Enhanced Voltage Control

ED2 Engineering Justification Paper

ED2-LRE-SPEN-001-CV1-EJP

Issue	Date	Comments
Issue 0.1	May 2021	Issue to internal governance and external assurance
Issue 0.2	May 2021	Reflecting comments from internal governance and assurance feedback
Issue 1.0	Jun 2021	Issue for inclusion in Draft Business Plan submission
Issue 1.1	Oct 2021	Reflecting updated DFES forecasts
Issue 1.2	Nov 2021	Reflecting updated CBA results
Issue 2.0	Dec 2021	Final Business Plan Submission

Scheme Name	Enhanced Voltage Control		
Activity	Replacement of Voltage Control Relays		
Primary Investment Driver	Increased Controllability and Enhanced Functionality of the Voltage Control Relays		
Reference	ED2-LRE-SPEN-001-CV1		
Output	Voltage regulation		
Cost	SPD - £2.192m	SPM - £2.910m	
Delivery Year	2024-2028		
Reporting Table	CV1		
Outputs included in ED1	~~Yes~~/No		
Business Plan Section	Develop the Network of the Future		
Primary Annex	Annex 4A.2: Load Related Expenditure Strategy: Engineering Net Zero Annex 4A.6: DFES		
Spend Apportionment	**ED1**	**ED2**	**ED3**
	£m	**£5.102m**	**£m**

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Technical Governance Process

Project Scope Development

IP1(S)

To be completed by the Service Provider or Asset Management. The completed form, together with an accompanying report, should be endorsed by the appropriate sponsor and submitted for approval.
IP1 – To request project inclusion in the investment plan and to undertake project design work or request a modification to an existing project
IP1(S) – Confirms project need case and provides an initial view of the Project Scope
IP2 – Technical/Engineering approval for major system projects by the System Review Group (SRG)
IP2(C) – a Codicil or Supplement to a related IP2 paper. Commonly used where approval is required at more than one SRG, typically connection projects which require connection works at differing voltage levels and when those differing voltage levels are governed by two separate System Review Groups.
IP2(R) – Restricted Technical/Engineering approval for projects such as asset refurbishment or replacement projects which are essentially on a like-for-like basis and not requiring a full IP2
IP3 – Financial Authorisation document (for schemes > £100k prime)
IP4 – Application for variation of project due to change in cost or scope

PART A – PROJECT INFORMATION

Project Title:	**Enhanced Voltage Control**
Project Reference:	**ED2-LRE-SPEN-001-CV1**
Decision Required:	**Concept approval for the upgrade of voltage control systems to enhance current functionality and enable more flexible network operation.**

Summary of Business Need:

Growth in demand for electricity due to the electrification of heat and transport and increasing levels of distributed generation are expected to continue and indeed accelerate as the UK transitions to Net Zero. The electricity networks must be prepared to accommodate these levels of new demand and generation without the risk of stressing the network beyond design limits.

With increasing Low Carbon Technology (LCT) volumes, we are likely to see more complex power flows. This will result in a more complex management of the system. To increase controllability and provide the required flexibility to manage voltage constraints, as well as to enable the connection of more distributed generation, this project aims to enhance the functionality of the existing voltage control regime. This will be achieved by extending the controllability of the voltage control relays (e.g. voltage set point) at both Primary and Grid substation sites via the Control Room.

The proposed functionality is essentially an extension to the functionality we already use to meet our obligation to National Grid ESO to implement an "on-command" voltage reduction of 3% (stage 1) or 6% (stage 2) to provide emergency demand reduction. This enhancement will enable the network to be operated more flexibly in response to network need. An additional benefit of this project is the reduction in customer energy use resulting from lower average network voltages.

Summary of Project Scope, Change in Scope or Change in Timing:

This proposal aims to complement the current voltage control relay modernisation programme (which is based on asset condition), by targeting sites where enhanced controllability would allow a more flexible network operation and enable further penetration of small-scale generation, such as PV.

- 128 units to be upgraded in SPD primary substations
- 195 units to be upgraded in SPM primary substations and 57 units in grid substations.

The total cost of the scheme is £5.102m (in 2020/21 prices) under Primary Reinforcement (CV1) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

Expenditure Forecast (in 2020/21 prices)

Licence Area	Reporting Table	Description	Total (£m)	Incidence (£m)				
				2023/24	2024/25	2025/26	2026/27	2027/28
SPD	CV1	Primary Reinforcement	**2.192**	0.411	0.445	0.445	0.445	0.445
SPM	CV1	Primary Reinforcement	**2.910**	0.598	0.578	0.578	0.578	0.578
SPEN	**Total**		**5.102**	**1.009**	**1.023**	**1.023**	**1.023**	**1.023**

PART B – PROJECT SUBMISSION

Proposed by	Sofía Cobo de Guzmán	Signature	[signature]	Date:	30/11/2021
Endorsed by	Russell Bryans	Signature	[signature]	Date:	30/11/2021

PART C – PROJECT APPROVAL

Approved by	Malcolm Bebbington	Signature	[signature]	Date:	30/11/2021

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1 Introduction

Growth in demand for electricity due to the electrification of heat and transport and increasing levels of distributed generation are expected to continue and indeed accelerate as the UK transitions to Net Zero. The electricity networks must be prepared to accommodate these levels of new demand and generation without the risk of stressing the network beyond design limits.

