. Financial Benefits

Financial Benefits Table

Scale	Benefit/Cost	Benefit £m NPV - Updated			Benefit £m NPV - Bid		
		2030	2040	2050	2030	2040	2050
SP ENW Scale Benefits	QUEST Benefits*	22.8	37.3	48.2	22.8	32.4	35.6
	QUEST Roll-Out Costs	2.55	5.04	5.94	1.5	2.6	3.0
	Net Benefits**	**20.2**	**32.3**	**42.3**	**21.3**	**29.8**	**32.6**
GB Scale Benefits	QUEST Benefits*	60.7	220.7	380.6	65.6	202.1	308.2
	QUEST Roll-Out Costs	26.30	91.66	106.79	14.6	37.1	41.5
	Net Benefits**	**34.4**	**129.0**	**273.8**	**51**	**165.1**	**266.7**
	Additional Benefits***	£10,237m by 2050			£4,300m by 2050		

*QUEST Benefits include network capacity release benefits and losses reduction. (These are the benefits directly attributable to DNO)
**Net Benefits is the difference between QUEST Benefits* and QUEST Roll-Out Costs.
*** Additional Benefits refer to the consumption reductions benefits only for GB Scale. These are the energy saving benefits received by the end consumer consuming less due to a voltage reduction at the point of supply.

(Note: During external review the respective scale of each benefit has been noted and suggested this should inform how best to use the range of ongoing voltage management techniques. This suggestion is outside the scope of the QUEST project to answer. QUEST set out to prove voltage techniques at each level can be optimised, and be optimised against a range of priorities, without defining what customer group should benefit first, or in in what order)

10.2. Carbon Benefits

Carbon Benefits Table

Scale	**Benefit/ Cost**	**Benefit (tonnes of CO2e) - Updated**			**Benefit (tonnes of CO2e) - Bid**		
		2030	**2040**	**2050**	**2030**	**2040**	**2050**
SP ENW Scale Benefits	Losses reduction (main business case benefits) *	4,749	11,848	19,195	2,161	5,286	8,373
	Energy consumption reduction (additional benefits) **	105,987	265,156	431,026	70,217	172,617	275,022
GB Scale Benefits	Losses reduction (main business case benefits) *	9,337	57,657	142,579	4,088	22,090	51,498
	Energy consumption reduction (additional benefits) **	208,468	1,292,443	3,210,079	82,461	451,901	1,070,380

*Losses reduction (main business case benefits) refers to the carbon benefits due to losses reductions by QUEST project.
**Energy consumption reduction (additional benefits) refers to the carbon benefits due to energy consumption reductions by QUEST project.

10.3. Conclusions

Comparisons between the 2020 NIC application stage benefits analysis and the post QUEST project completion benefits assessment reflect that QUEST will deliver the benefits estimated in 2020. QUEST has proven that additional voltage reduction benefits of 3.5% above CLASS LCNF findings are achievable rather than the 2.5% estimated at the NIC application stage. This is reflected in an increase in the GB benefits anticipated following a rollout of QUEST.

The updated Business and Carbon Benefits Cases following the QUEST trials reflect the changes in the prices from 2020 to 2025 and consider the latest updated DFES scenario forecasts. The updated results show that the breakeven point of the project is in the year 2032, where the impact of the QUEST project starts becoming beneficial. After 2032, there is a significant increase in the cumulative QUEST benefits at a GB scale. Although the network has grown slightly during the project QUEST Project, this growth has not materially impacted the underlying business case.

The QUEST project has established higher achievable voltage reduction (3.5%) in the network compared to bid stage calculations (2.5%) which has led to a stronger business case as reflected in the NPV values in Table 1. Additionally, the value of reduction in CO2 emission is significantly higher, see Figure 2, mainly due to higher losses reduction on the HV network achieved compared to the NIC bid stage.

Following ~£8 million of investment, QUEST has proven its value for investment establishing potential GB benefits in excess of £250m by 2050.

While the DFES has evolved during the QUEST project, the scenario used for both the initial NIC application and post project are consistent and applicable. The results depicted in the updated benefits cases are based on a DFES “Best View” scenario.

