WESTERN POWER DISTRIBUTION

REVISE

FLEXIBLE SOLUTIONS FOR AN EVOLVING NETWORK

Network Innovation Competition 2018

WPD/EN/NIC/05

RIIO NIC NETWORK INNOVATION COMPETITION

ofgem

RIIO NIC NETWORK INNOVATION COMPETITION

Project Code/Version Number:
WPD/EN/NIC/05

Section 1: Project Summary

1.1. Project Title:	REVISE
1.2. Project Explanation:	REVISE will develop, design and implement an Advanced Connection Solution, Dynamic Protection System and Intelligent Network Reconfiguration system as part of an innovative trial on a 33kV overhead line network in the West Midlands. The Project will aim to release substantial network capacity and significantly increase network availability.
1.3. Funding Licensee:	Western Power Distribution (WPD) West Midlands
1.4. Project Description:	*1.4.1. The Problem(s) it is exploring* • The capacity of installed Distributed Generation (DG) is expected to double across all our licence areas by 2030. • Traditionally network design has focussed on achieving lowest cost rather than low carbon. Improvements need to be implemented to achieve a lower carbon network design. • There is still a heavy reliance on fossil fuel generation partly due to the abundance of DG that have non-firm connections to the network. *1.4.2. The Method(s) that it will use to solve the Problem(s)* • **Advanced Connection Solution** to overcome the limitations of 'rigid' connections for DG; • **Dynamic Protection System** to safely protect a changing and complex network; and • **Intelligent Network Reconfiguration** to unlock network capacity and increase availability. *1.4.3. The Solution(s) it is looking to reach by applying the Method(s)* REVISE will aim to increase DG connectivity, availability and utilisation, enabling accelerated customer connections on the 33kV overhead line network and allow WPD to exploit latent capacity that otherwise couldn't be released using network reinforcement and/or Active Network Management (ANM). *1.4.4. The Benefit(s) of the project* Roll-out of REVISE across GB could represent a saving of **1.34m tonnes of CO_2** and **£191m** by 2050.

1.5. Funding			
1.5.1. NIC Funding Request (£k):	11,103.06	1.5.2. Network Licensee Compulsory Contribution (£k):	1,257.10
1.5.3. Network Licensee Extra Contribution (£k):	0	1.5.4. External Funding – excluding from NICs (£k):	0
1.5.5. Total Project Costs (£k):	12,570.98		

1.6. List of Project Partners, External Funders and Project Supporters (and value of contribution):	Project Partners: None External Funders: None Project Supporters: Lightsource BP, Becon, Ecotricity & British Solar Renewables		
1.7. Timescale			
1.7.1. Project Start Date:	January 2019	1.7.2. Project End Date:	May 2023
1.8. Project Manager Contact Details			
1.8.1. Contact Name & Job Title:	Jonathan Berry Innovation Engineer	1.8.2. Email & Telephone Number:	wpdinnovation@westernpower.co.uk 0121 623 9459
1.8.3. Contact Address:	4th Floor, Toll End Road, Tipton, DY4 0HH		
1.9. Cross Sector Projects (only complete this section if your project is a Cross Sector Project, ie involves both the Gas and Electricity NICs)			
1.9.1. Funding requested the from the [Gas/Electricity] NIC (£k, please state which other competition)	Not applicable.		
1.9.2. Please confirm whether or not this [Gas/Electricity] NIC Project could proceed in the absence of funding being awarded for the other Project.	No.		
1.10. Technology Readiness Level (TRL)			
1.10.1. TRL at Project Start Date:	4	1.10.2. TRL at Project End Date:	8

Section 2: Project Description

2.1 Aims and objectives

REVISE will revolutionise the operation of the 33kV distribution network through the use of new technologies and Methods to provide enhanced network flexibility and intelligent network reconfiguration. The Project will maximise the availability of DG and provide enhanced Solutions to current Business As Usual (BAU) practices. The pioneering work included within REVISE will help shape the network of the future and provide significant learning for the transition from a Distribution Network Operator (DNO) to a Distribution System Operator (DSO).

REVISE consists of three technical Methods shown in Table 2-1.

Table 2-1 – REVISE technical Methods

	Methods	Aims and Objectives
REVISE	**Advanced Connection Solution** A new Solution for connections to the 33kV network	▪ Increasing the availability of DG through the use of new technologies; ▪ Releasing latent capacity without compromising quality of supply; ▪ Demonstrating the value of intelligent, dynamic reconfiguration of the network; ▪ Producing specifications, technical guidance, tools and policy documentation for new technologies and methodologies; and ▪ Disseminating learning to GB DNOs for BAU planning, operation and enhanced management of 33kV networks.
	Dynamic Protection System Real-time optimisation of system protection for a dynamic and changing network	
	Intelligent Network Reconfiguration Intelligent and autonomous reconfiguration of the network to increase flexibility and capacity	

Through the implementation of these Methods across GB, the benefits that would be delivered are summarised in Table 2-2.

Table 2-2 – Benefits generated by REVISE

	Carbon Savings (2050)	
	WPD Roll-out (4 Licence Areas) **444,283 tonnes of CO_2**	GB Roll-out (14 Licence Areas) **1,343,653 tonnes of CO_2**
	Financial Savings (2050)	
	WPD Roll-out (4 Licence Areas) **£62.67m**	GB Roll-out (14 Licence Areas) **£191.17m**
	Capacity Released (2050)	
	WPD Roll-out (4 Licence Areas) **2,588 MVA**	GB Roll-out (14 Licence Areas) **11,852 MVA**

2.1.1 The Problem(s) that need to be resolved

The Problems that need to be resolved are two-fold:

1 Low cost is prioritised over low carbon

The Problem

Connections to the network are currently designed to be the lowest cost Solution whilst ensuring the minimum safety and technical requirements are met.

This approach makes economic sense for both the network operator and prospective customers by minimising upfront capital expenditure.

However, by implementing this low cost approach maximising the availability of the customer's connection is not taken into account. Often DG customers will have a "non-firm" connection (i.e. a single source of supply with no back-up alternative) consisting of a t-connection to the network.

Why is it a Problem

Historically, the network was passive in operation with the configuration remaining static for the majority of the time. However, with a significant volume of DG connecting to the distribution network and fluctuations in load patterns becoming more apparent, the configuration of the network is having to change and become increasingly active.

These frequent changes in network configuration result in DG having to be disconnected as the connections are not designed for flexible operation which would have maximised their output.

Why does it have to be resolved

WPD's Shaping Subtransmission to 2030 Report predicted that the West Midlands' licence area will see connected DG capacity more than double from 1.5GW in 2017 to 3.2GW in 2030 as shown in Figure 2-1. These changes will result in more DG connections further increasing network complexity and the frequency of network reconfigurations.

A new Solution is required which prioritises low carbon design to ensure that existing and future DG can stay connected to the network during reconfigurations or outages.

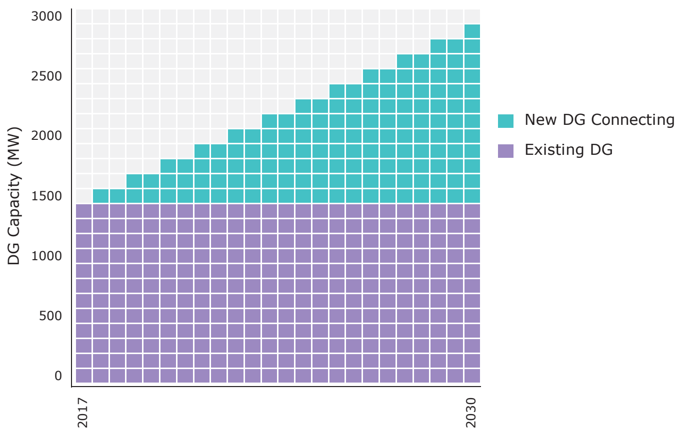


Figure 2-1 – WPD West Midlands increase in DG capacity

2 Reliance on fossil fuels

The Problem

Any work associated with a new connection, maintenance or fault on the network can result in a prolonged outage and/or network reconfiguration to allow the work to safely take place. During this outage or reconfiguration period, DG connected to the network is often disconnected due to curtailments imposed due to the inflexibility of the network.

Each DG curtailment will potentially result in a loss of clean power sources for loads on the network which may ultimately be supplied by fossil fuel power, significantly increasing the carbon impact of the system.

Why is it a Problem

The UK government has published a Clean Growth Strategy which sets out specific measures to accelerate the transition to the low carbon economy. A key focus of the strategy is the decarbonisation of heating and transport, two major areas that contribute to 56% of total UK greenhouse gas emissions[1]. The proposed transition will also focus on the introduction of vast amounts of renewable energy to replace fossil fuels which will see 85% of the UK's electricity supply generated from clean sources as shown in Figure 2-2.

Why does it have to be resolved

DG curtailment will increase as alternative connections which rely on customer flexibility through ANM are rolled-out for the forecast uptake of new renewable energy on the distribution network. Therefore, there is a need for a more flexible network to increase DG availability to meet the clean power source target.

In addition, flexible and dynamic operation of the network is required so that the balance between decarbonised loads and DG can be optimised.

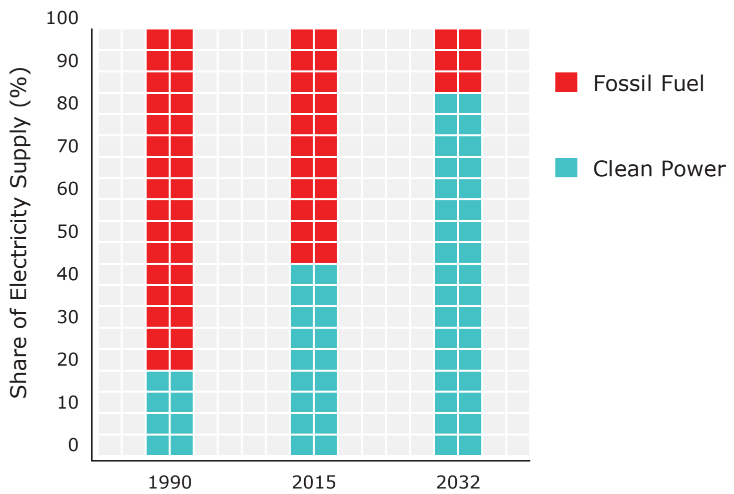


Figure 2-2 – Share of electricity supply under Clean Growth Strategy

[1] BEIS (2017) UK Greenhouse Gas Inventory Statistics (1990-2015) https://www.gov.uk/government/collections/final-uk-greenhouse-gas-emissions-nationalstatistics; BEIS analysis

2.1.2 The Method(s) being trialled to solve the Problem

Three Methods are proposed to solve the Problems identified. They are as follows:

1 Advanced Connection Solution

Overview: This Method will develop a new, ultra-compact, sustainable customer connection arrangement that will boost the amount of low carbon energy from renewable DG connecting to the 33kV overhead line network.

Current practice and limitations: The existing philosophy for new connections to the 33kV network typically involves a simple t-connection as shown in Figure 2-3. The t-connection is widely used because it is a low cost Solution and involves establishing a fixed, inflexible supply to the main DNO network. The t-connection is deemed a "non-firm" connection, meaning that there is no alternative to supply the customer in the event of an outage. Non-firm connections account for around 90% of all DG connections on our West Midlands 33kV network.

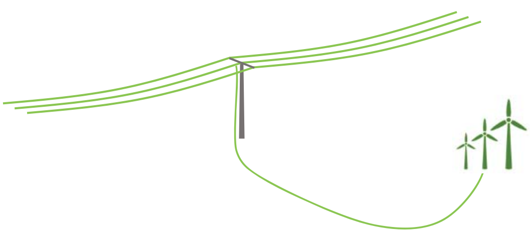
Proposed Solution and benefits: The Advanced Connection Solution (ACS) will be a new generation of connection and represents a huge step forward in terms of the philosophy for connecting DG to our network. The two key advancements of the ACS are:

Scale – The ACS will offer an ultra-compact Solution compared with a traditional 33kV switching station; this Solution could be up to 80% smaller. This will have significant benefits in relation to land acquisition and visual amenity.

Technology – The ACS will implement new and largely untested technology innovations that will ensure suitable reliability and redundancy, whilst challenging the need for separate equipment which perform only one function.

Figure 2-3 and Figure 2-4 show the effects of the ACS pre and post implementation.

T-connection connecting a windfarm to the main 33kV distribution network



T-connection is disconnected when there is an outage on the main DNO circuit; the windfarm has to be switched off

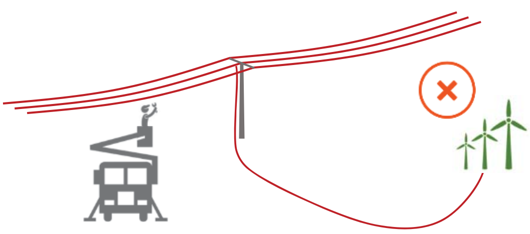
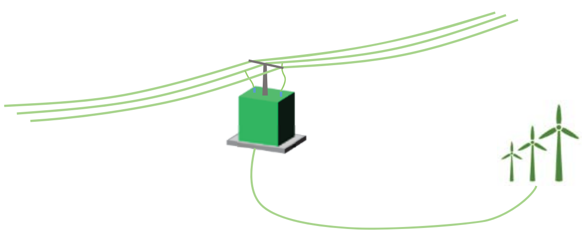


Figure 2-3 – Pre ACS implementation

ACS replaces the t-connection on the 33kV distribution network to provide greater network flexibility for the windfarm



The ACS allows the windfarm to continue generating low carbon energy for any circuit outage condition

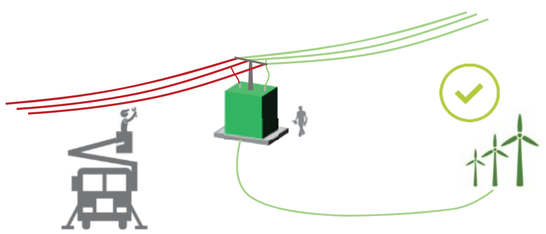


Figure 2-4 – Post ACS implementation

2 Dynamic Protection System

Overview: This Method will develop, test and trial a new, advanced and dynamic protection system that will be a necessity for ensuring that low carbon networks of the future are safely protected.

Current practice and limitations: The protection of the network is based on rules and standards which have been created for a network that does not frequently change state or configuration. These protection schemes often consist of an individual device per function that is configured for a fixed operating arrangement. A manual, on-site, intervention is required for any changes in network arrangement to implement the necessary updates to the scheme. In addition, conventional protection arrangements can be a limiting factor on DG capacity as the static nature of them means they cannot accommodate this additional complexity. As the network becomes increasingly complex, the protection schemes have to be altered to limit the need for manual intervention. However, this has resulted in protection schemes which will still ensure safety, but compromise on accuracy.

Proposed Solution and benefits: The Dynamic Protection System (DPS) will be a first of a kind trial of new technologies deployed to protect the 33kV network. Existing static protection schemes will be replaced by technologies which are capable of self-diagnostics and self-healing which limit the burden on designers and operators and allow the distribution network to respond rapidly to changes in configuration. The new DPS will facilitate the multitude of network configurations, in-turn allowing the low carbon future to be realised. The two key advancements of the DPS are:

> ***Accuracy –*** The DPS will continuously monitor, in real-time, changes in network configuration, power flows and the status of connected devices to calculate and implement both the optimal protection function and the most appropriate settings. A change in any of the variables would result in the system re-evaluating the applied functions and settings, determining their suitability and re-calculating if necessary.
>
> ***Technology –*** The multiple functions delivered in separate devices currently, will be replaced by a state-of-the-art device which not only has all functions available, but can enable the rapid transfer between functions. This is a first of a kind trial on the distribution network.

Figure 2-5 and Figure 2-6 show the effects of the DPS pre and post implementation.

The existing circuit protection is no longer suitable for the network after new DG is installed

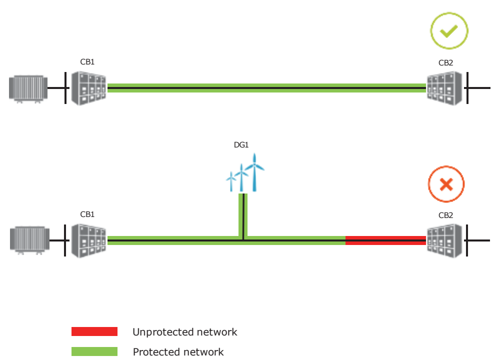


Figure 2-5 – Pre DPS integration

Application of DPS allows the connection of multiple DG without the need for protection upgrades each time

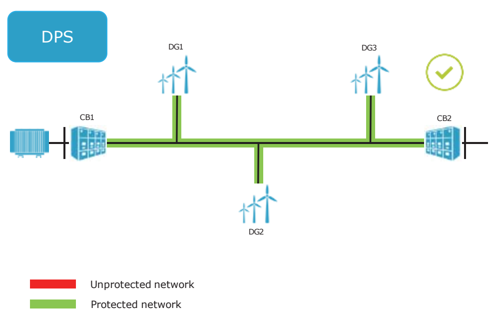


Figure 2-6 – Post DPS integration

3 Intelligent Network Reconfiguration

Overview: This Method will trial a fundamental change in the way that 33kV distribution networks are controlled and operated in response to the significant amounts of diverse connections that are expected in the coming years. It will be a comprehensive control system which will use the latest advances in artificial intelligence and data processing techniques to determine the optimum running arrangement for the network.