With increasing Low Carbon Technology (LCT) volumes and embedded generation capacity, we are likely to see more complex dynamic power flows. This will result in a more complex management of the system.

To increase controllability and provide the required flexibility to manage voltage constraints, as well as to enable the connection of more distributed generation, this project aims to enhance the functionality of the existing voltage control regime. This will be achieved by extending the controllability of the voltage control relays (e.g. voltage set point) at both Primary and Grid substation sites via the Control Room.

The proposed functionality is essentially an extension to the functionality we already use to meet our obligation to National Grid ESO to implement an "on-command" voltage reduction of 3% (stage 1) or 6% (stage 2) to provide emergency demand reduction.

The estimated cost for the upgrade of 380 units is £5.102m (in 2020/21 prices) with 100% contribution to be included in the RIIO-ED2 load related expenditure.

The timing of the project is spread throughout the period, based on a yearly programme of work starting in 2023/24.

2 Background Information

The Electricity Safety, Quality and Continuity Regulations (ESQCR) require network operators to maintain system voltages within certain limits. On the LV network this limit is 230V +10%/-6% however, in practice, this is controlled at the Primary substations. Primary transformers are fitted with automatic voltage control relays which keep system voltage within a certain bandwidth by applying a series of on-load tap changer operations. This control tends to be at a local level with no remote controllability. By enhancing current functionality, a much more precise control of the voltage set point can be provided, increasing the voltage headroom/legroom.

3 Needs Case

Historically power flows on distribution networks were relatively predictable. With greater penetration of distributed generation, in combination with more dynamic demand consumption patterns from electric vehicles and heat pumps, network power flows become more dynamic and complex, as shown in Figure 1 and Figure 2. Heavily stochastic power flows can trigger early reinforcement or cause instability of current automatic voltage control relays, as changing reactive power flows can distort the voltage set point leading to transformer taps not operating as expected.

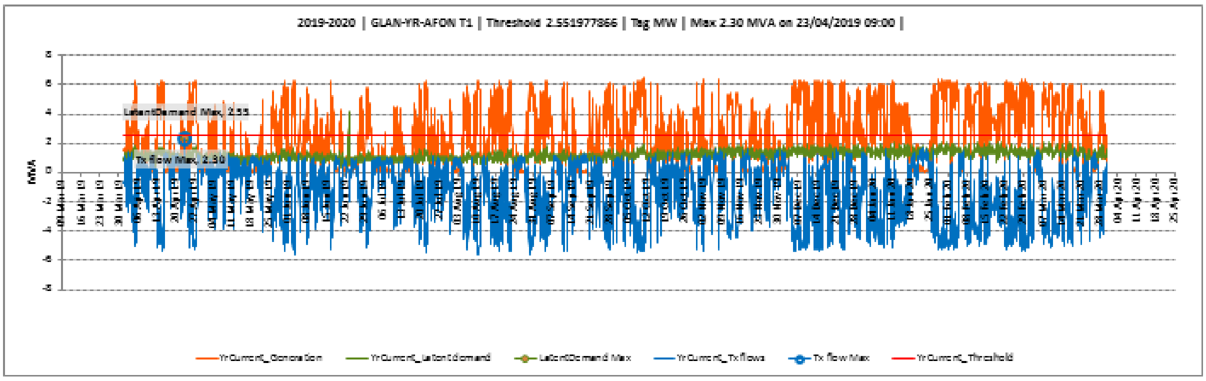


Figure 1. Distributed generation export and transformer power flows at Glan-Yr-Afon primary group

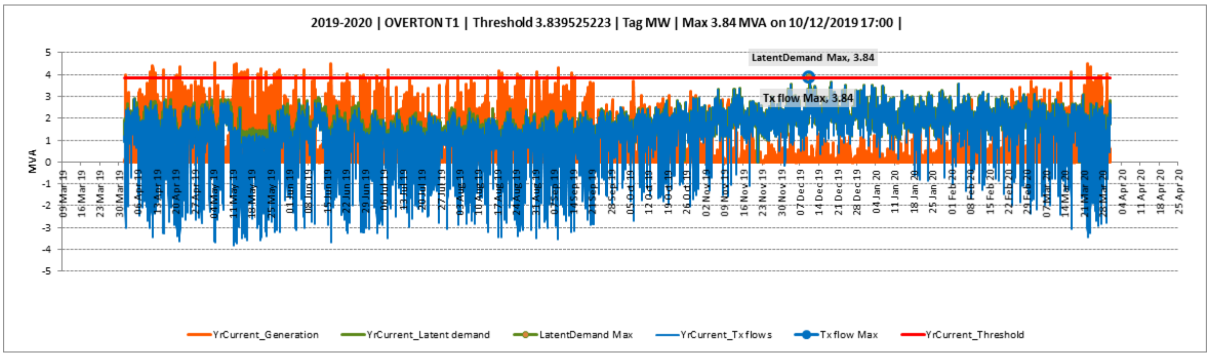


Figure 2. Distributed generation export and transformer power flows at Overton primary group

These dynamic power flows require more advanced dynamic control of network voltage. Voltage can be controlled through the installation of more conventional reactive power compensation equipment, such as capacitor banks, shunt reactors or STATic synchronous COMpensators (STATCOMs). However, through network optimisation software and a more dynamic control of the voltage set point, which can be adjusted in real-time and centrally controlled by network optimisation software, voltage control can be achieved in a similar manner. System headroom for generation could also be increased through better optimisation of voltage set points and permissible voltage range.