QUEST GB roll out costings have changed significantly during the project; therefore, appropriate adjustments have been made to account for this.

Another reason for the large difference between post-trial and application calculations for “Energy consumption reduction (additional benefits) **” at GB scale” is an error found in the original methodology. The original calculations incorrectly summed the ‘HV consumption reduction benefit’ and ‘loss reduction benefit’. This has now been corrected to sum the ‘HV consumption reduction benefit’ and ‘LV consumption reduction benefit’.

11. Lessons learnt for future innovation Projects

The project delivery generated significant lessons that will be useful for future innovation projects and other business projects. There was learning derived from the technical approaches used in the project and learning from the delivery of the core project scope and has been gathered from all project partners.

Most of the significant issues and lessons from the project resulted from what was initially viewed as a small IT change that rapidly escalated due to world events. Many of these issues could not have been foreseen but various mitigation measures were undertaken.

The core project, outside of the impacts of IT system delays, progressed relatively smoothly generating useful project learnings for implementation and future projects

IT Lessons (including Design, Build and Operate)

The IT requirement to separate systems differently to that envisaged in the bid, resulted in an apparently simple high-level design that ultimately became increasing complex as design and implementation became detailed, and various assumptions were challenged and changed.

SP ENW IT Change approval process. Increased time needs to be applied to confirm with enhanced requirements

SP ENW IT Hardware configuration. Project specific partner responsibilities required non-standard access. This could have been specified earlier and communicated wider.

SP ENW IT Accounts. Increased time / Clearer communication needed to reduce time to connect and test.

SP ENW IT complexity. Noting final solution required multiple SP ENW IT BaU systems and processes to be used for project partners to access QUEST. Where possible this complexity could have been developed earlier to pre-empt issues, rather than resolution after issue.

SP ENW IT firewalls & port changes. Design detail required earlier and shared earlier to ensure consequential impacts can be checked earlier to reduce volume of work required.

ICCP set up. Recognition that alternative management tools are available, each with slightly different configuration requirements. Learning to confirm tools and increase ICCP specification detail earlier.

ICCP Certification (Set up and renewal). SP ENW and partner experience built into future process (time and complexity)

QUEST hardware failure. Not preventable but lesson that this may happen, and influence events

System and subsystem backups. Lesson that Innovation systems still need back-up systems and processes and these need regular checks and confirmations.

System Memory. Noting Innovation projects may need to be scaled for worst case assumptions, as delays to rectify issues may have greater impact.

Separating system elements for Innovation work, may result in additional processes where previously automated data/system updates are broken by separation. Learning is deeper understanding of unintentional consequences of design change.

Testing and debugging. The core IT delay and the nature of the QUEST system integration resulted in the more periphery systems being tested remotely and with test data and systems. This was required to keep project moving but resulted in several issues only being identified post-trial commencement and being rectified "on the fly" via multi-party teams calls.

BSP TS Signals. The QUEST < > SCADA ICCP eventually contained around 25,000 individual points. During testing/trials it became apparent the points required for BSP TS were not fully available and would require another time-consuming change and test cycle to resolve. However, as the QUEST software benefit calculation was unaffected (the calculated benefit QUEST generates is based upon its internal model and real time values provided to it, the calculated benefit is not affected by whether the controls sent actually change the network configuration), and the possible conflict (between NEM & BSP TS impacting final tap positions) proved to be untestable without significant excursion from ESQCR and the BSP TS physical function being testable from production system, this change was not made and the time saved used for more extensive testing. On the SP ENW network the nominal tap position to achieve nominal network voltage is such that the application of the most extreme combination of NEM and Tap Stagger, results in the tap position staying within the available tap range of the transformers. In designing QUEST, it was assumed tap range would be a constraint, this constraint may be present on other DNOs' networks.

SGS Historian. Issue identified during early trials, where captured data wasn't being fully recorded. This was an oversight in commissioning the last system elements.