Current practice and limitations: The provision of additional capacity on the existing network is presently realised through the use of reinforcement schemes and ANM. The use of traditional reinforcement schemes are often unsuitable for customers due to the prohibitive cost and delivery timescales when considering the investment for new DG. ANM schemes overcome short-term network constraints by leveraging flexibility in the curtailment of DG, however, this does not allow the full capability of DG to be exploited. These Solutions alone will not offer a sustainable way to facilitate the connection of the DG that is forecast to connect over the coming years.

Proposed Solution and benefits: Intelligent Network Reconfiguration (INR) will maximise the operational capacity of the network by analysing real-time information, such as network status, load and generation levels and asset information, as well as meeting the appropriate security of supply standards. This will enable network flexibility, rather than customer flexibility, to exploit existing network capacity. The two key advancements of INR are:

Technology – We will implement advanced computational Methods to assess and analyse network status, determine the optimal running arrangement and autonomously implement this on the live network. This will vastly reduce the human decision and implementation requirements that would be necessary for operating a capacity optimised system.

Cybersecurity – As we move towards more automation and the transfer of vast quantities of data, cybersecurity will become an important aspect of maintaining a safe and secure distribution network. As part of the delivery of the technology, the INR Method will also investigate the need for a robust cybersecurity system and implement the appropriate Solution for the trials.

Figure 2-7 and Figure 2-8 show the effects of the INR pre and post implementation.

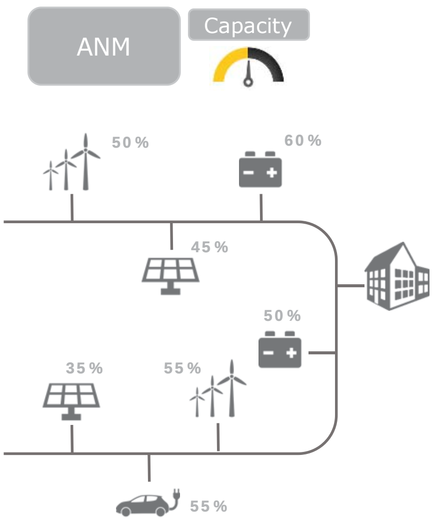


Figure 2-7 – Pre INR implementation

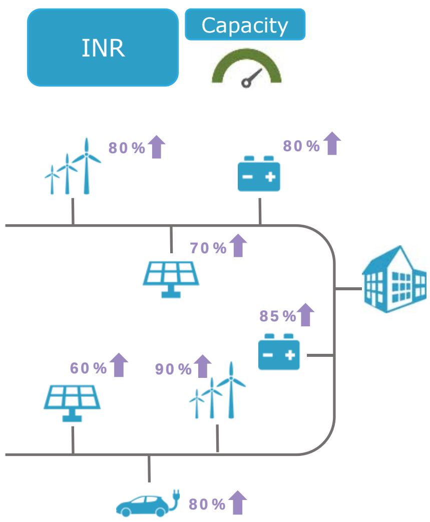


Figure 2-8 – Post INR Implementation

2.1.3 The Development or Demonstration being undertaken

We plan to demonstrate the performance of the ACS, DPS and INR on trial areas within the West Midlands' licence area. Appendix G provides further details of the trial areas which have been shortlisted as part of this FSP. Our research has shown that the challenges of limited capacity and inflexible connection arrangements are most prevalent on the 33kV network which has become the most dense connection point for DG as detailed in Section 3.

The West Midlands' licence area was chosen for the trials due to the complex nature of the 33kV rural networks contained within it to demonstrate each Method's suitability in difficult operational environments to ensure they are suitable for wider replication.

The three Methods will be demonstrated in stand-alone trials as detailed in Table 2-3. However, all three Methods will be physically delivered across common trial sites to demonstrate the complementary benefits of combining more than one Method over an area.

Table 2-3 – Demonstration of the Methods

Trial	Description
ACS	This trial aims to demonstrate the advantages of enhanced control and flexibility at five trial sites on the 33kV network for generators and remote customers through the provision of the Advanced Connection Solution. The objective is to demonstrate that the connection can be maintained in the majority of network outages and fault conditions.
DPS	This trial aims to demonstrate that the Dynamic Protection System applied across ten trial sites can effectively receive inputs from the network in real-time, calculate the appropriate protection settings for the equipment associated with the trial area and communicate with the necessary relays, updating the protection scheme and settings.
INR	This trial aims to demonstrate that Intelligent Network Reconfiguration is sufficiently capable of reconfiguring the network following an optimisation study taking into account equipment ratings, network loading and power flows. The optimal operating arrangement will be calculated, the configuration will be confirmed and the necessary switching operations to reconfigure the network will be implemented. INR will be implemented over two distinct trial areas.

2.1.4 The Solution(s) which will be enabled by solving the Problem

The Methods proposed by REVISE will revolutionise the operation of the 33kV network facilitating the connection of DG and adapting the system ready for the future. REVISE will demonstrate that the incorporation of new technology and revised control methodologies will help facilitate the transition towards a DSO. REVISE will facilitate the following Solutions:

1 - Increasing the capability of DG connections: The primary Solution that will be delivered through REVISE will be the increased capability for DG to connect and generate on to the 33kV network. The deployment of the Methods will result in a 33kV network which is capable of intelligent reconfiguration through highly flexible connection arrangements thereby maximising the output from DG.

2 - Enhanced utilisation of existing network assets: REVISE is an innovative alternative to traditional reinforcement and ANM Solutions that will demonstrate a significant improvement in network flexibility. The Project will demonstrate that additional network capacity can be released through alternative operational Methods and that the investment required for traditional reinforcement is unnecessary when alternative pioneering approaches are available.

3 - Powering LCTs from clean power sources: In order to achieve the UK Government's targets set out in The Clean Growth Strategy, Low Carbon Technologies (LCTs) must be seamlessly integrated on the distribution network. The Project will trial new techniques, which will balance the power requirements for LCTs with clean power sources that are already connected to the 33kV network. This will ensure that the benefits from LCTs are fully harnessed when supplied using renewable energy rather than fossil fuel.

4 - Facilitate the transition to a DSO: REVISE will provide a significant technical Solution towards a DSO through the piloting of new technologies and methodologies that have not previously been trialled on the distribution network. Real-time management of the network will give an enhanced understanding of the barriers to connecting further DG, as well as LCTs, and provide Solutions that can be rolled-out across all 33kV networks.

2.2 Technical description of Project

The following sections provide an overview of the technical Methods. Further detailed technical descriptions can be found in Appendix L.

Advanced Connection Solution

The ACS is an ultra-compact 33kV connection Solution which will enable greater connectivity and availability of DG. The technical features of the ACS will be: **Small form factor enclosure** – *enabling pre-commissioned delivery*; **Digital substation** – *removing interfacing barriers*; **Plug and Play Communications** – *all standards accommodated*; and **Advanced Sensors and Auxiliary Systems** – *consolidation of functions*.

Dynamic Protection System

The DPS is an advanced protection system that will ensure that the networks of the future are adequately protected. The technical features of the DPS will be: **Automatic function selection** – *enabling variable protection philosophies*; **Real-time calculations** – *providing optimised system protection*; **Self-healing** – *autonomous testing and verification*; and **Compatibility** – *supplier agnostic Solutions*.

Intelligent Network Reconfiguration

The INR is a comprehensive control system which will use the latest technological advances to optimise the configuration of the network. The technical features of INR will be: **Full autonomous control** – *enabling rapid optimised reconfiguration*; **Machine learning** – *continuous improvement and safety*; **Cybersecurity** – *ensuring a safe and secure network*; and **Selectable priorities** – *providing optimisation based on performance requirements*.

2.2.1 REVISE is innovative

Manufacturing and design of an ultra-compact universal connection – REVISE will develop a "one size fits all" connection Solution for the 33kV network. Typically, connections to the 33kV network are site specific and are derived from a selection of off-the-shelf components. A number of new technologies and Solutions have been developed but have not been integrated and trialled as a single device. Combining these together into one Solution will represent significant technical, operational and safety challenges that will need to be met before the ACS can be considered as BAU. The Project aims to meet these challenges and develop the ACS to TRL 8.

Self-healing protection schemes - Self-selection and self-testing of protection schemes will be a first of a kind trial in GB. The value and benefit of these Solutions is well understood, however, to date the practical realisation has been unachievable due to existing legacy equipment. Whereas legacy equipment is reliant on manual input for changes and is purely reactive, the DPS will be intelligent and pro-active with the ability to determine the optimal scheme and settings.

Autonomous control of a 33kV network - The configuration of the 33kV network is currently fixed and only changes to manage maintenance and fault conditions. The INR will pro-actively assess the network configuration based on real-time information and determine an optimal configuration to meet a selected objective (e.g. maximise DG output, minimise losses etc.). Never before on the distribution network has wide scale autonomous control of the network been undertaken at any voltage level, meaning that REVISE represents a huge transition towards a fully active network.

2.3 Description of design of trials

2.3.1 Overview

The Solutions to enable a more flexible, efficient, better protected network will provide key learning that will be shared amongst all network licensees, specifically:

- Functional specifications for the proposed technologies and control methodologies;
- Standard designs for the technology elements within the three Methods to ensure other network licensees can integrate the Solutions into their BAU activities;
- Policies, practices and procedures for the integration of an Advanced Connection Solution in a new or existing network;
- Policies, practices and procedures for the application of a Dynamic Protection System;
- Policies, practices and procedures for the integration of an Intelligent Network Reconfiguration system; and
- Provision of application and connection hierarchy of Solutions to provide guidance and instruction on the appropriate implementation of the Methods.

The information used as inputs to the Project has come from a number of robust and verified sources such as the Long Term Development Statement (LTDS), our Innovation Strategy and other relevant internal documentation.

2.3.2 Scale of Trials

ACS – 5 trial sites: Analysis of the trial sites to date has shown that there are several different configurations where the ACS could be deployed which require flexibility in the design. Five sites have been selected to both enable a suitable defined "standard" ACS to be tested and enable the Project to confirm applicable networks where ACS can be integrated.

DPS – 10 trial sites: The 10 trial sites for DPS installation have been chosen with consideration of how benefits will be measured across various network configurations both with and without the complementary benefits from other Methods. As such, the five ACS sites will be trialled with DPS along with a further five independent sites, enabling technical benefits to be appropriately benchmarked for each type of trial.

INR – 2 trial areas: INR will be implemented across two wide 33kV trial areas encapsulating networks that are enabled both with and without ACS and/or DPS. The value of INR will increase in proportion to the size and complexity of the network under its control. Therefore, trialling over two separate areas will provide sufficient use cases to carry out the technical trials and demonstrate the benefits.

2.3.3 Robust delivery

As with all WPD innovation Projects, significant internal and external review of the design and delivery phase of the trials will be used to ensure that the outcomes are statistically sound and sufficiently robust to deliver GB wide learning. We will use the latest information available both internally and externally to ensure that the Project trials will provide industry leading and valuable learning. We will include a number of stage gate reviews throughout the Project to ensure that it delivers against its aims and objectives; principally these will be as we transfer from site selection to design, design to build and build to trials. A designated research workstream has been included within the Project to robustly capture the learning from the Project and appropriately disseminate amongst the key stakeholders.

The outputs for all Methods are detailed in Section 9 and summarised in Table 2-4 below.

Table 2-4 – Summary of outputs

Advanced Connection Solution
▪ A technical specification for the functionality of an Advanced Connection Solution ▪ Sample Advanced Connection Solution detailed designs ▪ System integration designs and a network integration testing methodology ▪ An operational philosophy ▪ Lessons, outcomes and recommendations for future installations
Dynamic Protection System
▪ A robust review of the limitations of traditional protection equipment and philosophies ▪ Description of the Dynamic Protection System technology and architecture ▪ A technical specification for the Method and sample detailed designs ▪ Site selection and network integration testing methodology
Intelligent Network Reconfiguration
▪ Operational and technical specification ▪ Security of supply & failsafe mechanisms ▪ Algorithm design and consideration ▪ Data Security and Resilience ▪ Learning and outcomes

2.4 Changes since Initial Screening Process (ISP)

There are no material changes since the ISP. The Method names have changed for clarity; however, the aims and objectives remain the same. The request for funding has reduced from £14.58m to £11.1m following a detailed costing exercise using results from our Request for Information (RFI) and refinement of the overall Project delivery methodology.

Section 3: Project Business Case

3.1 The Problem

The architecture of electrical distribution networks is changing considerably due to increasing numbers of DG connecting to the network. The drivers for this change are primarily due to central government decarbonisation targets, such as the UK government's commitment to reduce carbon emissions by at least 80% by 2050. However, this change is also driven by the falling cost of new technologies, especially in the renewable technology sector.

The forecast increase in DG represents a significant opportunity for the UK government to meet the objectives set out in the Carbon Plan. This change is also a prime opportunity for system operators to trial new Methods to connect and manage these assets in a way that supports the transition to greener electricity distribution, utilises the network in a more efficient manner and maximises their benefits to electricity customers.

The BAU processes used to connect new DG are primarily traditional reinforcement and ANM schemes. These options have, and will continue to play, an important role in their connection to the network. The new Methods that will be trialled in REVISE will update these existing BAU processes and will equip all network operators with the tools to deliver secure, cost efficient and low carbon networks to their customers. The net benefits of REVISE are summarised as:

Table 3-1 – The business case benefits of REVISE

£	**Financial Savings 2040**		**Financial Savings 2050**	
	WPD Roll-out *(4 Licence Areas)* **£32.53m**	GB Roll-out **£100.6m**	WPD Roll-out *(4 Licence Areas)* **£62.67m**	GB Roll-out **£191.2m**
	Carbon Savings 2040		**Carbon Savings 2050**	
	WPD Roll-out *(4 Licence Areas)* **239 $ktCO_2e$**	GB Roll-out **719 $ktCO_2e$**	WPD Roll-out *(4 Licence Areas)* **444 $ktCO_2e$**	GB Roll-out **1,344 $ktCO_2e$**
	Capacity Released 2040		**Capacity Released 2050**	
	WPD Roll-out *(4 Licence Areas)* **1,753 MVA**	GB Roll-out **7,679 MVA**	WPD Roll-out *(4 Licence Areas)* **2,588 MVA**	GB Roll-out **11,852 MVA**

3.2 Alignment with the WPD Innovation Strategy

Our Innovation Strategy recognises that distribution networks are undergoing considerable change as the UK implements the Carbon Plan and moves towards a low carbon economy. REVISE will address the key issue identified in our strategy, which is developing new Methods to integrate and manage the increasing numbers of DG on the distribution network in a sustainable, flexible manner that fully unlocks the benefits of these technologies. Our innovation strategy can be broken down into five broad areas of focus which are summarised

Our Areas of Innovation Focus
■ Network improvements and system operability
■ Transition to a low carbon future
■ New technologies and commercial evolution
■ Customer and stakeholder focus
■ Safety, health and environment

Table 3-2 – Areas of innovation focus

in Table 3-2. The REVISE Methods are applicable to all five areas but in particular will provide significant benefits to the top three.

The ACS Method will be a key component of our transition to a low carbon future and alignment with the UK's Carbon Plan. It will provide a fully flexible connection for DG so that they are able to transfer significantly more low carbon energy across the distribution network.

The INR Method is strongly aligned with our innovation objective to "develop new and smart techniques to accommodate increased load and generation at lower costs than conventional reinforcement". INR will release both load and generation capacity on the 33kV distribution network by dynamically reconfiguring the network.

Both INR and DPS Methods satisfy a number of our need cases for innovation which deliver network improvements and system operability that are fundamental to realise a DSO. INR will achieve this by performing autonomous network reconfiguration using bespoke algorithms. In a similar fashion, DPS will automatically adapt protection functions and settings for sections of network that are subject to regular changes in configuration.

3.3 Project Benefits

REVISE will deliver significant benefits to the GB distribution network by developing and deploying three innovative Methods. The business case has been developed so that each Method is standalone delivering both financial and carbon benefits over the counterfactual. This section summarises the benefits of each Method in more detail:

Advanced Connection Solution - The ACS will be a revolutionary new connection Solution for DG on the 33kV distribution network. It will be the first instance in the UK that a connection Solution has been developed from the ground up with the primary purpose of accelerating the decarbonisation of the electricity network. The ACS will be a key enabler for operating as a DSO as it provides a fully flexible connection for DG; it can work together with active energy control systems to seamlessly shift energy from DG to areas of high demand when required.