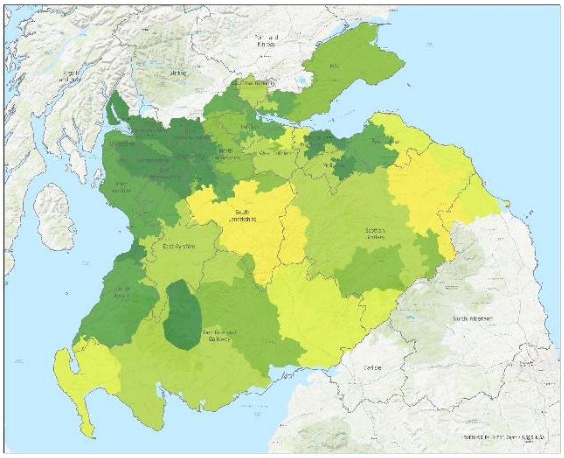
An additional benefit of this project is the reduction in customer energy use resulting from lower average network voltages.

In order to comply with ESQCR, section 9 of the Electricity Act and Condition 21 of our license obligation "to develop and maintain an efficient, coordinated and economical system for the distribution of electricity" an enduring design solution is required in order to satisfy the existing generation requirements and accommodate future generation growth.

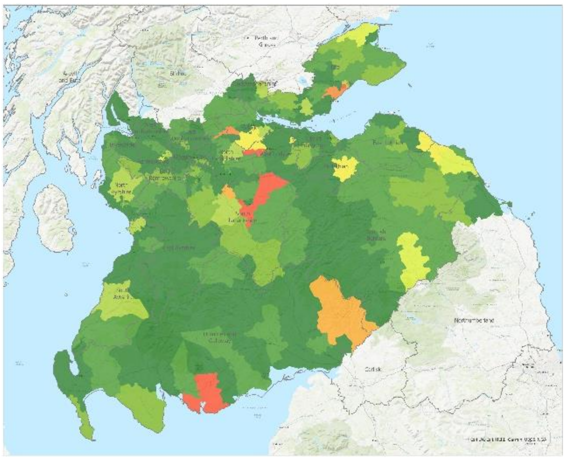
3.1 Forecast generation

Growth in generation connections is expected to continue and indeed accelerate as UK generation decentralises to meet Net Zero targets. SP Energy Networks (SPEN) Distribution Future Energy Scenarios (DFES) forecast that by 2030 distribution generation is likely to triple in SPD (reaching ca. 7GW) and double in SPM (reaching over 5GW).

All scenarios show a significant increase in generation. Most of the increase in capacity is expected to come from wind, PV, and storage. Figure 3 shows the geographical breakdown of how the generation and storage capacity connected to the SP Distribution network could change by 2030 from current levels for the high forecast scenario.



GSP level forecast



Primary level forecast

Figure 3. SPD installed generation and storage capacity by GSP and primary substation areas for the high scenario by 2030

Figure 4 shows the range of Net Zero compliant distributed generation forecasts for the SP Distribution network.