Recognising need for new processes, fast development and establishing of regular update and cleansing routines within partner systems and across integrated systems

Project and General Lessons

Delays from IT impacted focus and timeframes for remaining deliverables, impacting resourcing and subsequent decision calls.

Documentation. On reflection several project documents were viewed as being overly long and complex, resulting in long review periods and key information being buried. Conversely other documentation was found ultimately to be too superficial resulting in extra layers of design and issues being uncovered late in the project. The learning taken was to consider document production, review and suitability early between project partners to set project expectations and modify what may be existing partner expectations

Internal Communications. The project adopted regular (often weekly) 1:1 and team calls, as a basis of progress checking and early escalation. This was felt by all partners to work well, even when sessions were found to be not required. This process was adopted for key delivery streams (e.g. Trials and Analysis). Use of a common project data sharing platform, and MS Teams was also beneficial. (Note: Some communication mediums / processes were found to be unsuitable for SP ENW IT secure items). Internal sharing of team member holidays also supported better work planning.

Issue Management: Multi-party teams calls were found to be the most effective technical issue resolution method, in preference to documentation and email trails. These calls however could take some time to organise across multiple parties.

SP ENW installed SGS ANM outstations with little help from SGS, demonstrating an ability to adapt and integrate 3rd party products by a DNO.

Project Resourcing. It is worth noting that most of the individuals identified as project resources at project commencement, left and were replaced (often more than once) during the project's life. Generally, the project handled these changes well but acknowledge they did impact project timeframes. This is to be acknowledged for future projects.

Resourcing – Specific deliverables. The project required non-core project subject matter experts (especially IT) at critical times during the project. These resources were often limited, fully utilised and unavailable at short notice. This is to be acknowledged for future projects with either project scope reduced to lessen the need for this type of resource, or extra allowances made to ensure resources can be extracted from BaU activity when required.

Development. The initial project set up, to develop and refine use cases on which to build detailed designs worked well and delivered a quality outcome and would be a good model to re-use.

Technical configuration, testing and debugging. This took longer than anticipated and required multiple cycles. The QUEST test system allowed several systems to be built and tested in a safe space; however, the test system is not a complete replica of reality so final configuration and test had to be completed in production. SP ENW IT process usually required an equivalent change to be proven in the test system, before production.

Software issues. During the trials and analysis phase, system responses were being observed and confirmed. In doing so this rapidly developed the user understanding and knowledge in using the system, and ideas on how to improve. It also identified several software changes to ensure the project met its objectives. These included:

- A fix to CLASS performance to resolve a SCADA timing issue
- A fix to improve response to CLASS Primaries in Test mode
- A fix to rectify CLASS DR becoming inhibited post activation
- A fix to improve BSP TS and response calculation

During the project, changes to the NESO market in which CLASS operates were announced (Optional Fast Reserve market to be replaced with a Quick and a Slow Reserve market). This caused a resource conflict as changes to CLASS BaU are required to meet the requirements for the new market rules. The SE resources for QUEST are also supporting the NMS upgrade project and the additional CLASS changes.

The BaU CLASS changes for NESO will also need to be included in any QUEST BaU roll out.

Project Initiation Document. Some of the learning above should be embedded in any future PID and PID templates.

Learning for adoption into BaU

OT and IT environments can be integrated seamlessly using appropriate protocols like the Secure ICCP, the depth of skill sets to deliver this work is now better appreciated. ICCP (Inter-Control Centre Communications Protocol) is an established IT methodology/technology to allow multiple control centres to talk to each other. There are different levels of security that can be applied, based on trusted status of each party, and slightly different commercial solutions available.

ICCP and system point naming. The data chain required to deliver a single action from the QUEST machine, via the ICCP, SP ENW SCADA, site relay and the confirmation route back to the QUEST machine was found to more complex than anticipated. This was exasperated as certain points only existed in the QUEST system. The SP ENW OT and SE teams took various learnings from this for future BaU services.