Dynamic Protection System – The DPS will develop and trial next generation adaptive protection schemes on the 33kV distribution network for the first time. The DPS will monitor various parameters such as system impedance (following network reconfiguration), circuit breaker positions and system fault level to inform the autonomous computation of the optimum protection function and associated settings to be deployed to the protective devices in the field. The primary benefit is that this Method will deliver a powerful tool to automate protection systems and ensure that the network is secure and safe as it moves towards greater complexity through increased DG connections and automated reconfiguration.

Intelligent Network Reconfiguration – The INR Method will be an advanced control system to enable the automatic reconfiguration of the 33kV network. The existing distribution network is operated manually at a control centre usually to reconfigure the network following a fault to ensure customer supplies are secured. The INR Method will take automated control actions based on real-time measurement data in order to optimise the performance of the network for various metrics e.g. network capacity, electrical losses, demand/generation balancing.

Consideration and analysis has been performed to show that the proposed trial and roll-out of the technical Methods on the 33kV distribution network is justifiable and will provide the most benefit to customers. The graph in Figure 3-1 shows that the majority of DG connected to our network is apportioned to the 33kV network and that this voltage level is linked to the biggest increase in DG connecting between 2015 and 2017. The graph in Figure 3-2 highlights the density of DG (MW/km) which is also greatest for the 33kV voltage level.

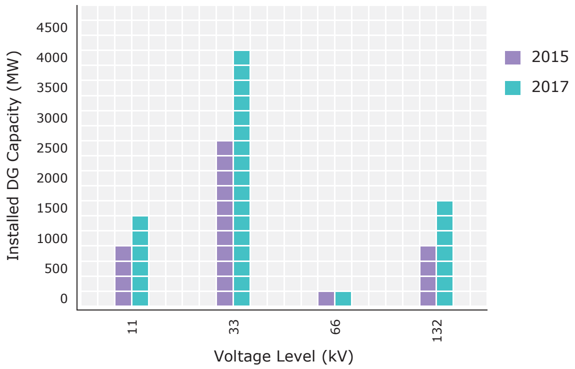


Figure 3-1 – DG on WPD's network

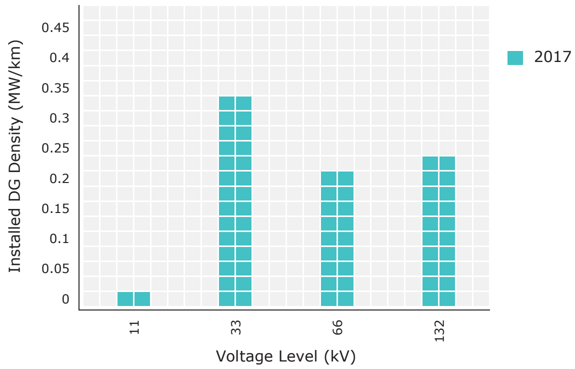


Figure 3-2 – DG density on WPD's network

The Methods trialled in REVISE are applicable and scalable across the GB distribution network. With the exception of the London conurbation, all licence areas have substantial lengths of 33kV rural overhead line. A study was performed on a number of trial area networks which has shown that there is significant scope to adopt the Project across all areas with 33kV overhead line networks. Since the Project is scalable across WPD and GB, the knowledge and learning generated from the Project will be applicable to all DNOs. This has considerable benefit as the output of the trials will allow significant cost savings for the wider roll-out of the technologies. For example, the trial will involve production of both technical specifications and policy documentation for all Methods. This information will be disseminated and will substantially reduce the engineering costs of installing the Methods across other DNO licence areas.

3.4 ACS Business Case

The business case for the ACS has been formulated on the basis that each unit will increase the availability of DG that is connected to the ACS when compared to the counterfactual 't-connection' shown in Figure 3-3. The ACS facilitates this increase by maintaining the connection of the generator for the duration of a circuit outage as described in Figure 3-4. The calculation of both financial and carbon benefits is based on the additional energy that the ACS has allowed to be transported over the 33kV distribution network during a circuit outage. The typical outage duration for a 33kV connected generator has been calculated using our detailed outage planning records. A detailed description of the methodology and the assumptions can be found in the supplementary Appendix K.

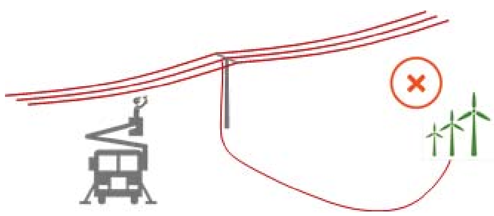


Figure 3-3 – T-connection during an outage

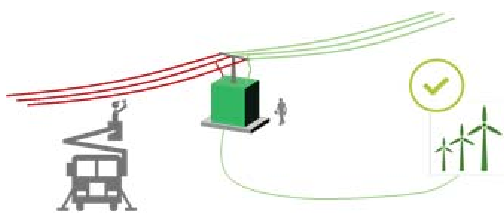


Figure 3-4 – The ACS during an outage

The financial benefit analysis has included both Capex and Opex costs of the ACS. The Capex costs were attained from manufacturers that responded to our RFI, whilst the Opex costs has been derived by calculating the expected maintenance costs over the lifetime of the ACS. The Capex costs have been forecast to reduce over time as more units are produced and rolled-out: the initial cost post-trial is £257k, falling to £231k in 2029 when the technology matures and further reducing to £218k from 2039 as the volumes of ACS roll-out increase.

The carbon benefit is quantified by assuming the additional energy transferred by the ACS under a circuit outage is derived from low carbon sources. The detailed methodology and assumptions are described in detail in Appendix K. The cumulative carbon savings have been calculated for each year of the trial and roll-out phase. The embodied carbon of the base case and ACS installation has been estimated and also factored into the analysis. It was found that the ACS embodied carbon is easily offset by the carbon savings generated by the Method.

The anticipated roll-out methodology has been based on our Shaping Subtransmission to 2030 report for the West Midlands which predicts a doubling of DG on the West Midlands network by the year 2030. This data has been supplemented by National Grid's forecast for the increase in distributed generation capacity across GB up to 2050. This is detailed in the National Grid Future Energy Scenarios (FES) 2017 document. The National Grid data is in broad alignment with our Shaping Subtransmission to 2030 report. Further detail of the roll-out methodology can be found in the supplementary Appendix K.

3.4.1 Financial and Carbon Benefits

The financial benefit of the ACS Method is £97.3m for the GB scale roll-out up to 2050. The figure presented is in Net Present Value (NPV) terms. The carbon benefit of the ACS Method is 840.7 ktCO2e saved across GB by 2050.

The full financial and carbon benefits of the ACS Method post-trial, roll-out across all WPD licence areas and roll-out across GB are shown in Appendix A.

3.5 DPS Business Case

Protection systems on the distribution network have been developed over time to be passive in nature because there was no requirement for regular updates or modifications. The main driver for this was that the distribution network was largely static and did not reconfigure frequently; usually the network only reconfigures in response to an electrical fault to restore customer supplies. The distribution network is now becoming more complex as DG uptake continues to accelerate and the transition to active networks is required for a DSO. As this complexity increases we will need new Methods of protecting the network from electrical faults because the electrical parameters of the network can no longer be considered 'static' as was previously the case.

3.5.1 Case Study

The business case for DPS is demonstrated via the following case study. The network shown in Figure 3-5 is indicative of a typical 33kV network. INR is rolled-out on this network as there are significant benefits by having the facility to operate autonomously in a variety of different configurations. With INR applied, the previously static network now becomes significantly more complex. INR will seek to identify all possible network configurations and will control switching points on the network to implement the optimal arrangement to accommodate changes in generation/load or to balance the network. Figure 3-5 and Figure 3-6 propose two Solutions to overcome the additional complexity.

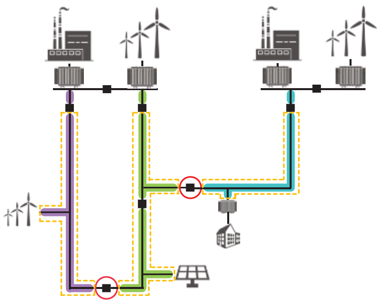


Figure 3-5 – Typical 33kV network

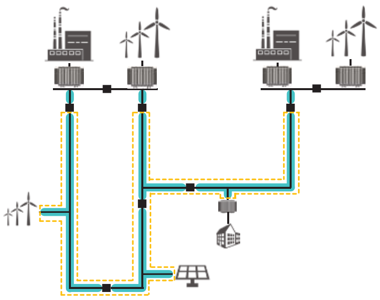


Figure 3-6 – Reconfigured network with INR

Counterfactual Solution 1

Without DPS applied, the protection functions and settings would have to be manually designed for each possible configuration. These would then have to be deployed to the protective devices at site whenever the network is reconfigured, normally by a site operative. To reduce the burden of constantly updating the protective devices locally, a Solution would be to switch between a particular group of settings remotely by the Network Management System (NMS), however, this would still require significant input by an engineer.

Counterfactual Solution 2

Figure 3-6 shows the reconfigured network with INR with the coloured portion representing the new larger area. This would mean that one set of protection settings would exist for all the possible configurations and INR could operate correctly with minimal protection scheme updates. However, the trade off with this Solution is that if a fault does occur, large areas of the network could be disconnected. In short, the protection system loses selectivity and there will be more unnecessary customer interruptions.

Applying either counterfactual Solution may not be significantly detrimental because the number of configurations is relatively small. However, for a real network, the complexity introduced by INR increases dramatically because there will be many more locations where the network can be switched. For example, in Trial Network 1 in Appendix G there are over 10 switching locations representing significant a number of network configurations. It is clear that the task to study each possible configuration quickly becomes unmanageable on full-scale networks. If the counterfactual is adopted this means that:

1. The roll-out of INR will be limited in scope to small portions of network to maintain the same protection functionality that exists at the moment; or
2. The performance of protection systems is reduced to cope with the reconfiguration changes introduced by INR, leading to more customer interruptions.

3.5.2 Financial Benefits and Carbon Benefits

It has not been possible to quantify the direct financial and carbon benefits of DPS due to the high level of innovation contained in this Method and the absence of a credible base case for comparison. A qualitative account of the DPS benefits can be found in Appendix K. It is clear from this case study, however, that automated networks are a fundamental part of the future energy system. However, the impracticalities of the current way we implement protection studies, although appropriate for a static network, introduce severe barriers to a large scale roll-out of network automation across GB. DPS will maintain high levels of protection system performance when INR is deployed and the network is constantly reconfiguring. In this respect, the business case for DPS is that it is a fundamental component to facilitate the wider uptake of network automation so that the benefits of this Method are fully realised across GB.

3.6 INR Business Case

The business case for the INR Method has been formulated on the basis that each INR installation will release network capacity above that of the counterfactual. The counterfactual in this instance is the existing network in its ‘normal’ running arrangement with the application of ANM. INR will work together with ANM to provide DNOs with an additional tool to release capacity.

The INR Method releases network capacity by finding the optimum network configuration and automatically switching to this state. This process is described in Figure 3-7 and Figure 3-8. Figure 3-7 indicates the counterfactual network which is static. The power flows are imbalanced which constrain the amount of generation/load that can connect. Figure 3-8 shows the network with INR applied. The network has been reconfigured to its optimum state which has balanced the power flows and released additional capacity.

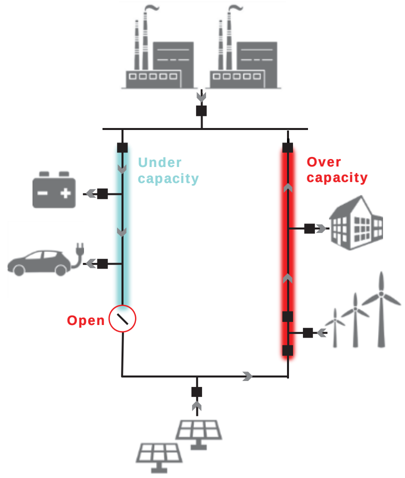


Figure 3-7 – INR Counterfactual (normal running arrangement with ANM)

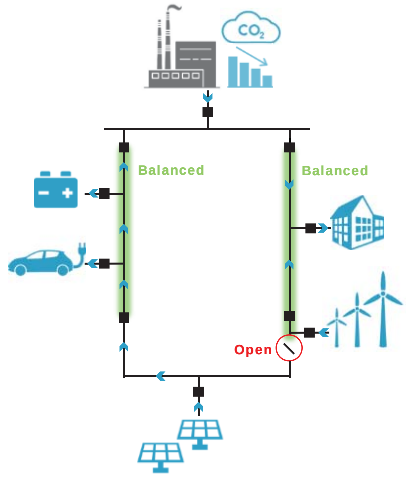


Figure 3-8 – INR (network running in the optimum configuration to release capacity)

We have implemented a robust methodology to model the operation of the INR Method and calculate the additional capacity that is released. A series of power system studies were performed on three 33kV networks selected for the purpose of this business case. A full description of this process on the trial networks can be found in Appendix K.

3.6.1 Financial and Carbon Benefits

The average generation capacity released by INR across the three trial networks was calculated to be 41.7MVA per INR installation. This additional capacity release translates to a reduction in traditional reinforcement cost required to accept the forecast levels of DG connection over the course of the analysis period. We have calculated that the INR Method will accelerate generator connection timescales by a conservative estimate of three months when compared to the counterfactual. Therefore, a significant additional financial benefit is attributed to new DG being able to sell more energy over the analysis period. The total financial benefit of INR has been calculated as £209.2m (NPV) provided across GB by the INR Method by 2050.

The accelerated connection times for renewable DG result in increased energy flows over the analysis period. This energy would have had to be supplied from the centralised UK energy mix in the Base Case but with INR it is supplied by local renewable DG which results in the most significant carbon benefit. An additional carbon benefit is derived from the INR capacity release. This capacity release offsets the construction of traditional reinforcement schemes which have a large embodied carbon footprint. Therefore, INR reduces the embodied carbon intensity of the network over the analysis period. The roll-out of INR across GB will translate to 502.9 ktCO_2e of carbon savings by 2050.

Section 4: Benefits, timeliness, and partners

4.1 Accelerates the development of a low carbon energy sector and/or delivers environmental benefits whilst having the potential to deliver net financial benefits to future and/or existing Customers.

Low Carbon Network Sector Development

REVISE will help enable the transformation of the distribution network to accommodate future developments in the low carbon sector. Smart technologies which can be intelligently controlled are now being connected to the distribution network and this trend is expected to grow substantially in the coming years. Changes in the way the distribution network is controlled and managed are required to ensure that it keeps pace with the advances in technologies being connected to it. The transition towards a DSO is a key facilitator to achieve a network which can to respond to the demands of an ever developing low carbon economy. Implementing the three Methods of REVISE will provide a significant step towards operating as a DSO and also accelerate the connection of DG by:

- **Providing faster connection times and greater availability** through the development and trialling of an Advanced Connection Solution
- **Ensuring the network of the future is adequately protected** using Dynamic Protection Systems
- **Creating a network which is more flexible** through Intelligent Network Reconfiguration

The Methods of REVISE will provide DNOs with additional tools to increase network capacity for new DG alongside the existing options of network reinforcement and ANM schemes.

Our calculations have shown that implementation of all three Methods will allow an additional 2,588MVA of generating capacity to be connected to WPD's four licence areas by 2050. Development of standard designs and clear implementation processes through REVISE will enable roll-out across GB and promote the growth of the low carbon network sector.

Environmental Benefits

REVISE will deliver substantial carbon savings compared to counterfactual processes which are detailed in Appendix A. The provision of additional network capacity, greater generator availability and increased flexibility will promote the connection of low carbon DG.

All three Methods combined will deliver 77,693 tonnes of CO_2 savings by 2030 if rolled-out in the WPD region alone and 1,343,653 tonnes of CO_2 savings by 2050 if rolled-out across GB as indicated in Table 4-1. The calculation is based on the increased availability and accelerated connection times for low carbon generation. A detailed description of the methodology for calculating the carbon benefits can be found in Appendix K.

Table 4-1 – CO_2 savings following REVISE roll-out

Year	Across WPD Licence Areas (tCO_2e)	Across GB (tCO_2e)
2030	77,693	219,287
2040	238,844	718,505
2050	444,283	1,343,653

The ACS is the only Method where we are installing equipment through major construction activities and as such embodied carbon will be required for this Method. Although we recognise that the ACS will have a slightly higher level of embodied carbon compared with the counterfactual, this is completely offset by the savings from increased DG availability and connectivity. The ACS is also a key facilitator of INR and active energy networks which will introduce further carbon benefits through increased network flexibility.

Financial Benefits

Creating a distribution network with improved flexibility, control and capacity through REVISE will see existing and future customers benefit financially. Our analysis has shown that financial benefits will be realised through the Project trials. If REVISE was to be rolled-out across WPD and GB, the overall benefits would be significant as indicated in Table 4-2 below. A detailed summary of the financial NPV analysis and break-even points is included in Appendix I.