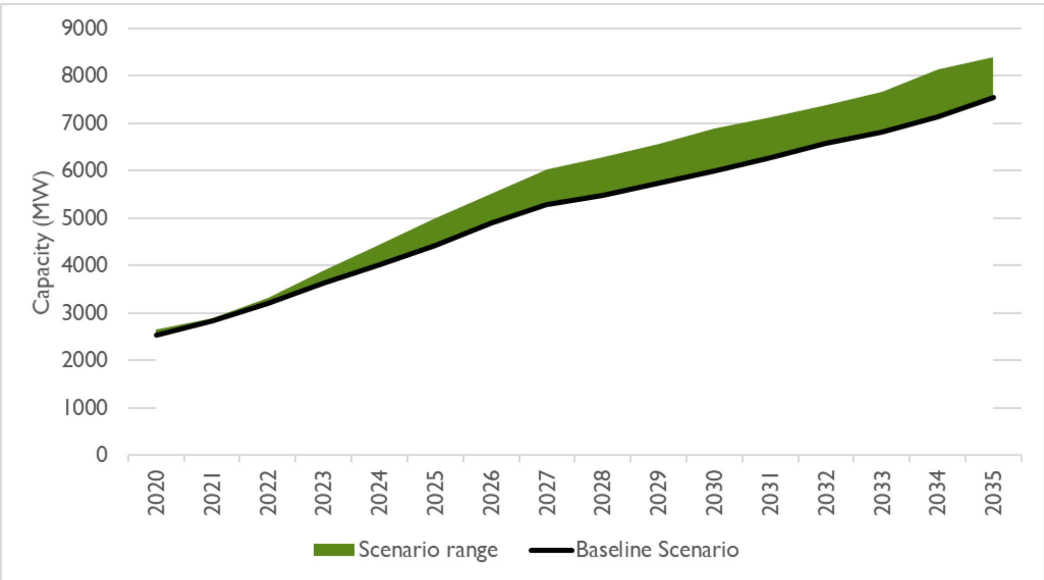
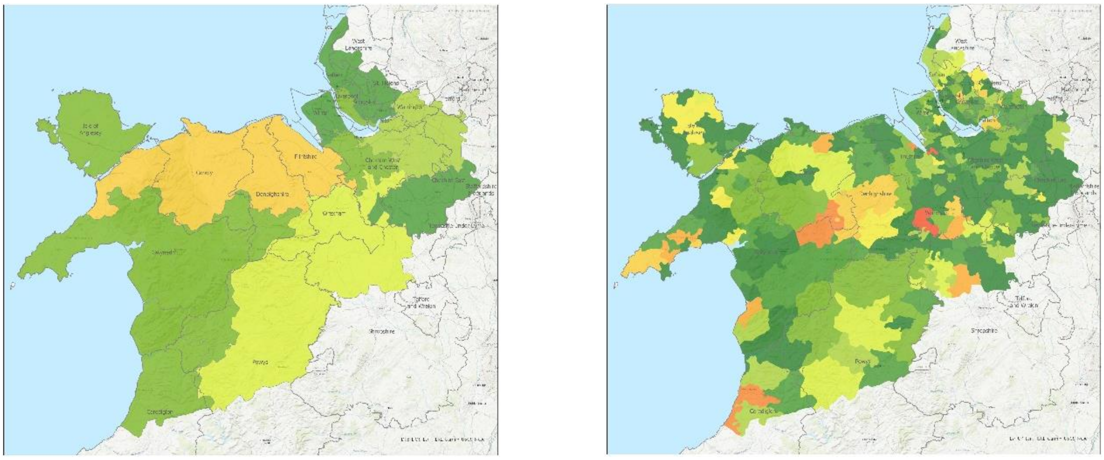


Figure 4. SPD range of Net Zero compliant distributed generation forecasts

Figure 5 shows the geographical breakdown of how the generation and storage capacity connected to the SP Manweb network could change by 2030 from current levels for the high forecast scenario.



GSP level forecast Primary level forecast

Figure 5. SPM installed generation and storage capacity by GSP and primary substation areas for the high scenario by 2030

Figure 6 shows the range of Net Zero compliant distributed generation forecasts for the SP Manweb network.

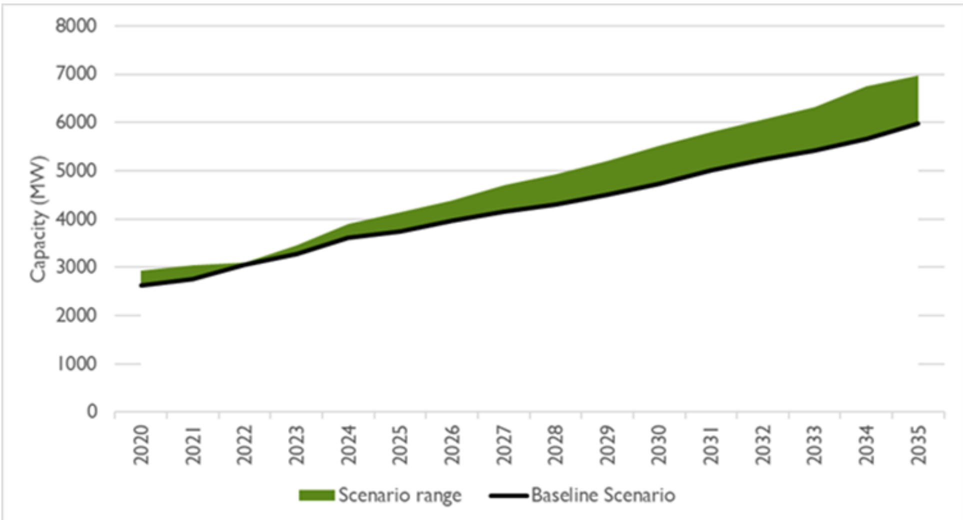


Figure 6. SPM range of Net Zero compliant distributed generation forecasts

4 Optioneering

Table 4.1 shows a summary of the options considered for the scheme. The baseline option represents the lowest cost conventional option, i.e. the minimum level of intervention without application of innovation. The shortlisted options are taken forward for detailed analysis and included in the cost-benefit analysis.