Operating the QUEST trial identified several enhancements to include in a future BaU product to be developed in conjunction with SE including:

- Enhancement to the “Smart Street Demand Boost Safe mode” option, to improve handling of control confirmations handled through the mobile network. This is an example of general learning around the speed of controls for LV assets (usually mobile network based) compared to higher voltages (usually private fibre network) and the impact on optimisation.
- Enhancement to SCADA local mode, to ensure QUEST is aware of Tap Changer local mode (fixed tap)
- Enhancement of ANM co-ordination function, to apply lower in network hierarchy ideally down to each primary and to better reflect the SP ENW

hierarchy. The QUEST ANM function tested works at a Grid level, a BaU function needs additional granularity.
Enhancement for Topology Changes within the network hierarchy display
Enhancement for the improvement of system response to a failure of Comms to a Distribution OLTC, to maximise benefits

Review of QUEST dashboard UI, incorporating comments from control engineers logged during trials.
Review of CLASS 30min reschedule / CLASS activation / QUEST impact
Review of impact to CLASS BaU software changes
Review of impact of core system upgrade
Review of Smart Street operation, especially if a fast distribution fast tap functionality is developed (a fast tap unit was a theoretical consideration included in the initial use cases, which along with improved LV comms would improve proactive LV control response)
Review of how to practically test QUEST responses during extreme network system emergencies

12. Planned implementation

SP ENW are looking to implement QUEST and its additional technical changes and benefits into business as usual. This is because the QUEST project has proven we can deliver the flexibility of voltage management to deliver a range of often conflicting end benefits that currently or potentially could exist. For example, we have refined the range of class demand response available and reduced the risk of conflicting techniques impacting our customer service.

The transition into BaU will not be as simple as thought at the time of bid submission.

Additional work will be required to embed the project learning and update the software so it can be integrated into the production infrastructure and arbitrate safely and correctly with the other core NMS functionalities.

Additional work will be required to update the software to take account of the ongoing CLASS BaU software changes, and the upgrade to core NMS system. These two items are likely to push implementation toward an ED3 timeframe.

Work has commenced with SP ENW and its NMS partner SE to define what will be a new implementation project.

Also relevant is the ED3 price review itself, especially the treatment of services provided using voltage management techniques. QUEST has proven the whole distribution network voltage can be optimised and maximised for a series of benefits for different users. The benefits for this flexibility may be changed should any future services significantly reduce the flexibility required.

The learning from the project is open to all other DNOs to adopt, dissemination events have been held, and SP ENW will continue to support any further discussions with DNOs on delivering the range of voltage management techniques.

13. Key Project learning documents

All project learning documents have been published to the SP ENW project website.

QUEST home page {QUEST}

QUEST Initial Report - Use Cases. {Deliverable 1} A document introducing the Project and detailing the use cases and scenarios.

These form the basis of all QUEST development, and potential conflicts considered.

QUEST System Design and Architecture Lessons Learned. {Deliverable 2} A document explaining Project progress including the following outputs:

- Review of architecture options
- Specification for the network models and modelling regime

These form the basis on how a QUEST system could be built, and how an independent network model could be built and used to challenge the output of a QUEST system.

QUEST Trials, Design and Specification Report. {Deliverable 3} A document explaining Project progress including the following outputs:

- Functional specification for chosen architecture
- Functional specification for voltage control methodology
- Trial design
- Detailed site design

These provide refinements and additional detail to specifications and designs.

QUEST Interim Report - System Design and Technology Build Lessons Learned. {Deliverable 4} A document detailing Project progress to date including lessons learned from:

- QUEST software development and testing
- Power system model development
- Site installation for the voltage control and ANM equipment

These provide further detail and progress on development.

QUEST System Integration Lessons Learned Report. {Deliverable 5} A document detailing the lessons learned from the installation and commissioning of the QUEST system including system integration and the results of site acceptance testing.

These cover the significant lessons learned during the creation of the QUEST system, including significant lessons from the IT changes initiated by the change in the cyber security environment

QUEST Customer Research Findings Report. {Deliverable 6} A document detailing the outputs from the customer research.

This provides a complete cradle to grave review of the customer engagement performed in the project to confirm the main hypothesis and to better understand a select set of EHV and HV customer needs.