Table 4-2 – Cumulative NPV Analysis for REVISE roll-out

Scale	NPV 2030 (£m)	NPV 2040 (£m)	NPV 2050 (£m)
Post-trial	0.965	1.977	2.726
WPD Roll-out	2.342	32.53	62.665
GB Roll-out	13.633	100.624	191.166

A brief summary of the financial benefits are listed below.

- **Availability** – DG will benefit from an increase in availability as the network becomes accessible more often through the installation of Advanced Connection Solutions. This will help prevent customers having to endure lost revenue when their connection is interrupted for planned maintenance and fault events.
- **Capacity** – New customers will benefit from the additional capacity which will be released as the network is reconfigured depending on the real-time measurements at strategic points. This additional capacity will help to defer network reinforcement and could complement ANM schemes.
- **Efficiency** – All customers will benefit from a network that is running in the most efficient configuration for the real-time operational scenario. Reconfiguring the network to its optimal state will avoid the need to reinforce the 33kV network for load growth on the downstream network. A further benefit is also the reduction of system losses.
- **Accelerated DG connections** – The INR Method will provide faster connection times compared with traditional reinforcement allowing customers to begin generating earlier which translates to increased customer revenue.

4.2 Provides value for money to electricity distribution/transmission Customers

The methodology for implementing REVISE has been prepared with the aim to maximise value whilst minimising cost. We will use our well established project governance, internal procedures and external inputs to generate outputs which will be extremely valuable both during and after Project delivery. Figure 4-1 summarises these points with further details listed below.

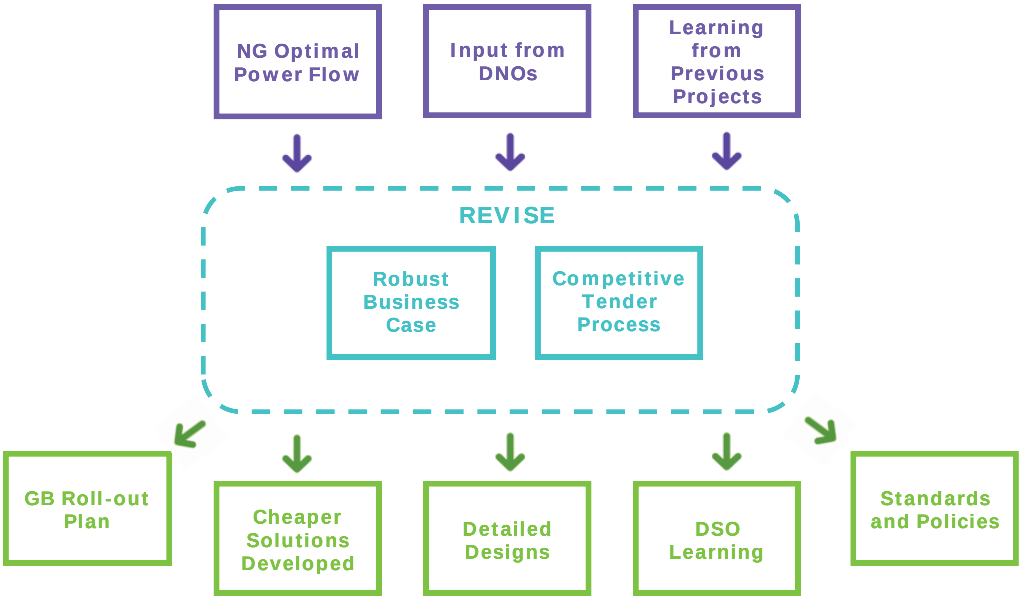


Figure 4-1 – Value for money from REVISE

- **Input: Input from DNOs** – At various milestones throughout the Project we will engage with other DNOs to seek their views and advice on how the Project should be developed to extract the maximum value from the funding. We will actively seek contributions on the design and implementation of each of the Methods through workshops and regular meetings. Experience from previous Projects has shown that this type of engagement has helped to add value by including critical review or performing additional analysis at an early stage.
- **Input: Learning from previous Projects** – We recognise that a substantial amount of learning has been produced already from previous NIC (and LCNF) Projects and have assessed relevant Projects during the preparation of this FSP. The deliverables for REVISE are unique due to the voltage level, technologies and processes that will be developed, however, learning generated from Projects such as our Low Carbon Hub and FALCON; NPg's CLNR; ENW's C_2C; and SPEN's ARC are relevant and will help us to focus the deliverables and avoid repetition of work that has been completed previously.
- **Input**: **National Grid OPF** – We will build upon the work conducted for the Optimal Power Flow (OPF) tool which aims to maximise power output whilst minimising losses and operating costs. The work for REVISE will complement this work, where instead of focussing on determining the optimal operating point of individual devices (such as tap-changers and reactive power sources), it will provide a particular focus on achieving the best network configuration.
- **Internal: Competitive Tender Process** – We have consciously decided that we will tender for Project Partners to support the Project after funding has been

awarded. This decision has been taken on the basis of our experience in delivering successful innovation Projects. This is justified through our RFI process, completed as part of this FSP, where we identified a number of technology manufacturers. However, at this stage in the process, the Solutions offered are still in their infancy and not in line with our requirements. We recognise that the Methods contain high levels of innovation and therefore we will look to select Project Partners in a competitive process after funding has been secured. This will allow us to define the technology requirements in sufficient detail so that the manufacturers can develop the innovative Methods to the explicit requirements of the network. We have demonstrated on numerous occasions that investing the time to develop a clear, robust and definitive scope of work, after funding has been secured, has translated to significant cost savings both in the competitive tender process and in the long term over the duration of the Project. We have already identified which Project Partners by type will be required during the design and delivery phases, and have used a number of previous estimates and project costs to calculate appropriate costs for this FSP. We will use our standard tendering procedures for each main Project Partner and award the Contract to the "Most Economically Advantageous Tender", considering technical performance and cost.

- **Internal: Robust Business Case** – The business case for REVISE has been prepared using the latest industry forecasts and trends whilst taking into account our extensive experience in delivering successful innovation Projects. We recognise that the GB electricity industry is in a period where certainty is not guaranteed and therefore we have performed sensitivity analysis as part of our business case to account for different outcomes in the GB market. In addition, when preparing the business case for REVISE we have included additional margins within our estimates which allows for additional contingencies.
- **Output: GB Roll-out Plan** – The Methods for REVISE have been designed so that they can be rolled-out on the 33kV network across GB. Our business case has studied the benefits that would be realised if the Methods were to be adopted by all DNOs in-line with industry forecasts. Identification of trial areas has shown that there is clear scope to adopt the Project across all licence areas with 33kV overhead line networks.
- **Output: Cheaper Solutions Developed** – REVISE will develop new Solutions, take these through to detailed designs which will then be tested and trialled on the network. Developing these Solutions to meet the stringent requirements of all network operators will take significant effort and involve input from expert engineers and other DNOs. However, once developed and trialled through REVISE, these Solutions will be refined and will offer a more cost effective Solution than is currently available in BAU.
- **Output: Detailed Designs** – Key deliverables from REVISE will be the production of standardised designs that will be used by WPD and all DNOs for the future roll-out of the Methods. We will develop and share standard integration designs for the Methods which can be developed in conjunction with our own internal teams and manufacturers with input from other DNOs. These designs will capture the various different configurations for new equipment and will serve as a useful tool for transition to BAU. In addition, standardising and sharing designs

will mean reduced duplication of effort in the transition to BAU which will have significant financial benefit.

- **Output: Standards and Policies** – To complement the integration designs we will also develop equipment specifications, connection/application guides and maintenance and control policies as part of the Project. These documents will provide WPD and other DNOs with the necessary "tool-kit" to allow the Methods to be replicated across GB.
- **Output: DSO Learning** – REVISE will implement systems which will enable intelligent control and automation on the 33kV network. Researching, designing and implementing new protection, control and cybersecurity systems will provide significant learning that can be used for the DSO transition.

The points above demonstrate that REVISE will generate significant learning and outputs that can be used by all DNOs to help shape future networks and the transition to a DSO, thus providing value for money to electricity distribution customers. In addition, we will focus on using learning from previous Projects and also input from other DNOs to inform the scope of the Project.

The total cost for delivering REVISE has been estimated as £12.57m. Table 4-3 provides a summary of the Full Submission Spreadsheet detailing the cost breakdown for each main element of the Project per Method.

Table 4-3 – Breakdown of Method Costs

Element	ACS Method (£k)	DPS Method (£k)	INR Method (£k)	Research and Dissem. (£k)	Sub-Total (£k)
Labour	[redacted]	[redacted]	[redacted]	[redacted]	**1,701.14**
Equipment	[redacted]	[redacted]	[redacted]	[redacted]	**5,975.00**
Contractors	[redacted]	[redacted]	[redacted]	[redacted]	**3,368.36**
IT	-	-	-	-	**-**
IPR	-	-	-	-	**-**
Travel & Expenses	[redacted]	[redacted]	[redacted]	[redacted]	**274.57**
Payments to Users	-	-	-	-	**-**
Contingency	[redacted]	[redacted]	[redacted]	[redacted]	**1,131.91**
Decommissioning	-	-	-	-	**-**
Other	-	-	-	[redacted]	**120.00**
TOTAL	**2,949.69**	**4,262.68**	**4,408.98**	**949.64**	**12,570.98**

Table 4-4 provides a breakdown of staffing costs for each Method.

Table 4-4 – Staffing costs per Method

Resource	ACS Method	DPS Method	INR Method	Research and Dissem.	Sub-Total
Direct Labour					
Unit Rate (£ per day)*	[redacted]	[redacted]	[redacted]	[redacted]	
No. Days	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total (£k)	**353.96**	**640.95**	**567.15**	**139.08**	**1,701.14**
Consultant					
Unit Rate (£ per day)	[redacted]	[redacted]	[redacted]	[redacted]	
No. Days	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total (£k)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

**The Direct Labour Unit rate varies depending on the different grades of staff used for each Method*

As discussed previously, the costs and units for REVISE have been calculated using data from previous Projects and information received from an RFI carried out during the FSP stage.

4.3 Is innovative (i.e. not business as usual) and has an unproven business case where the innovation risk warrants a limited Development or Demonstration Project to demonstrate its effectiveness

REVISE represents a globally innovative trial and demonstration of three Methods that have the potential to revolutionise the operation of the distribution network. The Advanced Connection Solution, Dynamic Protection System and Intelligent Network Reconfiguration Methods will produce learning and methodologies applicable to all GB DNOs. Figure 4-2 shows how the three innovative Methods can be applied to the existing network to develop a network that is flexible, protected and efficient, and ready for the future.

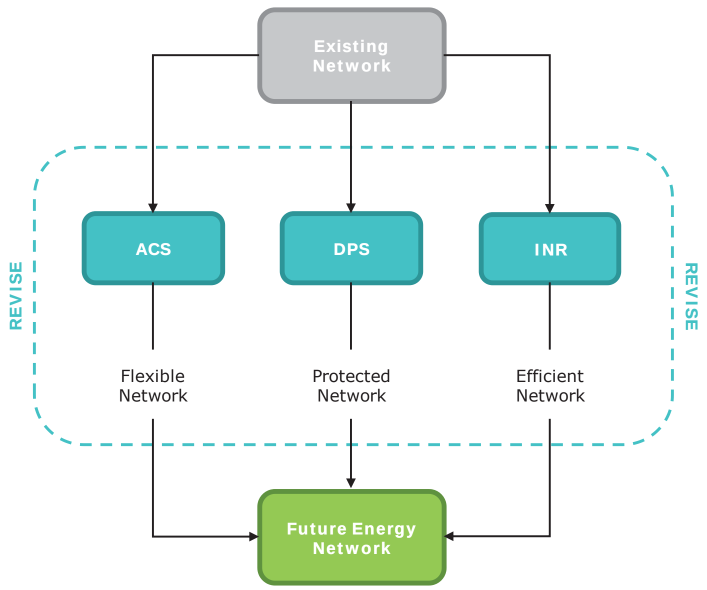


Figure 4-2 – Three innovative Methods for REVISE

Methods

REVISE will take learning from previous research, trials and Projects and combine with existing and emerging technologies to enable DNOs to unlock capacity on the network, extract more energy from low carbon sources and reduce customer costs. Application of the Project Methods has never previously been trialled on 33kV distribution networks in GB.

The **Advanced Connection Solution** will increase existing and future connection flexibility to the 33kV network. It will offer a remotely configurable, pre-packaged, pre-commissioned, standardised connection. We recognise that pre-packaged Solutions at 33kV are currently available for many customer connections. However, these Solutions are often bespoke with a focus on the customer's needs and do not represent a forward thinking Solution for distribution networks of the future. The Advanced Connection Solution will use learning generated from previous Projects, such as SSE's MASC, and develop a Solution which will incorporate traditional switchgear with the latest innovative developments in control and auxiliary systems to provide a standalone, packaged Solution designed to help facilitate the transition to DSO. Funding will be used to design the Advanced Connection Solution to meet the requirements of both the DNO and DSO with a focus on safety, operability and installation requirements.

Dynamic Protection System will pilot adaptive protection in combination with a smart communications system. The network of the future will need to respond to changes that are happening around it on a real-time basis. The Dynamic Protection System will dynamically optimise the protection parameters based on measurements and signals received from the surrounding network. Currently, most protection schemes on the 33kV network are static or provide only limited scope for changes (which normally have to be carried out manually). Innovation for protection systems is required to ensure that the existing systems do not prohibit the operation of a dynamic network in the future. Therefore this Method will design and implement new protection schemes that for a future network, operating in a multitude of different scenarios and configurations that have not previously been considered. We recognise the importance of ensuring that sensitive network data is handled carefully so our network is not comprised. As such, we will use learning from previous Projects to investigate, design and implement robust cybersecurity.

Intelligent Network Reconfiguration will deliver a fundamental change in how the 33kV network is controlled and operated. As mentioned above, the network of the future requires the flexibility to adapt and respond to changes around it. This will become more apparent as more DG and LCTs are connected and rapid fluctuations in power flow become more apparent. REVISE will develop and trial a new Solution for releasing capacity by increasing network flexibility to complement current offerings in the form of traditional reinforcement and ANM schemes. The Method will design, develop and trial an autonomous system that is capable of determining the optimal running arrangement in real-time and implement reconfiguration of the network accordingly. Intelligent Network Reconfiguration represents an innovative trial on our 33kV network which, if successful and rolled-out accordingly, can deliver substantial benefits across GB.

Project Risk

Our business case for REVISE has been developed using the latest information and forecasts along with our own experience from delivering successful innovation Projects. The forecast benefits from our business case show that implementing the Methods from REVISE will deliver a Solution which is more attractive than the counterfactual in terms of cost and performance. NIC funding will be used to develop the Methods of REVISE, refine the details and demonstrate the benefits of a flexible, protected and efficient network. Through many previous innovation trials, we recognise the importance of identifying and managing the risks associated with an innovation Project of this scale. Receiving NIC funding for REVISE will allow us to allocate the appropriate amount of time and resources to ensure that we are able to design and implement new systems which have never previously been trialled together on the live operational 33kV network.

4.4 Involvement of other partners and external funding

4.4.1 Project Partners

We recognise that we will need to engage with a number of Project partners to deliver REVISE and have begun identifying these as detailed in Appendix D. Our experience in delivering previous innovation Projects has shown that tendering for Project partners after funding is received and scope has been detailed, provides improved value for money compared with entering into agreements at FSP stage.

We would plan to tender for the following services using the procedure detailed in Figure 4-3 if funding was received:

- **Technical Consultant(s)** – We would tender for services to assist with developing conceptual designs, power system studies, detailed designs and testing/commissioning.
- **Specialist Consultant** – Developing the requirements for a robust cybersecurity system will require input from a consultant specialising in data security and communication systems.
- **Contractors** – There may be a need to engage with installation contractors to complement our existing in-house delivery teams and assist with specialist engineering services (such as geo-technical surveys and complex works)
- **Suppliers/Manufacturers** – We have received a positive response to the RFI which was issued during the FSP stage as is summarised in Appendix Q. Following further development of the three Methods, we will produce tender documents for the supply and installation of software, equipment and tools.