Table 4.1. Longlist of solution options

#	Options	Status	Reason for rejection
(a)	Do nothing	Rejected	Not compliant with ESQCR and Distribution code requirements.
(b)	Intervention plan using only Energy Efficiency	Rejected	Discounted due to lower cost effectiveness (peak MW reduction per £) and the number of individual interventions required across the wide area supplied by this network.
(c)	Programme of work to upgrade voltage control systems to enhance current functionality	Shortlisted as **Baseline** option in Detailed Analysis	
(d)	Installation of mechanically switched capacitors (MSC)	Shortlisted as **Option 1** in Detailed Analysis	
(e)	Installation of dynamic voltage control devices (STATCOM)	Shortlisted as **Option 2** in Detailed Analysis	
(f)	Installation of additional primary substations (new infeeds)	Rejected	The overall scheme cost of establishing new primary sites will be significantly higher, with a longer lead time.

5 Detailed Analysis & Costs

5.1 Proposed Option (Baseline) – Enhanced Voltage Control

The proposed option for this scheme requires the installation and commissioning of modern voltage control relays with the associated ancillary protection and control equipment across 75 primary substations in SPD, 177 primary substations in SPM and 43 grid substations in SPM. Table 5.1 shows the scheme summary.

Table 5.1. Proposed option summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Conventional	Enhanced Voltage Control	Installation and commissioning of modern voltage control relays	5.102	-

Table 5.2 shows a summary of reinforcement costs and volumes for the proposed scheme under RIIO-ED2. These volumes do not include sites where the voltage control system is upgraded as part of a RIIO-ED2 non-Load activity. Costs variations between regions are attributed to the number of transformers within a single site.

Table 5.2. Proposed option summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Other Costs (Identify Below)		5.102	5.102	-
Total Costs		5.102	5.102	-
Identify activities included within other costs (please provide high-level detail of cost areas)				
Cost includes relay unit, control panel, installation and commissioning time. • SPM Grid sites: 57 units (at 43 sites) • SPM Primary sites: 195 units (at 177 sites) • SPD Primary sites: 128 units (at 75 sites)				

Due to the proposed volumes of installation, it is proposed to start the works in 2023/24.

5.2 Option 1 – Installation of Mechanically Switched Capacitors

MSCs are mechanically switched capacitor banks that act as a source of reactive power to an electricity network. Usually these are installed to support electricity networks to increase power factor correction and voltage regulation as well. They are much cheaper compared to STATCOMs however, their reactive power and voltage regulation capabilities are lower. This option considers the installation of 5MVAr mechanically switched capacitors (MSC) to provide reactive power compensation (see Appendix 1). Table 5.3 shows the scheme summary.

Table 5.3. Option 1 summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Innovation	Enhanced Voltage Control	Installation of 5MVAr mechanically switched capacitors (MSC) at 61 sites in SPM and 27 sites in SPD	27.107	-

Table 5.4 shows a summary of reinforcement costs and volumes for Option 1 under RIIO-ED2.

Table 5.4. Option 1 summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
6.6/11kV UG Cable	3.65	0.429	0.429	-
6.6/11kV CB (GM) Primary	73	2.024	2.024	-
33kV UG Cable (Non Pressurised)	0.75	0.150	0.150	-
33kV CB (Gas Insulated Busbars) (ID) (GM)	15	2.504	2.504	-
Civil Works at 33 kV & 66 kV Substations		3.650	3.650	-
Civil Works at 132 kV Substations		0.750	0.750	-
Other Costs (Identify Below)		17.600	17.600	-
Total Costs		27.107	27.107	-
Identify activities included within other costs (please provide high-level detail of cost areas)				
4x1.25 MVAr Mechanically Switched Capacitor Banks at each location				
Associated protection, control or SCADA equipment located at a site				

5.3 Option 2 – Installation of STATCOMs

A STATCOM is a voltage source converter (VSC)-based device, with the voltage source behind a reactor and can act as either a source or sink of reactive power to an electricity network. Usually a STATCOM is installed to increase voltage stability, power factor correction and voltage regulation. This option considers the installation of ±2.5MVAr STATCOMs to provide dynamic reactive power compensation (see Appendix 2). Table 5.5 shows the scheme summary.

Table 5.5. Option 2 summary

Category	Scheme Name	Scheme Summary	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
Innovation	Enhanced Voltage Control	Installation of ±2.5MVAr dynamic voltage control devices (STATCOM) at 61 sites in SPM and 27 sites in SPD	53.507	-

Table 5.6 shows a summary of reinforcement costs and volumes for Option 1 under RIIO-ED2.

Table 5.6. Option 2 summary of reinforcement costs and volumes

Asset Description	Volumes	Prime Costs (£m)	RIIO-ED2 Contribution (£m)	Customer Contribution (£m)
6.6/11kV UG Cable	3.65	0.429	0.429	-
6.6/11kV CB (GM) Primary	73	2.024	2.024	-
33kV UG Cable (Non Pressurised)	0.75	0.150	0.150	-
33kV CB (Gas Insulated Busbars)(ID) (GM)	15	2.504	2.504	-
Civil Works at 33 kV & 66 kV Substations		3.650	3.650	-
Civil Works at 132 kV Substations		0.750	0.750	-
Other Costs (Identify Below)		44.000	44.000	-
Total Costs		53.507	53.507	-
Identify activities included within other costs (please provide high-level detail of cost areas)				
Installation of ±2.5MVAr STATCOM				
Detailed Dynamic Compensation and Power Quality assessment studies				

5.4 Options Cost Summary Table

Summary of the costs for each of the evaluated options is presented in Table 5.7.