QUEST Trials and Analysis Report. {Deliverable 7} A document detailing:

- Final results from network trials
- Final results from modelling trials
- Output from the voltage demand relationship research
- Any adaptation required to voltage control methodology

This provides a detailed description of the trial methodology, set up, delivery and outcomes. It includes a comparison of the QUEST system (including its own internal models and calculations) to an external digital twin network model for a number of key test scenarios.

Where any deliverable has been supported by associated documentation and reports these are available via the same link as the key project deliverable

The annual Project Progress Reports can be viewed on the website {PPRs}

The Customer Engagement Plan, Industry Steering Group & Energy Innovation Summit presentations are also published. {QUEST library}

The project has also been the subject of three CIRED papers:

CIRED 2023: QUEST – An Overarching Control Solution
CIRED 2023: Voltage Demand Relationship Modelling for Future Energy Scenarios
CIRED 2025: QUEST – An Overarching System Control Solution: Operational Trials

An abstract for a fourth paper has been submitted:

CIRED 2026: QUEST – An Overarching System Control Solution: Live Trials & Digital Twin Validation

QUEST has also been presented at several industry forums and conferences
QUEST, along with its constituents CLASS and Smart Street, have been communicated through multiple SP ENW stakeholder forums.

14. Data access details

All project reports and associated document are published and stored on the SP ENW website as per previous links.

The Innovation data sharing policy is also available on the SP ENW web site: Our data sharing policy

The SP ENW policy is:

We will make available on our website any aggregated network, consumption or other relevant data pertaining to a particular innovation project trial. This is in line with Ofgem's governance on projects funded under the Network Innovation Competition (NIC) and the Network Innovation Allowance (NIA).

Due to the high volumes of data produced by the different innovation project trials, we will only publish the latest available data i.e. data from the current month for each relevant trial.

Previous months' data will be made available if the party requesting it can demonstrate that release of the data is in the interest of electricity consumers. For data protection purposes this data may be subject to anonymisation and/or redaction.

The contact detail for further information is included on the webpage linked to above, and is "innovation@enwl.co.uk"

14.1. Licensee parties.

SP ENW are developing a project to bring QUEST into a business usual product. The key development for this last stage is the integration of the QUEST functionality into the core NMS system, including the real time arbitration with the existing NMS functions. This product will form part of the SE NMS suite provided under contract to SP ENW.

SP ENW have disseminated information to other licensed parties through the project and believe that the information shared both for QUEST and its precursor projects CLASS and Smart Street is appropriate for their requirements.

SP ENW have and remain open to discussing and answering any Network Licensee queries that pertain to this and any other innovation learning.

15. Peer review

NORTHERN POWERGRID
Mark Callum
Smart Grid Development Manager
Mark.Callum@northernpowergrid.com
98 Aketon Road
Castleford
WF10 5DS

Andrew Howard
Innovation Programme Manager
SP Electricity North West
Linley House
Dickinson Street
Manchester
M1 4LF

26 January 2026

Dear Andrew

QUEST closedown report peer review

Thank you for giving Northern Powergrid the opportunity to peer review the QUEST closedown report. Taken together with the QUEST closedown event in Manchester on 10 December 2025, and several conversations we have had during the iterative updates of the closedown report; I can confirm that the final report:

1) Was robustly review by Northern Powergrid;
2) Was updated by SP Electricity North West to accommodate comments made during the peer review process;
3) Is sufficiently clear, understandable and reflective of the work undertaken and learnings found during the project; and
4) Is endorsed by Northern Powergrid for publication.

I look forward to continuing learning more detail about QUEST from further conversations and reading the other published documents produced during this project.

Voltage management is becoming increasingly important and complex, but opportunity exists to provide additional customer benefits. QUEST has shown that different techniques can be coordinated and is a key step towards enhanced voltage management. QUEST, however, does not determine which techniques should be prioritised, and I look forward to working with SP Electricity North West and the wider industry to answer this question as we all produce and implement voltage management strategies that provide maximum whole system benefits.

Yours sincerely,

M. Callum

Mark Callum
Smart Grid Development Manager
Northern Powergrid