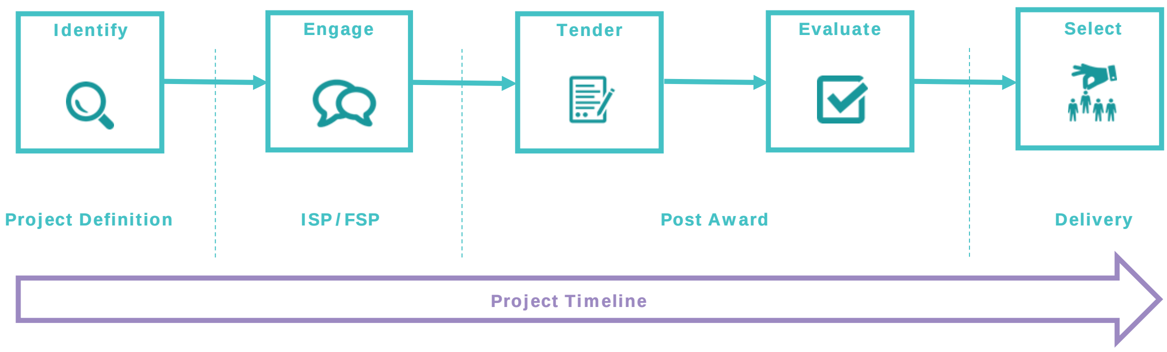


Figure 4-3 – Project Partner Selection Process

4.4.2 Project Supporters

The business case for REVISE is supported by a number of stakeholders who recognise that the existing network, although fit for purpose today, requires incremental change through innovation to meet their future needs. As part of our engagement plan we have pro-actively interacted with a number of stakeholders to verify the Project need case and develop the scope for the three Methods. Details of the interaction is summarised Table 4-5 and further detail can be found in Appendices O and P.

Table 4-5 – Engagement with Project stakeholders

	DG Operator's Forum - Presentation and Feedback Session – 19 July 2018 One of the supporting reasons for developing REVISE was to address feedback from DG Operators who had "non-firm" connections and were subject to disconnections for faults, maintenance and construction work. At the DG Operator's Forum meeting in July we presented the Project aims and objectives and gathered feedback from all participants. Further details of this can be found in Appendix O.
	DNO Connection Designers – Interviews July 2018 To develop the scope for REVISE we engaged with engineers who are influential in the design of Extra High Voltage (EHV) connections for DG. We conducted interviews with connection designers from UKPN, SSEN, ENW and also internally within WPD. Each DNO recognised that REVISE would help to accelerate the development of new connection Solutions and network improvements which will be required to meet the low carbon network of the future.

4.5 Relevance and timing

4.5.1 Clean Growth Strategy

The UK energy sector is undergoing a significant transition where we are seeing significant reductions in emissions as electricity supplies generated from clean sources begin to overtake those from large fossil fuel plants. The Clean Growth Strategy presents a pathway which would see this trend accelerate with clean sources supplying 85% of the UK's electricity by 2032 resulting in emissions reducing to 16 $MtCO_2e$ as shown in Figure 4-4 and Figure 4-5.

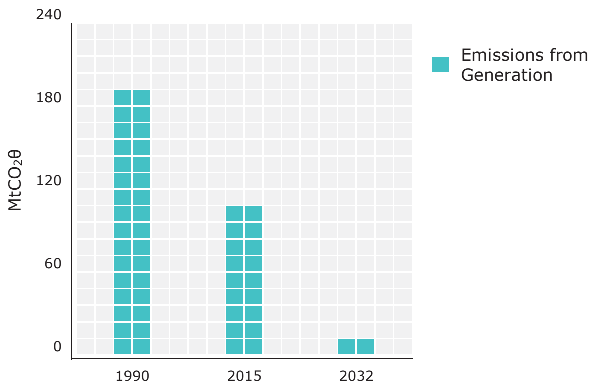


Figure 4-4 – Emissions generated as part of electricity supply production

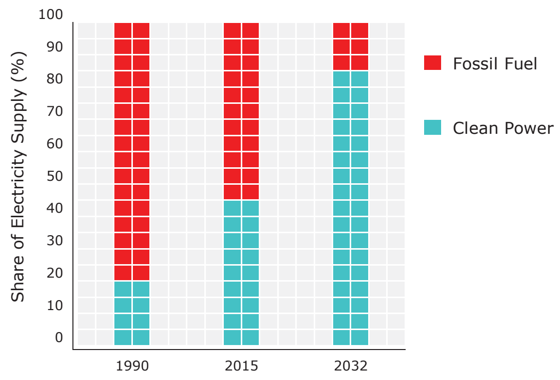


Figure 4-5 – Share of electricity supply from fossil fuel and clean power

This predicted increase in generation from clean sources will see a profound increase in the volume of DG connections on the network across GB. In particular, we expect the majority of increases to occur on the 33kV network as previously detailed in Section 2.1 of this document. To deliver the ambitious emission reduction target of the Clean Growth Strategy, DG will need more than a simple connection to the network, it will need an advanced connection which provides much improved availability over existing Methods. In addition, it is important that the DG is not curtailed by a network which is inflexible and rigid. The network needs to be developed to one which is highly efficient through the use of intelligent automation, whilst exceeding the current levels of security and reliability. The three Methods of REVISE will new techniques and technologies which will provide the necessary Solutions to develop targets in the Clean Growth Strategy.

4.5.2 ENA Electricity Network Innovation Strategy

Recent consultation between industry bodies, DNOs and other stakeholders have identified the need to develop an energy system which is clean, smart and coordinated. The Energy Networks Association (ENA) published the Electricity Network Innovation Strategy in March 2018 after two periods of consultation with stakeholders and the strategy provides a list of challenges in the form of "Innovation Themes" which have been taken from individual DNO strategies and wider trends in the GB energy industry. The Electricity Network Innovation Strategy introduces five main innovation themes as detailed in Table 4-6.

Table 4-6 – ENA Joint Innovation Strategy Themes

1. Network improvements and system operability
2. Transition to a low carbon future
3. New technologies and commercial evolution
4. Customer and stakeholder focus
5. Safety, health and environment

The Methods from REVISE will address all five innovation themes, providing substantial learning for the move towards a Smart, Flexible Energy System. The strategy also highlighted that new technologies has had "a relatively low representation in innovation projects, so may benefit from increased innovation focus". REVISE will aim to address this particular challenge by trialling new technologies across all three Methods including new hardware and software that are a pre-requisite for the transition to a DSO.

Section 5: Knowledge dissemination

Having successfully delivered a number of large scale innovation projects, we recognise that effective knowledge dissemination plays a critical role in the overall success of a Project. The importance of planning knowledge dissemination during the FSP stage has become a key focus in more recent years as we seek smarter and more efficient ways to share information across a broad range of innovation subject areas.

The deliverables for REVISE include a dedicated output for Knowledge Capture and Dissemination. This deliverable has been included to complement the Ofgem Common Deliverable and ensure that learning is captured concisely, coordinated with other DSO related projects and disseminated effectively and at regular interval amongst DNOs and other stakeholders.

Throughout the course of the Project we will engage with internal and external stakeholders to advise on progress, collate feedback and discuss our next steps. We will use the information from this regular engagement to help shape the next stages of the Project to ensure that learning is tailored where possible.

5.1 Learning generated

REVISE will generate significant new learning throughout the course of the Project from concept through to implementation and trialling of all three Methods. The learning that will be generated is also directly linked with industry strategy documents which call for a need to generate innovation and share the outputs with DNOs and other stakeholders. Table 5-1 describes the learning that REVISE will generate, the intended recipients and the ENA Electricity Network Strategy Themes (as detailed in Table 4-6) that each Method aligns with.

Table 5-1 – Learning generated by REVISE

Description	Intended Recipient					ENA Strategy Theme				
	DNOs	Industry	Regulator	Government	Academia	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
ADVANCED CONNECTION SOLUTION						•		•	•	
Targeted research of new technologies	•				•					
Collate and report on learning from other network operators (UK and Europe)	•	•	•							
Detailed site selection methodology	•									
Technical specification	•	•								
Equipment and installation tenders	•	•								

Description	Intended Recipient					ENA Strategy Theme				
	DNOs	Industry	Regulator	Government	Academia	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
Detailed site integration designs	•	•								
Testing procedures and outcomes	•	•								
Results of trials, measured benefits	•	•	•		•					
Production of policy documentation	•	•		•						
Summary of all learning	•	•	•	•	•					
DYNAMIC PROTECTION SYSTEM						•		•		•
Targeted research of new technologies	•				•					
Collate and report on protection limitations for distribution networks	•				•					
Equipment integration requirements	•									
Technical specification	•									
Detailed implementation strategy	•									
Equipment and installation tenders	•	•								
Detailed site integration designs	•	•								
Testing procedures, simulations and studies	•	•								
Results of trials, measured benefits	•	•	•		•					
Production of policy documentation and updates	•	•		•						
Summary of all learning	•	•	•	•	•					

Description	Intended Recipient					ENA Strategy Theme				
	DNOs	Industry	Regulator	Government	Academia	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
INTELLIGENT NETWORK RECONFIGURATION						•	•	•		
Targeted research of technologies and industry trends	•				•					
Cybersecurity requirements for Distribution Networks	•	•	•	•	•					
Communication system integration requirements	•									
Control system requirements	•									
Detailed implementation strategy	•									
Solution tenders	•									
Control system integration designs	•									
Testing procedures, simulations and studies	•	•								
Results of trials, measured benefits	•	•	•		•					
Production of policy documentation and updates	•	•		•						
Summary of all learning	•	•	•	•	•					

Table 5-1 shows that REVISE will contribute learning towards all five of these themes through the research, design, trialling and output from all three Methods.

Support from other DNOs

We have actively engaged with other DNOs during the FSP production to verify the Project need case and also refine the scope. During July 2018 we conducted a series of interviews with DNO engineers who are actively involved with the design of EHV connections for DG. During the interviews we asked engineers for their input on current design practices and how these will need to be shaped for the future. The feedback received was very positive with each DNO supportive of the aims for REVISE (see Appendix P). We will continue to engage with all DNOs throughout the Project to refine scope and feedback learning.

Other WPD Projects

A number of WPD's projects complement REVISE and the learning generated during these projects will be built upon over the course of the Project and taken further as outlined in the Learning Objectives in Section 2. Figure 5-1 indicates this commonality with previous LCNF Tier 2 and NIC funded projects we've previously delivered. The key objective of REVISE is to significantly expand the learning on network management of the 33kV network in addition to a contribution towards new standards/methodologies as well as novel protection schemes; the latter has not been explored by other Projects to date.

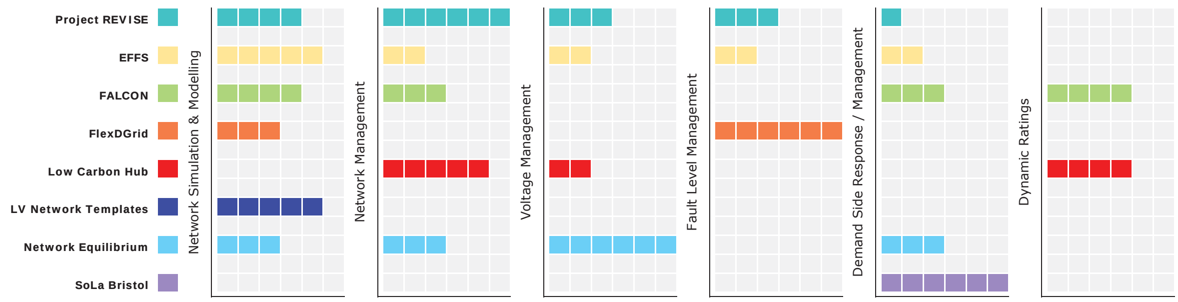


Figure 5-1 – Past WPD Innovation Projects

5.2 Learning dissemination

Methodology for Knowledge Capture

Successful knowledge capture and dissemination is key to the success of REVISE and requires a robust methodology to capture the learning outcomes of the Project. As we will generate a significant amount of learning through the delivery of the three innovative Methods, our Project Plan includes a dedicated Knowledge Capture and Dissemination deliverable.

We will focus our learning dissemination around three key media as detailed in Figure 5-2.

Figure 5-2 – Learning dissemination medium

Learning will be disseminated at regular intervals during the course of the Project. We recognise that sharing information frequently will allow us to receive feedback in a timely manner to allow this to be incorporated as the Project progresses. Our past experience of delivering innovation projects has shown that sharing information with key stakeholders throughout the course of the Project provides a very effective way of achieving high levels of engagement. Figure 5-3 shows how we plan to share learning at each key milestone to ensure that stakeholders benefit from the knowledge generated. At specific milestones we will ask for feedback from the stakeholders which will be used to assist in the delivery of the next milestone and help shape future learning.

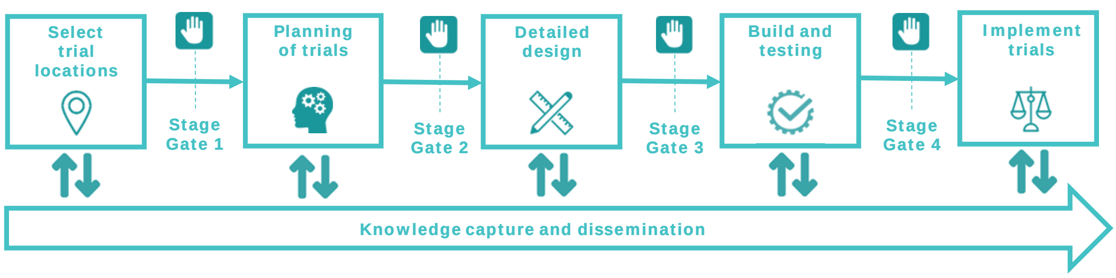


Figure 5-3 – Knowledge capture process

It is anticipated that the learning captured at each of the stages as indicated in Figure 5-3 will form not only part of Deliverable 8 as outlined in Section 9 but it will be used in the final Project report.

5.3 IPR

REVISE conforms to the default IPR requirements set out in the Electricity Network Innovation Competition Governance Document v.3.0.

Section 6: Project Readiness

6.1 Evidence of why the Project can start in a timely manner

REVISE is ready to commence following the thorough preparation and planning which has been undertaken as part of this FSP. The delivery plan for the Project has been prepared with input from a number of stakeholders and we are eager to demonstrate the benefits the Project can deliver in a timely manner.

Our commitment to deliver REVISE can be evidenced based on the following:

- WPD Senior Management Team, the Future Networks Team and Primary System Design Team have all been engaged in the preparation of the FSP and are committed to the successful delivery of this Project
- We have a successful track record of delivering high value, high profile, large innovation funded Projects
- An experienced delivery team have been identified and are ready to be deployed to deliver the Project
- We have taken learning from previous LCNF, NIA and NIC projects and used this within the methodology for REVISE
- We have received a positive response to the RFI from interested parties
- Stakeholders have expressed support for the Project
- Clearly defined Project Methods have been prepared and are ready to undergo detailed design, implementation and trials. The combined functionalities and expected results from these Methods have also been well-defined
- Trial areas which would see a significant benefit have been identified
- The Project has been designed to ensure repeatability across a number of sites to maximise Project learning
- A detailed Project delivery plan, scope of works, risk register, organisational chart with well-defined Project roles have all been prepared as part of this FSP

These points are further described in the following sections:

Support from WPD Senior Management and Engineering Teams

WPD's Senior Management Team have been engaged in REVISE from concept and recognise the benefits it will deliver and how it is aligned with the key messages in our Innovation and DSO strategies. Having successfully delivered previous NIA, NIC and LCNF projects they are committed to providing the correct level of resource and understand the timescales involved to ensure that REVISE fulfils its potential. In addition, the directors of WPD's parent company, Pennsylvania Power and Light (PPL), have been briefed on the drivers, benefits and scope of the Project.

Successful track record with NIC and LCNF funded Projects

WPD has successfully delivered and closed out a number of successful Tier-2 LCNF funded projects similar in scale to REVISE. The valuable experience gained through the delivery of these Projects, and others, has been used to inform the methodology for REVISE. The Projects detailed in Table 6-1 are similar to REVISE in that they trialled new methodologies and technologies and have either been successfully delivered or are on track to achieve their objectives.

Table 6-1 – WPD Projects trialling new methodologies and technologies

Project	Description
Lincolnshire Low Carbon Hub	This £3.5m Project was successfully completed in 2015 and demonstrated a variety of new and innovative techniques for integrating significant amounts of low carbon generation on to electricity distribution networks including the installation of a 33kV Statcom.
FlexDGrid	This Project trialled new methodologies to improve understanding of fault levels on the HV network in Birmingham and released significant levels of fault level capacity through the use of innovative technologies. The £17.5m Project was completed in 2017 and included the integration of fault level monitors and fault level mitigation devices at a number of substations in and around Birmingham.
Network Equilibrium	Currently in the final year of delivery, this £10m Project in the South West of England focuses on achieving balanced power flows and voltages across the distribution network through the integration of new technologies and software tools.

Successful management

The specific Project examples mentioned above demonstrate that we are capable of managing large multi-disciplinary teams of experts from a number of backgrounds including internal staff, consultants, manufacturers, suppliers and contractors. The successful delivery of the Projects requires a clear communication and management structure that will be adopted for REVISE as indicated in Figure 6-1.