Table 5.7. Cost summary for considered options

Options	Option Summary	SPEN (£m)
Baseline	Enhance voltage control relay functionality	5.102
Option 1	Installation of MSCs	27.107
Option 2	Installation of STATCOMs	53.507

Derivation of costs for these options are based on the SPEN RIIO-ED2 Unit Cost Manual for intervention. This is based on bottom up cost assessment of the components of activity detailed within the RIGs Annex A for the above activities, SPEN's contractual rates for delivery, market available rates and historic spend levels.

6 Deliverability & Risk

6.1 Preferred Options & Output Summary

The adopted option represents the upgrade of voltage control systems to enhance current functionality and enable more flexible network operation.

6.2 Cost Benefit Analysis Results

A cost benefit analysis (CBA) was carried out to compare the NPV of the options discussed in the previous sections. Considering the lowest forecast capital expenditure, the proposed option has the highest total NPV against other options. The summary of the cost benefit analysis is presented in Table 6.1. The full detailed CBA is provided within 'ED2-LRE-SPEN-001-CV1-CBA – Enhanced Voltage Control'.

Option 1 would alleviate the voltage constraints; however, it is rejected based on higher reinforcement costs of £27.107m. Option 2 would alleviate the voltage constraints; however, it is rejected based on higher reinforcement costs of £53.507m.

Table 6.1. Cost benefit analysis results

Options considered	Decision	Comment	NPVs based on payback periods, £m (2020/21 prices)			
			10 years	20 years	30 years	45 years
Baseline – Enhanced voltage control relay functionality	**Adopted**					
Option 1 – Installation of MSCs	Rejected	Discounted on the basis of higher cost.	-11.46	-15.99	-18.68	-20.76
Option 2 – Installation of STATCOMs	Rejected	Discounted on the basis of higher cost.	-25.15	-35.13	-41.05	-45.62

We believe an optimised control of voltage can bring wider societal benefits through consumption reduction, depending on the type of electrical load. We are continuing to assess the potential impacts of voltage control on domestic and commercial customer consumption in further CBAs.

6.3 Cost & Volumes Profile

Table 6.2 shows the breakdown of expenditure for the proposed scheme (in 2020/21 prices) and the cost incidence (in 2020/21 prices) over the RIIO-ED2 period is shown in Table 6.3. The total cost of the proposed scheme is £5.102m.

Table 6.2: Summary of reinforcement costs and volumes

Licence area	Substation	No of relays	Total Cost(£m)
SPD	EHV/HV	128	2.192
	132kV/EHV	-	-
SPM	EHV/HV	195	2.340
	132kV/EHV	57	0.570
SPEN			**5.102**

Table 6.3: Cost incidence over the RIIO-ED2 period, £m (2020/21 Prices)

Total Investment	Total (£m)	Incidence (£m)				
		2023/24	2024/25	2025/26	2026/27	2027/28
CV1 Expenditure (SPD)	**2.192**	0.411	0.445	0.445	0.445	0.445
CV1 Expenditure (SPM)	**2.910**	0.598	0.578	0.578	0.578	0.578
CV1 Expenditure (SPEN)	**5.102**	**1.009**	**1.023**	**1.023**	**1.023**	**1.023**

6.4 Risks

The volumes of activity that will need to be delivered in RIIO-ED2 are comparable in SPD (25 units/year in RIIO-ED1 vs. 26 units/year in RIIO-ED2) and significantly higher in SPM (27 units/year in RIIO-ED1 vs. 50 units/year in RIIO-ED2) compared to those in RIIO-ED1. To mitigate risks associated with supplier availability, and to prevent type failures we have already engaged with several suppliers.

6.5 Outputs Included in RIIO-ED1 Plans

There are no outputs expected to be delivered in RIIO-ED1 that are funded within this proposal.

6.6 Future Pathways – Net Zero

Primary Economic Driver

The primary driver for this investment is increased controllability of the voltage control relays to enable the network to be operated more flexibly in response to network needs and provide additional capacity for embedded generation.

6.6.1 An additional benefit of this project is the reduction in customer energy use resulting from lower average network voltages.

Payback Periods

The CBA indicates that for the proposed option demonstrates better NPV results in all assessment periods (10, 20, 30 & 45 years) against other two options. As the intervention is forecast to carry at
6.6.2 least a 45-year asset life expectancy, the CBA at this time justifies the intervention. Consumers will also benefit from reduced network risk immediately on completion of the project.

Sensitivity to Future Pathways

The network capacity and capability that result from the proposed option is consistent with the
6.6.3 network requirements determined in line with the section 9 of the Electricity Act and Condition 21. Additionally, the proposed option is consistent with the SPEN's Distribution System Operator (DSO) Strategy and Distribution Future Energy Scenarios.