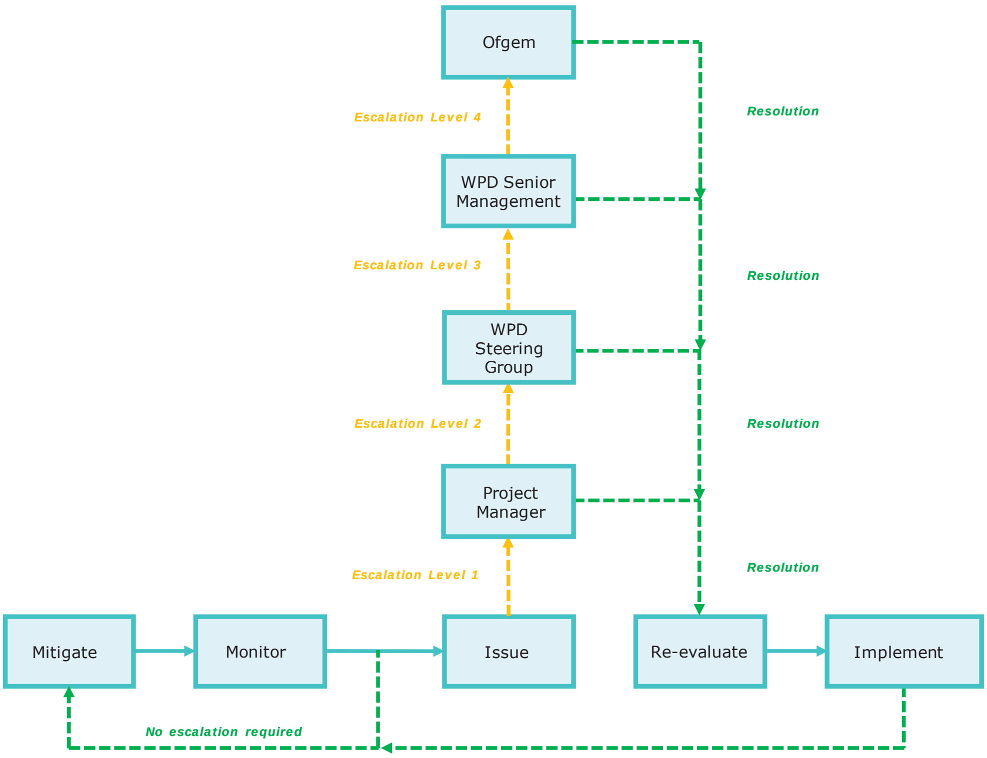


Figure 6-1 – WPD Escalation Procedure

The Project and the wide ranging benefits that it seeks to provide has been discussed extensively throughout this submission process and the required internal and external resources to support the successful delivery of the Project have been identified as indicated in the organogram in Figure 6-2.

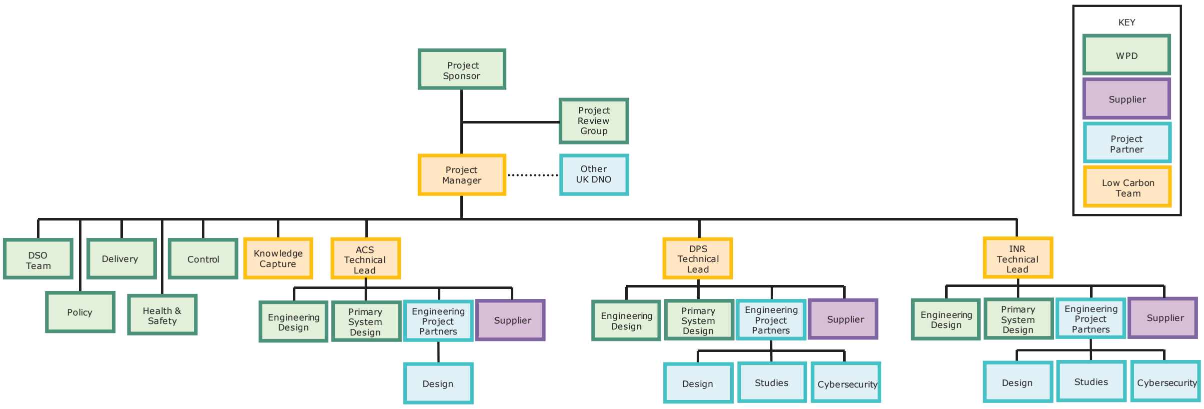


Figure 6-2 – REVISE Organogram

We will use key members of staff who have previously taken up strategic delivery roles in previous LCNF, NIA and NIC Projects to ensure a smooth transition from the bid stage to implementation. The Project will see integration across a number of different departments in WPD as well as manufacturers, contractors and consultants. Figure 6-3 below shows a high level Responsible, Accountable, Consulted and Informed (RACI) matrix for REVISE.

		WPD Project Manager	WPD Technical Lead	Primary System Design	Engineering Design	Engineering Project Partners	ACS Supplier	DPS Supplier	INR Supplier
Project Execution	Select Trial Locations	A	R	C		R			
	Plan Trials	A	R			R			
	Detailed Design	A	RC	CI	CI	RC	RA	RA	RA
	Method Build	RA	R		RCI		RA	RA	RA
	Method Testing	RA	R		CI		RA	RA	RA
	Implement Trials	A	R			R			
	Knowledge Capture	RA	RI	C	C	R	I	I	I
	Knowledge Dissemination	RA	C			C	I	I	I
Project Management	Risk Management Meetings	RA	R			RI			
	Action Management Meetings	RA	R			RI			
	Design Meetings	RA	R		RI	RI			
	Steering Group Meetings	RA	I						

R Responsible
A Accountable
C Consulted
I Informed

Figure 6-3 – RACI matrix for REVISE

We have appointed a Project Review Group from selected representatives and will also invite Project collaborators (if funding is awarded) to ensure that the Project is on track to deliver against its targets and objectives.

Creating and building learning

Learning from REVISE will build upon previous Tier 2 LCNF and NIA and NIC Projects. The Project will also generate a significant amount of new learning through all three Methods as we trial new methodologies and technologies surrounding network management, protection systems and control techniques. Figure 6-4 below provides an overview of the learning areas that REVISE will generate.

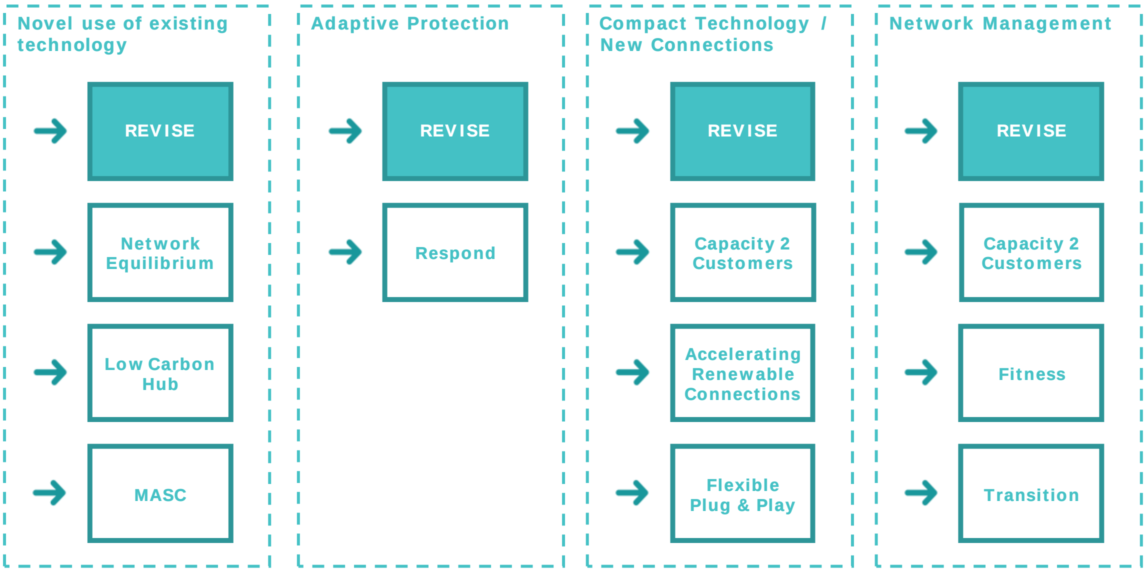


Figure 6-4 – Overview of learning from REVISE

Expressions from interested parties

WPD will operate an open and competitive tendering process for the procurement of equipment and services for REVISE.

As part of our preliminary investigation, we have compiled and circulated an RFI which received significant interest from manufacturers. Based on the information gathered to date and the reputable companies that have expressed interest, we believe that there is sufficient time to design, develop, trial and implement all three proposed Project Methods.

Clearly defined Project Methods

The Methods that have been explored for this Project are as a result of observations of the outcomes of past innovation projects and the understanding of what the future network requires and the Methods bridge the gap between what is required and the current network operation. The Methods have been designed to complement each other but also deliver their tangible benefits when implemented individually.

Trial flexibility

The trials have been designed to align with our innovation strategy and with sufficient flexibility to allow for changes which could occur throughout the Project e.g. sites becoming unavailable, changes in the uptake of DG and feedback from stakeholders through our regular dissemination activities.

Project Delivery Plan

A detailed Project delivery plan can be found in the Appendix C. This has been created taking into account the availability of Project teams and the works to be completed. A clear scope of works has been refined over the course of this submission to ensure that the Project achieves its aims and objectives.

6.2 Evidence of the measures a Network Licensee will employ to minimise the possibility of cost overruns or shortfalls in Direct Benefits

Understanding and managing risks

The preparatory work for REVISE included investigation of the risks associated with a project of this scale and the outcome of this was captured in the Risk, Assumptions, Issues and Dependencies (RAID) log in Appendix F. The RAID log details a number of areas where risks were identified in relation to the possibility of cost overruns and shortfalls in Direct Benefits and suitable measures were captured to address these. The list below highlights the key risks for these areas along with the approach and measures considered to mitigate the risk:

1. **Project Costs** - The Project costs have been calculated using a bottom-up and top-down methodology. To prepare this cost estimate the Project was broken down into its component parts to understand the extent of what is to be achieved and the associated costs for each part. Costs for each part have been built up using experience gained through the delivery of a wide range of different innovation and BAU Projects.
2. **Methods** - The Project has been broken down into three distinct Methods with clearly defined aims and objectives. We have identified where the Methods interface and we have defined clear targets for the desired demonstration and outcomes. Although the Methods interface with each other, they can be delivered independently and still provide significant learning outcomes.
3. **Design** - Uncertainty in design shall be reduced at an early stage by following a detailed design process which will include liaison with internal teams and stakeholders. The designs will follow standard WPD policy and will follow our internal approval process to ensure that designs are fully checked before issuing. New equipment will be put through our approval process with and will be proceeded by thorough lab testing. Each Method will have a staggered implementation, trial and evaluation phase to reduce risk and promote learning at each stage.
4. **Tendering** – There will be a requirement for a number of different tenders during the Project including those for new equipment, site installation work and other third party services. A competitive tendering structure has been put in place to ensure that WPD secures these services for the best possible price without compromising on quality and safety.
5. **Governance** – We have a strong track record of delivering Projects on time and within budget which has been demonstrated over the course of a number of Projects. This has been achieved through strong governance detailed within our policies and standards and is inherent throughout the Project lifecycle. Project tolerances and Key Performance Indicators (KPIs) are also monitored by WPD's senior management team on a regular basis through Project reviews and monthly reporting.

The RAID log developed during the FSP stage will be updated throughout the project to ensure that the risks are known and have suitable mitigation measures. Risks will be assigned an owner based on the risk rating and the suitability of the individual to manage the risk. New assumptions, issues and dependencies will also be captured as the Project progresses. The RAID log will regularly be reviewed and a suitable contingency plan will be in plan at all times. The RAID log developed during the FSP can be found in Appendix F.

Estimating benefits

The benefits from REVISE have been calculated based on the most recent financial and technical data available. The benefits that the Project will bring have been estimated in the following ways:

1. **Financial** – The financial benefit has been estimated based on the comparison between current best practice and the proposed Project Methods using the latest Unit Costs and methodologies.
2. **Capacity Release** – Capacity released has been calculated using the methodology in Appendix K which compares the current network with the network after implementation of the Project Methods.
3. **Network Flexibility** – The enhanced flexibility of the network is measured in terms of increase in generator availability by comparison of the same network area prior to Project implementation.
4. **Carbon Emissions** – The reduction in carbon emissions has been calculated by comparing the additional CO_2 that would be generated from the current UK energy mix when renewable generation is slower to connect due to traditional reinforcement works or not available due to a network configuration/outage.

The Methods explored in this Project are designed such that they can be rolled-out across GB, however, in the event that DG uptake does not follow the forecasts detailed within the business case, the Project will still bring benefits and offer a more attractive financial and technical Solution compared with current practices. This has been determined through sensitivity analysis whereby different roll-out scenarios have been studied to understand the effects on the Project benefits.

In fact, the business case in Appendix I shows that the Project will still deliver value for money in 2030 when deployed solely for the trial area.

Table 6-2 – REVISE benefits for Trial Area in 2030

Area	£k savings	MVA capacity	CO_2 savings (tonnes)
Trial Network	965	83.5	6,593

The trial area locations have been specifically selected from areas of the West Midlands where the network is complex in nature. We have taken this approach to ensure that the Methods are developed for the most onerous network conditions. Once the Methods have been developed, implementation of REVISE on other 33kV networks is likely to result in even greater benefits than those released from the trial areas.

To ensure that the business case is still valid, throughout the Project we will monitor the factors that influence the Project benefits to check that they do not differ substantially from those within this FSP. Should these factors change during the course of the Project we will re-evaluate the calculations to verify that the Methods are still providing a suitable benefit and will take action if this is not the case.

6.3 A verification of all information included in the proposal (the processes a Network Licensee has in place to ensure the accuracy of information can be detailed in the appendices)

The information used to produce the FSP and define the business case for REVISE has come from reputable internal and external sources which have been referenced. We have used information from BAU activities and procedures along with information gathered from RFIs to produce the FSP and the appendices that support it.

The latest industry statistics and information have been used to ensure that the business case is current and robust. The sources of information include, but are not limited to:

1. **WPD** – Our "Innovation Strategy", "Shaping Subtransmission to 2030" and "Distribution System Operability Framework" have been the key facilitators for developing the business case for the Project. We have used internal resources to obtain the latest technical and financial information from all our licence areas to develop the detailed methodologies for each of the Methods.
2. **DNOs** – The latest network data from the 2017 Long Term Development Statements (LTDS) has been used to define the need case and roll-out scenarios. We have also investigated the learning from previous innovation projects and used this when developing the methodologies for REVISE.
3. **National Grid** – "Future Energy Scenarios" gives an overview of the future energy landscape and the subsequent impact that the distribution network will see as a result of the changes on both the transmission network and distribution network. This has been used to assist with developing the need case and roll-out across GB.
4. **ENA** – The "Electricity Network Innovation Strategy" is a joint strategy which has been developed by GB DNOs and National Grid. It details a number of innovation themes regarding the necessary changes that need to happen on the network going forward and this has been used to verify the need case for REVISE.
5. **Independent bodies** – The Inventory of Carbon and Energy have a database of embodied energy and embodied carbon footprint factors which have been used for the calculation of carbon savings.
6. **Government bodies** – Department for Business, Energy and Industrial Strategy have provided reports on The Carbon Plan now The Clean Growth Strategy.
7. **Ofgem** – The Smart Systems and Flexibility Plan has been used to understand to what extent this Project will enable the overcoming of barriers to smart technologies and enable smart homes and businesses.

Developing the Project around the information demonstrates that REVISE is well aligned with current agreed strategies and forecasts in relation to an evolving network.

6.4 How the Project plan would still deliver learning in the event that the take up of low carbon technologies and renewable energy in the Trial area is lower than anticipated in the Full Submission

The REVISE trial does not have a reliance on new LCT and renewable energy connections as the Methods can be rolled-out to existing assets on the network. As part of the FSP we have identified a number of trial areas with existing DG and network characteristics that are suitable for the Method roll-outs.

All of the industry forecasts predict significant increases in DG and LCT growth even in the most conservative scenarios; however, should lower than anticipated growth occur, REVISE will still contribute valuable learning for the GB customer. This learning is summarised as follows:

- **Digital Substation** – The Advanced Connection Solution Method will trial the latest technology in relation to small scale substation control systems, protective devices, sensors and communication equipment. Although this technology is primarily being trialled for DG it will also offer important benefits for large demand customers. In addition, as the distribution network moves towards operating as a DSO, these developments will play a key role in shaping the network of the future.

- **Protection Systems** – The Dynamic Protection System Method will investigate and trial the latest equipment which can be used to protect a network that is constantly adapting to its surroundings. The new equipment shall be compact and intelligent with the ability to seamlessly integrate with other equipment of varying types. The new protection systems will provide a step forward in the development of a condensed alternative to the multiple relay Solution normally required by DNOs and a customers.
- **Network Management** – The Intelligent Network Reconfiguration Method seeks to trial a new control system which will ensure that the network is operating in its most efficient state based on real time information. This intelligent control of the network directly links with the strategy of developing a "Smart, Flexible Energy System".
- **Cybersecurity** – The implementation of the Methods will also involve investigating and implementing the latest tools and technology to achieve robust and secure communication infrastructure for the transfer of sensitive information. The communication infrastructure will be designed to accommodate the volumes of data required for the transition to DSO whilst providing a high level of security to prohibit unauthorised access.

The learning from the above areas will be communicated through our Research and Dissemination Method which will engage with DNOs and other stakeholders. This will allow interested parties to benefit from the learning of REVISE and incorporate into their own projects.

6.5 The processes in place to identify circumstances where the most appropriate course of action will be to suspend the Project, pending permission from Ofgem that it can be halted

WPD processes are in place to highlight events or circumstances where the most appropriate course of action would be to suspend the Project providing Ofgem are in agreement. Our Project Manager will be responsible for ensuring that the KPIs are on target and the Project risks are captured with suitable mitigation measures in place. Figure 6-5 below details how our regular reporting process will identify if a risk develops into an issue. If the issue cannot be addressed through the resolution plan WPD Senior Management will be informed to take a decision on the best course of action.

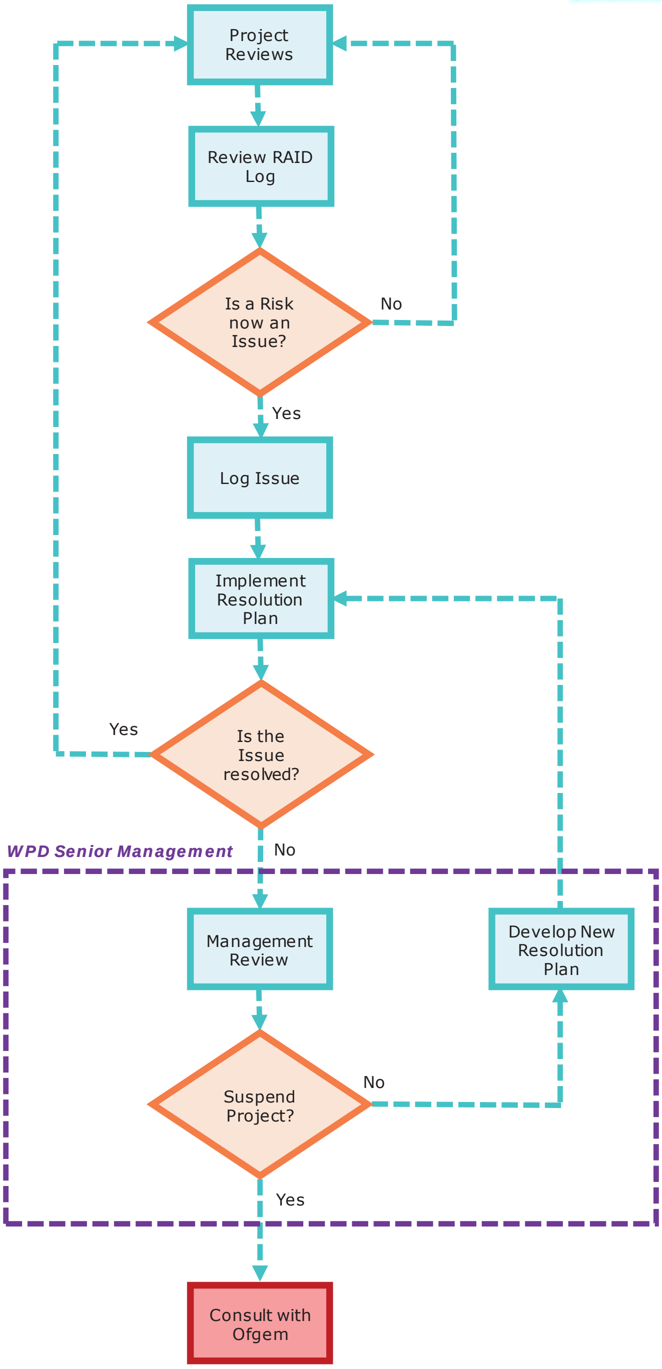


Figure 6-5 – WPD process for managing risks

Section 7: Regulatory issues

We understand that whilst REVISE is an innovation Project where new technology and methodologies will be tested on the 33kV network, WPD are still subject to the standard regulatory requirements.

REVISE will rigidly remain within Ofgem NIC governance and industry regulations for the Advanced Connection Solution Method, Dynamic Protection System Method and the Intelligent Network Reconfiguration Method. Most importantly we aim that no network will be operated outside of statutory limits during or after the Project trials.

The REVISE team will liaise with the Operational Teams from the beginning of the Project to understand the timescales for planned maintenance and to what extent necessary Project installations can be implemented during these outages. This will enable WPD to notify Ofgem of any possible exemptions due to additional outages.

7.1 Derogations

No derogations have been identified by REVISE.

7.2 Licence Consents

No license consents have been identified by REVISE.

7.3 Licence Exemptions

No license exemptions have been identified by REVISE.

7.4 Changes to Regulatory Arrangements

No changes to regulatory arrangements have been identified by REVISE.

Section 8: Customer Impact

8.1 The Project

Through the implementation of the three Methods, REVISE will significantly enhance system flexibility and release capacity on the distribution network. The main objective is to maximise the connection of DG whilst delivering value for money to new and existing customers. New technologies and methodologies will supplement current practices and procedures to provide an altogether more resilient, future-ready network.

Existing customers will benefit from a more resilient network and new customers will benefit from faster connection times and greater availability. All system users will benefit from an optimised system where financial benefits will be passed on through the operation of a more efficient network.

With the lasting and positive impacts that this Project will deliver, WPD anticipated that the benefits far outweigh the adverse impacts as demonstrated in Figure 8-1.

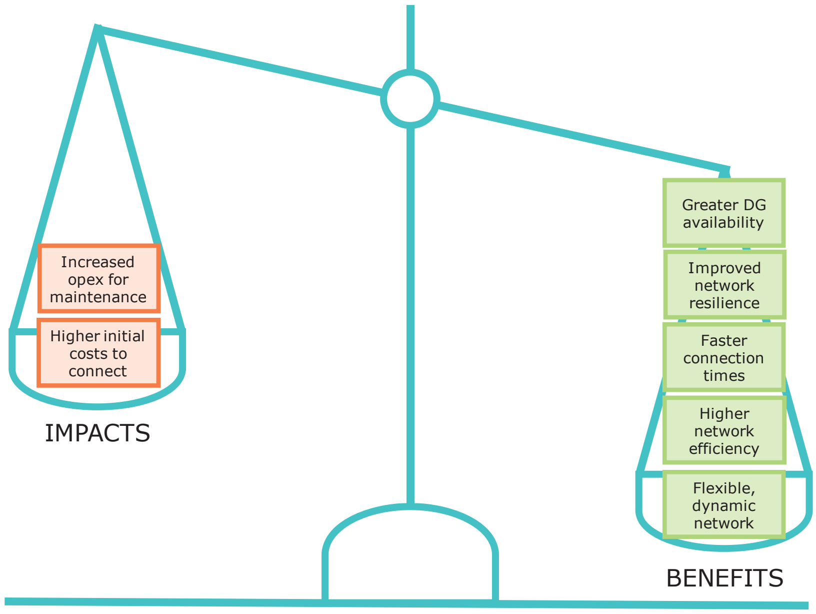


Figure 8-1 – The Benefits and Impacts of REVISE

WPD's internal policies will be applied to REVISE to ensure that operation and safety of the network is not compromised as a result of the Project and the impact on customers is mitigated. During REVISE we do not intend to deviate from statutory requirements. WPD will make every effort to eliminate network risks and it is not envisaged that REVISE will have any direct impacts on customers in terms of new charging mechanisms and contractual arrangements within the lifetime of the Project. We will aim to organise activities that involve network outages to align with planned maintenance to mitigate the impact on customers.

8.2 Customer Impact Mitigation Plan

REVISE will provide a substantial step forward in terms of system flexibility and distribution network optimisation. Together the Methods will provide significant learning in order to develop the network of the future and supplement existing practices.

Where system outages will be required to install new equipment, WPD will actively seek to combine this with planned maintenance activities to minimise customer impact. A comprehensive overarching Project mitigation plan will be devised to ensure that the

Project is not only delivered in a timely manner but equipment is rigorously tested offline prior to installation at site. Site installations will then be arranged sequentially as indicated in Figure 8-2 to mitigate the risk of compromising the integrity of the network. Each installation will be proceeded by an evaluation period of the previous installation to validate the performance of the Methods against the expected outcomes. It is anticipated that the evaluation period required will decrease with each installation.

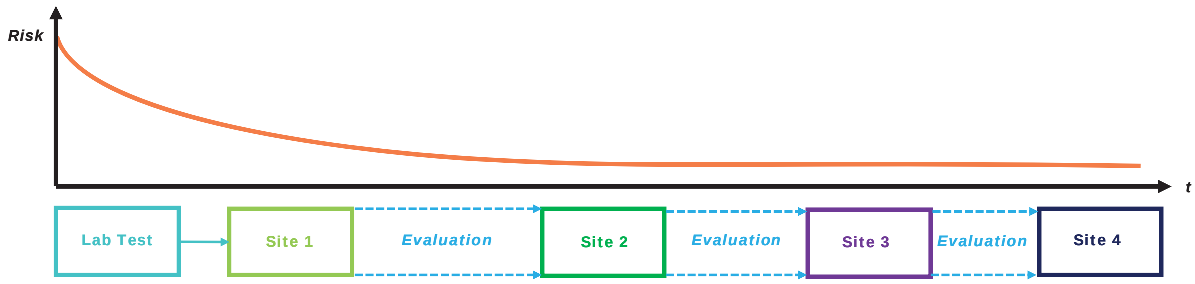


Figure 8-2 – Risk decreasing with testing and each site installation

The Project Methods and Customer Impact

WPD recognises that REVISE poses risks to the network which could impact customers however a risk mitigation plan will be carried out for each Method installation to minimise risk of unplanned supply interruptions. In the event of supply interruptions, WPD will follow standard procedures to expediently restore customers' supplies.

Circuit outages are frequently planned in order to undertake construction, asset replacement and new connection activities on the 33kV networks. REVISE will require a number of network outages for the installation of new equipment on site and all networks have a dedicated mitigation plan in place to ensure minimal impact on customers in the event of a fault occurring on the network whilst these activities are ongoing.

8.3 Advanced Connection Solution

The ACS is a novel pre-assembled and pre-commissioned device. In the event of a failure on the ACS, the network can be configured to ensure that customer connections on the 33kV network are maintained. The ACS will substantially improve network resilience to faults in that it will provide a Method to swiftly divert customer demand on the network in the event of a fault.

The ACS will be the first of its kind on the distribution network and so a comprehensive Factory Acceptance Testing (FAT) schedule shall be agreed with relevant stakeholders and manufacturers prior to testing. WPD internal teams shall be consulted as part of this process to ensure that testing covers all necessary aspects relating to safety, operation and performance.

Circuit outages are expected for the ACS installation however WPD's normal process for network modifications and maintenance shall be adhered to, to minimise the impact on customers. Studies have already been carried out at a number of sites to confirm that sufficient space is available and that the installations will not have any adverse effects on the surrounding network.

8.4 The Dynamic Protection System

When the network is rearranged and reconfigured, the systems protecting network components require updating. The DPS Method is designed to further improve existing protection schemes.

The DPS will be trialling new technology in place of existing relay technology. This Method will be tested offline and integrated using a suitable network integration methodology to minimise risk of failure and detrimental impacts on customers. We will ensure that customers are not impacted as this Method is installed and trialled.

8.5 Intelligent Network Reconfiguration

The INR Method will be a revolutionary control system as it will automatically optimise the configuration on the 33kV network to maximise the available generation and connected customers whilst adhering to security of supply standards. It will unlock capacity to connect additional DG and LCTs which otherwise would not have been able to readily connect.

The INR Method will see the implementation of new control philosophies which will be tested offline using a suitable replica network.

8.6 Engagement with Customers

WPD will engage with generation and demand customers as part of our wider stakeholder engagement. With regard to the purchase of new land or changes to installations on land owners' premises, we will utilise our internal Wayleaves Officers and ensure that existing policies and procedures are adhered to.

8.7 Protection from Incentive Penalties

REVISE will require no protection from incentive penalties.

Reference	Project Deliverable	Deadline	Evidence	NIC funding request
D1	**Specific:** Confirmation of Trial Area(s) and Detailed Methodology **Measurable:** The delivery of a report with the following sections for each Method: i. Trial Area Selection ii. Application of the Trial Methodology The report will use the following sections as detailed in the FSP: iii. Benefit Assessment iv. Capacity Release Calculation **Achievable:** Preliminary work undertaken as part of the FSP production will be used to inform this report. Time has been allocated at the start of the Project for this task. **Relevant:** A suitable trial area (complex in nature) will be selected to facilitate effective replication by other DNOs for BAU roll-out. Confirmation of the trial areas and detailing the methodology will allow us to calculate the expected benefits for that particular trial area. The results from this report can then be used to determine the success of the trials once implemented. **Time-bounded:** The report for deliverable D1 will be submitted 9 months after Project kick-off.	20 Sept 19	i. Report detailing the BSPs, circuits and trial areas selected ii. Methodology outlining the trials and the sites selected for each Method iii. Methodology detailing the trials for sites where multiple Project Methods interface iv. Benefit assessment for the trial areas selected v. Capacity Release Calculation for the trial areas selected	5%
D2	**Specific:** Detailed Design of the Advanced Connection Solution Method **Measurable:** Delivery of a report on the detailed design of the Advanced Connection Solution Method. The report will contain sections or appendices entitled: i. ACS technical specification ii. Operational philosophy iii. Network integration design iv. Sample ACS detailed designs v. Lessons and outcomes **Achievable:** The concept for the ACS was studied during the FSP and several manufacturers have responded positively to the RFI.	20 Dec 19	i. Production of a technical specification ii. Production of an operational philosophy iii. Production of network integration designs iv. Capture key learning outcomes and disseminate to key audiences	4%

	Outputs from D1 will be used as a basis to develop the integration designs for the ACS. **Relevant:** This deliverable corresponds to the delivery of the ACS Method. **Time-bounded:** The report for deliverable D2 will be submitted to Ofgem at the end of the ACS design phase.			
D3	**Specific:** Trialling and Demonstrating the ACS Method **Measurable:** Delivery of a report on the trialling and demonstration of the Advanced Connection Solution Method. The report will contain sections or appendices entitled: i. Testing and Performance ii. Learning outcomes from installation and commissioning iii. Guide for implementation of the ACS Method iv. Standards and Policies v. Assessment of the benefits **Achievable:** Completion of Deliverable D2 will provide significant input for Deliverable D3. Learning from previous projects can be used to inform the trials. **Relevant:** This deliverable corresponds to the delivery of the ACS Method. **Time-bounded:** The report for deliverable D3 will be submitted to Ofgem at the end of the ACS trials phase.	21 Jan 22	i. Installation and commissioning of 5 no. ACS ii. Guide to the implementation of the ACS Method iii. Sharing of standards and policies with other DNOs iv. Capture key learning outcomes and disseminate to key audiences v. Comparison of the expected benefits of Project trials against the demonstration results	19%
D4	**Specific:** Detailed Design of the DPS Method **Measurable:** Delivery of a report on the detailed design of the DPS Method. The report will contain sections or appendices entitled: i. Limitations of traditional equipment ii. Description of the DPS technology and architecture iii. DPS technical specification iv. DPS sample detailed designs v. DPS network integration designs vi. Lessons and outcomes **Achievable:** Analysis of the 33kV network has been conducted in parallel to the production of the FSP submission. Outputs from D1 will confirm the locations where DPS will be implemented. **Relevant:** This deliverable corresponds to the delivery of the DPS Method.	06 Mar 20	i. Production of a technical specification ii. Production of standard protection and control designs iii. Production of network integration designs iv. Capture key learning outcomes and disseminate to key audiences	9%