Table 6.4 shows electric vehicle and heat pump uptakes across a range of future pathways and Table 6.5 outlines the scale of investment that would be required to meet the highest uptake scenarios considering the scenarios outlined in the DFES, FES and CCC.

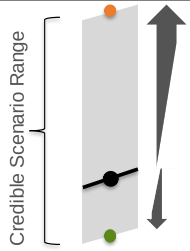
Table 6.4: Electric Vehicle and Heat Pump uptakes across a range of future pathways

End of RIIO-ED2		SPEN	DFES			CCC				
		Baseline	System Transformation*	Consumer Transformation	Leading the Way	Balanced Net Zero	Headwinds	Widespread Engagement	Widespread Innovation	Tailwinds
SPD	EVs	372k	166k	415k	546k	498k	343k	542k	493k	493k
	HPs	205k	145k	332k	369k	199k	183k	222k	192k	200k
SPM	EVs	302k	158k	388k	401k	437k	302k	475k	433k	433k
	HPs	161k	107k	215k	263k	182k	158k	195k	177k	173k

*Note: We have excluded System Transformation from our future pathways assessment as it does not meet interim greenhouse gas emission reduction targets.

Table 6.5: Scale of investment

6.6.4



	SPD	SPM
2028	£m	£m
High	2.224 (130 relays)	3.042 (263 relays)
Baseline	2.192 (128 relays)	2.910 (252 relays)
Low	2.192 (128 relays)	2.910 (252 relays)

Asset Stranding Risks & Future Asset Utilisation

Electricity demand and generation loadings are forecast to increase under all scenarios. The stranding risk is therefore considered to be low.

6.6.5 Losses / Sensitivity to Carbon Prices

Losses have been considered in accordance with Licence Condition SLC49 and the SP Energy Networks Losses Strategy and Vision to "consider all reasonable measures which can be applied to reduce losses and adopt those measures which provide benefit for customers".

Figure 7 below show the sensitivity of network losses with respect to embedded generation. Network losses have been found to increase and become highly stochastic. The impact of distributed generation on losses varies depending on the type of generation and network characteristics e.g. demand level, demand profile and topology at the point of connection:

- Radial connection: Where generation is connected directly to a Grid Supply Point (GSP), the connection will incur losses throughout the seasonal cycle.
- Connection to demand-dominated distribution network: In a demand dominated network, local distributed generation meets some of this demand, reducing the load on the voltage levels above. This may have the effect of reducing whole system losses. The extent to which losses are reduced will depend on the generation characteristics e.g. capacity, intermittency and correlation with peak demand.
- Connection to generation-dominated distribution network: Connection of generation to areas of the network with low demand and high existing generation may increase losses if generation is significant enough to have the effect of generally increasing current.

Customer load patterns are also undergoing a period of change with general energy efficiency reductions overlaid with increases in the electrification of heat and transport. Various technologies such as sophisticated energy management systems, embedded generation and energy storage at a range of scales mean that customers can interact more dynamically with the electricity network.

Increasing sophistication and deployment of smart energy controls is enabling greater flexibility and control of these energy resources. This could, in future, provide a resource for losses optimisation.

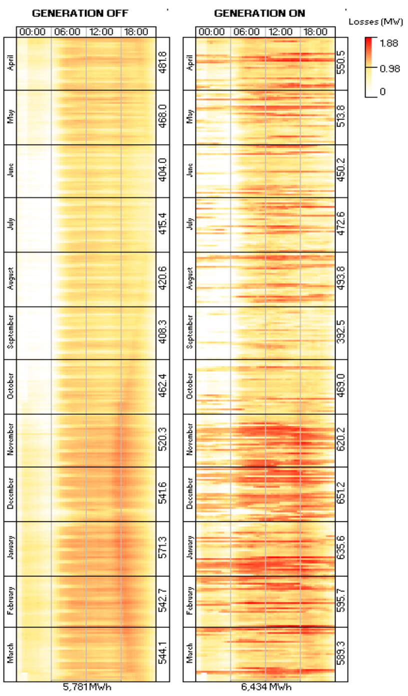


Figure 7. Variation in network losses with and without generation

Whole Systems Benefits

Whole system solutions have been considered as part of this proposal. No alternatives have been identified that could be provided through a whole systems solution. The completion of this scheme will maintain the integrity of the distribution network and its enduring ability to facilitate wider whole system benefits.

6.6.6 6.7 Environmental Considerations

Operational and embodied carbon emissions

The proposed replacement of Voltage Control Relays has the potential to result in embodied carbon from the delivery of interventions required. Any increase or decrease in losses could have an impact on SPEN's business carbon footprint (BCF).

6.7.1

During the evaluation of the options associated with the Enhanced Voltage Control programme, we have embedded within the CBA, where data are available, an assessment of the embodied carbon and the associated carbon cost to inform our NPV evaluation.

It should be noted that the embodied carbon evaluation undertaken has only considered the manufacture and supply of materials. Further collaborative industry-wide work is planned for the RIIO-ED2 price review period to better understand the overall embodied carbon values including, for example installation and commissioning services, decommissioning and disposal activities as well as refurbishment opportunities. More information regarding this can be found in Section 3.1.2 of our Environmental Action Plan, Annex 4C.3: Environmental Action Plan, SP Energy Networks, Issue 2, 2021.

6.7.2 Supply chain sustainability

For us to take full account of the sustainability impacts associated with the replacement of Voltage Control Relays, we need access to reliable data from our suppliers. The need for carbon and other
6.7.3 sustainability credentials to be provided now forms part of our wider sustainable procurement policy.

Resource use and waste

Replacement of Voltage Control Relays will result in the consumption of resources and the generation of waste materials.

Where waste is produced it will be managed in accordance with the waste hierarchy which ranks
6.7.4 waste management options according to what is best for the environment. The waste hierarchy gives top priority to preventing waste in the first instance, then preparing for re-use, recycling, recovery, and last of all disposal (e.g. landfill).

6.7.5 Biodiversity/ natural capital

The replacement of Voltage Control Relays will only affect sites containing existing assets. Therefore, the impact on, and the opportunity to improve biodiversity and natural capital is expected to be minimal.

Preventing pollution

SPEN will always follow all relevant waste regulations and will make sure that special (hazardous) waste produced or handled by our business is treated in such a way as to minimise any effects on the environment.

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Visual amenity

SPEN continually seeks to reduce the landscape and visual effects of our networks and assets. The proposed interventions at existing sites are not likely to generate any additional impact in relation to visual amenity.

Climate change resilience

6.7.6 In addition to our efforts to minimise our direct carbon emissions in line with our net-zero ambitions, we are also conscious of the need to secure the resilience of our assets and networks in the face of a changing climate.

6.7.7

7 Conclusion

In order to facilitate greater levels of distributed generation in combination with more dynamic demand consumption patterns from electric vehicles and heat pumps, the installation of more advanced voltage control equipment is required to keep system voltages within limits.

The recommended solution is to upgrade existing voltage control equipment at primary and grid substation sites to provide a more advanced dynamic voltage control relays, where the voltage set point can be centrally controlled in real-time by network optimisation software. This comprises:

- 128 units to be upgraded in SPD primary substations
- 195 units to be upgraded in SPM primary substations and 57 units in grid substations.

The total cost of the scheme is £5.102m (in 2020/21 prices), which is fully funded by SPEN in the RIIO-ED2 period. The proposed solution represents the lowest cost and most efficient engineering solution to manage system voltage when compared with the alternative schemes identified.

8 Appendices

Appendix 1. Mechanically Switched Capacitor (MSC)

Figure 8. Typical arrangement of Enclosed Capacitor Bank

Appendix 2. STATCOM

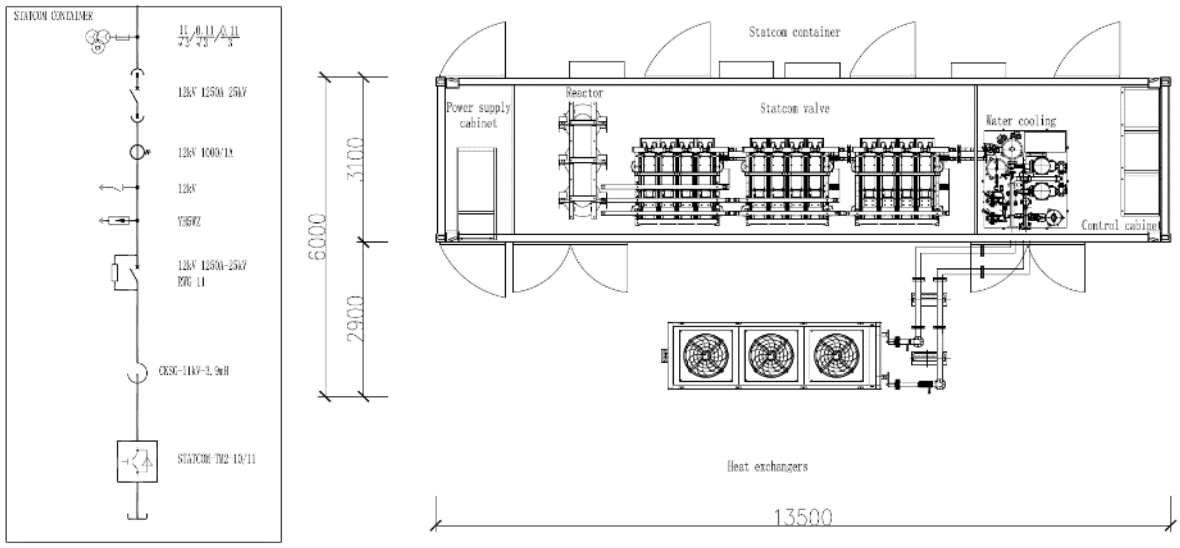

Figure 9. STATCOM single line diagram and layout

Appendix 3. Flexible Networks

This proposal incorporates the learning from the Flexible Networks project[1]

[1] Learning from our Flexible Networks for Low Carbon Future innovation project, https://www.smarternetworks.org/project/spt2003