	Time-bound: The report for deliverable D4 will be submitted to Ofgem at the end of the DPS design phase.			
D5	**Specific:** Installation and Trialling the DPS Method **Measurable:** Delivery of a report on the installation and trialling of the DPS Method. The report will contain sections or appendices entitled: i. Testing and Performance ii. Learning outcomes from installation and commissioning iii. Guide for implementation of the DPS Method iv. Standards and Policies v. Assessment of the benefits **Achievable:** Completion of Deliverable D4 will provide significant input for Deliverable D5. Learning from previous Projects can be used to inform the trials. **Relevant:** This deliverable corresponds to the delivery of the DPS Method. **Time-bounded:** The report for deliverable D5 will be submitted to Ofgem at the end of the DPS trials phase.	28 Oct 22	i. Installation and commissioning of DPS in the trial area ii. Guide to the implementation of the DPS Method iii. Sharing of standards and policies with other DNOs iv. Capture key learning outcomes and disseminate to key audiences v. Comparison of the expected benefits of Project trials against the demonstration results	23%
D6	**Specific:** Detailed Design of the INR Method **Measurable:** Delivery of a report on the detailed design of the INR Method. The report will contain sections or appendices entitled: i. INR operational and technical specification ii. Security of supply & failsafe mechanisms iii. INR algorithm design and consideration iv. Data Security and Resilience v. Lessons and outcomes **Achievable:** Analysis of the 33kV network has been conducted in parallel to the production of the FSP submission. Outputs from D1 will confirm the locations where INR will be implemented. **Relevant:** This deliverable corresponds to the delivery of the INR Method. **Time-bounded:** The report for deliverable D6 will be submitted to Ofgem at the end of the INR design phase.	17 Apr 20	i. Production of an operational and technical specification ii. Assessment of security of supply and Methods to achieve fail-safe design iii. Description of INR design requirements iv. Requirements for ensuring data security and high resilience v. Outline design demonstrating how INR will be integrated vi. Capture key learning outcomes and disseminate to key audiences	10%

D7	**Specific:** Installation and Trialling the INR Method **Measurable:** Delivery of a report on the installation and trialling of the INR Method. The report will contain sections or appendices entitled: i. Testing and Performance ii. Guide for implementation of the INR Method iii. Learning outcomes from installation and commissioning iv. Standards and Policies v. Assessment of the benefits **Achievable:** Previous experience and learning from other projects using control systems can be used to facilitate the implementation of the INR Method. A robust design process will have been carried out in D6 which will enable a smooth transition into implementation. **Relevant:** This deliverable corresponds to the delivery of the INR Method. **Time-bounded:** The report for deliverable D7 will be submitted to Ofgem at the end of the INR trials phase.	07 Oct 22	i. Installation and commissioning of INR in the trial area ii. Guide to the implementation of the INR Method iii. Sharing of standards and policies with other DNOs iv. Capture key learning outcomes and disseminate to key audiences v. Comparison of the expected benefits of Project trials against the demonstration results	23%
D8	**Specific:** Knowledge capture and dissemination **Measurable:** Delivery of a report to summarise the knowledge generated, learning from the Project and dissemination activities for REVISE against the targets set out during preliminary FSP investigations The report will contain sections or appendices entitled: i. Collation of the Testing and Performance data across all three Project Methods ii. Learning outcomes from installation and commissioning of all three Project Methods, individually and combined iii. Guide for Details of knowledge and learning dissemination reports and presentations (Including links to publicly available documents) iv. Details of REVISE Data available as per WPD's data sharing policy v. Details of REVISE Project presentations (Including links to publicly available presentations). vi. Detailed Roll-out plan for WPD	31 Mar 23	i. Knowledge and learning dissemination reports, presentations, webinars, DNO workshops, DG and stakeholder workshops ii. A report detailing the contribution of each of the Project Methods to the five themes outlined in the Electricity Networks Innovation Strategy iii. Network data being made available for each of REVISE's Methods iv. REVISE Project presentations delivered at eight industry conferences during the course of the Project	7%

	Achievable: Time and resource has been allocated for these activities to ensure that knowledge and learning generated by REVISE is captured in a robust way. **Relevant:** This deliverable will robustly summarise all the knowledge and learning that has been captured throughout the project lifecycle for REVISE. **Time-bounded:** The report for deliverable D8 will be submitted to Ofgem after the trials phase when all other deliverables have been submitted.		v. Production of a roll-out plan detailing how the three Methods can be combined and how they should be implemented across WPD and GB.	
Common NIC Deliverable				
N/A	Comply with knowledge transfer requirements of the Governance Document.	End of Project	1. Annual Project Progress Reports which comply with the requirements of the Governance Document. 2. Completed Close Down Report which complies with the requirements of the Governance Document. 3. Evidence of attendance and participation in the Annual Conference as described in the Governance Document.	N/A

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Appendix A Project Benefits Table

A.1 REVISE – Financial Benefits

Cumulative Net Financial Benefit (NPV terms)

Scale	Method	Method Cost (£m)	Base Case Costs (£m)	2030 (£m)	2040 (£m)	2050 (£m)	Notes	Cross References
Post-trial Solution (individual deployment)	ACS	1.487	6.773	-0.010	1.007	1.759	**Full details of the Financial Benefit Calculation can be found in App. H & K** The Base Case and Method costs presented here are the sum of the costs over the lifetime of the Method (40 year period or up to year 2058). The DPS Base Case cost is zero as there is no comparable Base Case. The Method costs for INR include the cost for the first post-trial installation (£2.03m) and the cost for subsequent installations which is lower (£0.51m). The individual deployment is for a single Method installation post-trial. 5 ACS units, 2 INR units and 10 DPS units.	Appendix H & K (pages 69 & 73 respectively)
	DPS	1.681	0.000	-1.215	-1.251	-1.277		
	INR	1.176	4.031	2.189	2.221	2.244		
	Total	**4.344**	**10.804**	**0.965**	**1.977**	**2.726**		
Licensee Roll-out Scale (if applicable, indicate the number of relevant sites on the Licensees' network)	ACS	57.527	214.821	-7.646	15.314	40.139	**Full details of the Financial Benefit Calculation can be found in App. H & K** The values presented here are for the medium roll-out projection. This translates to following number of Method roll-outs: 2030 - 23 ACS, 11 DPS, 11 INR 2040 - 33 ACS, 21 DPS, 21 INR 2050 - 43 ACS, 31 DPS, 31 INR The Method costs for INR assume that the system has already been enabled in the WPD area and therefore the Capex cost is £1.02m per roll-out. The Method Capex costs has been set to decrease over time due to technology maturity and volume of roll-out.	Appendix H & K (pages 69 & 73 respectively)
	DPS	48.158	0.000	-12.012	-20.187	-26.501		
	INR	33.702	121.274	22.001	37.404	49.027		
	Total	**139.387**	**336.095**	**2.342**	**32.530**	**62.665**		
GB Roll-out Scale (If applicable, indicate the number of relevant sites on the GB network)	ACS	151.424	551.358	-19.314	33.311	97.263	**Full details of the Financial Benefit Calculation can be found in App. H & K** The values presented here are for the medium roll-out projection. This translates to following number of Method roll-outs: 2030 - 52 ACS, 40 DPS, 40 INR 2040 - 85 ACS, 92 DPS, 92 INR 2050 - 115 ACS, 142 DPS, 142 INR The Method costs for INR include the Capex cost for enabling INR (£2.03m) at each DNO (£2.03m) and the Capex cost for each subsequent Method roll-out of INR (£1.02m). The Method Capex costs has been set to decrease over time due to technology maturity and volume of roll-out.	Appendix H & K (pages 69 & 73 respectively)
	DPS	218.443	0.000	-41.884	-84.056	-115.280		
	INR	163.030	553.865	74.831	151.369	209.183		
	Total	**532.896**	**1,105.222**	**13.633**	**100.624**	**191.166**		

A.2 REVISE – Carbon Benefits

Cumulative Carbon Benefit

Scale	Method	Method Cost (£m)	Base Case Costs (£m)	2030 (tCO2e)	2040 (tCO2e)	2050 (tCO2e)	Notes	Cross References
Post-trial Solution (individual deployment)	ACS	1.487	6.773	3,051.3	7,480.1	11,909.0	**Full details of the Carbon Benefit Calculation can be found in App. H & K** The carbon benefit from the ACS Method factors in the embodied carbon of manufacturing the unit as well as transportation, operation and maintenance. The DPS net carbon benefit is zero as the same amount of carbon would be produced for equivalent relays installed for the exsiting schemes. The INR Method embodied carbon is assumed to be negligible compared to the Base Case embodied carbon due to it being a software based Method. The cumulative Method roll-out numbers are the same as the respective roll-out scale in the financial benefit table.	Appendix H & K (pages 69 & 73 respectively)
	DPS	1.681	0.000	0.0	0.0	0.0		
	INR	1.176	4.031	3,541.7	3,541.7	3,541.7		
	Total	**4.344**	**10.804**	**6,593**	**11,022**	**15,451**		
Licensee Roll-out Scale (if applicable, indicate the number of relevant sites on the Licensees' network)	ACS	57.527	214.821	38,734.5	164,467.9	334,489.9	See above comments for Post-trial Solution	Appendix H & K (pages 69 & 73 respectively)
	DPS	48.158	0.000	0.0	0.0	0.0		
	INR	33.702	121.274	38,958.8	74,375.9	109,793.0		
	Total	**139.387**	**336.095**	**77,693**	**238,844**	**444,283**		
GB Roll-out Scale (If applicable, indicate the number of relevant sites on the GB network)	ACS	151.424	551.358	77,618.4	392,667.7	840,729.7	See above comments for Post-trial Solution	Appendix H & K (pages 69 & 73 respectively)
	DPS	218.443	0.000	0.0	0.0	0.0		
	INR	163.030	553.865	141,668.4	325,837.3	502,922.9		
	Total	**532.896**	**1,105.222**	**219,287**	**718,505**	**1,343,653**		
If applicable, indicate any environmental benefits which cannot be expressed as tCO2e	The carbon benefits that have been calculated above do not take into account the carbon benefit of electrical losses reduction that could be provided by the INR Method as this was not quantifiable in the business case.							

A.3 REVISE – Capacity Benefits

Capacity Released								
Scale	**Method**	**Method Cost (£m)**	**Base Case Costs (£m)**	**2030 (MVA)**	**2040 (MVA)**	**2050 (MVA)**	**Notes**	**Cross References**
Post-trial Solution (individual deployment)	ACS	1.487	6.773	0.0	0.0	0.0	**Full details of the Capacity Released Calculation can be found in App. H & K** The ACS releases additional energy flows (MWh) on the 33kV network, not network capacity (MVA). Therefore the Capacity Released for ACS is zero in the benefits table. The DPS is a facilitating Method for INR (which will release network capacity), however, does not in itself release capacity (MVA). Therefore the Capacity Released for DPS is zero in the benefits table. The cumulative Method roll-out numbers are the same as the respective roll-out scale in the financial benefit table.	Appendix H & K (pages 69 & 73 respectively)
	DPS	1.681	0.000	0.0	0.0	0.0		
	INR	1.176	4.031	83.5	83.5	83.5		
	Total	**4.344**	**10.804**	**83.5**	**83.5**	**83.5**		
Licensee Roll-out Scale (if applicable, indicate the number of relevant sites on the Licensees' network)	ACS	57.527	214.821	0.0	0.0	0.0	See above comments for Post-trial Solution	Appendix H & K (pages 69 & 73 respectively)
	DPS	48.158	0.000	0.0	0.0	0.0		
	INR	33.702	121.274	918.1	1,752.8	2,587.5		
	Total	**139.387**	**336.095**	**918.1**	**1,752.8**	**2,587.5**		
GB Roll-out Scale (If applicable, indicate the number of relevant sites on the GB network)	ACS	151.424	551.358	0.0	0.0	0.0	See above comments for Post-trial Solution	Appendix H & K (pages 69 & 73 respectively)
	DPS	218.443	0.000	0.0	0.0	0.0		
	INR	163.030	553.865	3,338.7	7,678.9	11,852.3		
	Total	**532.896**	**1,105.222**	**3,338.7**	**7,678.9**	**11,852.3**		

Appendix B Full Submission Spreadsheet

NIC Funding Request

	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	Total	
Total Project Cost *From Project Cost Summary sheet*										
Labour	33.43	298.08	344.10	803.64	194.15	27.74	-	-	1,701.14	
Equipment	-	-	2,765.00	3,110.00	100.00	-	-	-	5,975.00	
Contractors	-	1,362.34	1,081.34	614.34	307.84	2.50	-	-	3,368.36	
IT	-	-	-	-	-	-	-	-	-	
IPR Costs	-	-	-	-	-	-	-	-	-	
Travel & Expenses	3.71	52.56	57.68	108.74	41.02	10.86	-	-	274.57	
Payments to users & Contingency	3.71	171.30	424.81	463.67	64.30	4.11	-	-	1,131.91	
Decommissioning	-	-	-	-	-	-	-	-	-	
Other	-	-	-	-	-	120.00	-	-	120.00	
Total	40.85	1,884.28	4,672.93	5,100.39	707.31	165.21	-	-	12,570.98	
External funding *Any funding that will be received from Project Partners and/or External Funders - from Project Cost Summary sheet*										
Labour	-	-	-	-	-	-	-	-	-	
Equipment	-	-	-	-	-	-	-	-	-	
Contractors	-	-	-	-	-	-	-	-	-	
IT	-	-	-	-	-	-	-	-	-	
IPR Costs	-	-	-	-	-	-	-	-	-	
Travel & Expenses	-	-	-	-	-	-	-	-	-	
Payments to users & Contingency	-	-	-	-	-	-	-	-	-	
Decommissioning	-	-	-	-	-	-	-	-	-	
Other	-	-	-	-	-	-	-	-	-	
Total	-	-	-	-	-	-	-	-	-	
Licensee extra contribution *Any funding from the Licensee which is in excess of the Licensee Compulsory Contribution - from Project Cost Summary sheet*										
Labour	-	-	-	-	-	-	-	-	-	
Equipment	-	-	-	-	-	-	-	-	-	
Contractors	-	-	-	-	-	-	-	-	-	
IT	-	-	-	-	-	-	-	-	-	
IPR Costs	-	-	-	-	-	-	-	-	-	
Travel & Expenses	-	-	-	-	-	-	-	-	-	
Payments to users & Contingency	-	-	-	-	-	-	-	-	-	
Decommissioning	-	-	-	-	-	-	-	-	-	
Other	-	-	-	-	-	-	-	-	-	
Total	-	-	-	-	-	-	-	-	-	
Initial Net Funding Required										
Labour	33.43	298.08	344.10	803.64	194.15	27.74	-	-	1,701.14	
Equipment	-	-	2,765.00	3,110.00	100.00	-	-	-	5,975.00	
Contractors	-	1,362.34	1,081.34	614.34	307.84	2.50	-	-	3,368.36	
IT	-	-	-	-	-	-	-	-	-	
IPR Costs	-	-	-	-	-	-	-	-	-	
Travel & Expenses	3.71	52.56	57.68	108.74	41.02	10.86	-	-	274.57	
Payments to users & Contingency	3.71	171.30	424.81	463.67	64.30	4.11	-	-	1,131.91	
Decommissioning	-	-	-	-	-	-	-	-	-	Check Total = to Initial Net Funding request
Other	-	-	-	-	-	120.00	-	-	120.00	in Project Cost Summary
Total	40.85	1,884.28	4,672.93	5,100.39	707.31	165.21	-	-	12,570.98	OK
Direct Benefits *from Direct Benefits sheet*										
Total	-	-	-	-	-	-	-	-	-	
Licensee Compulsory Contribution / *from Project Cost Summary sheet*										
Labour	3.34	29.81	34.41	80.36	19.42	2.77	-	-	170.11	
Equipment	-	-	276.50	311.00	10.00	-	-	-	597.50	
Contractors	-	136.23	108.13	61.43	30.78	0.25	-	-	336.84	
IT	-	-	-	-	-	-	-	-	-	
IPR Costs	-	-	-	-	-	-	-	-	-	
Travel & Expenses	0.37	5.26	5.77	10.87	4.10	1.09	-	-	27.46	
Payments to users & Contingency	0.37	17.13	42.48	46.37	6.43	0.41	-	-	113.19	
Decommissioning	-	-	-	-	-	-	-	-	-	of Total Initial Net Funding Required
Other	-	-	-	-	-	12.00	-	-	12.00	OK
Total	4.09	188.43	467.29	510.04	70.73	16.52	-	-	1,257.10	Check that **Total** is = or > than Total Direct Benefits OK
Outstanding Funding required										
Labour	30.08	268.27	309.69	723.28	174.74	24.97	-	-	1,531.03	
Equipment	-	-	2,488.50	2,799.00	90.00	-	-	-	5,377.50	
Contractors	-	1,226.11	973.21	552.91	277.06	2.25	-	-	3,031.52	
IT	-	-	-	-	-	-	-	-	-	
IPR Costs	-	-	-	-	-	-	-	-	-	
Travel & Expenses	3.34	47.31	51.91	97.86	36.92	9.77	-	-	247.11	
Payments to users & Contingency	3.34	154.17	382.33	417.30	57.87	3.70	-	-	1,018.72	
Decommissioning	-	-	-	-	-	-	-	-	-	Check that Total is =to
Other	-	-	-	-	-	108.00	-	-	108.00	Total Outstanding Funding required
Total	36.77	1,695.85	4,205.64	4,590.35	636.58	148.69	-	-	11,313.88	OK

		2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	Total	
balance	11,103.06	0.00	9,370.44	5,267.17	750.00	143.51	(0.71)	0.00	(0.00)	11,103.06	
interest		0.00	102.37	73.19	30.09	4.47	0.71	(0.00)	0.00	210.82	
										11,313.88	-

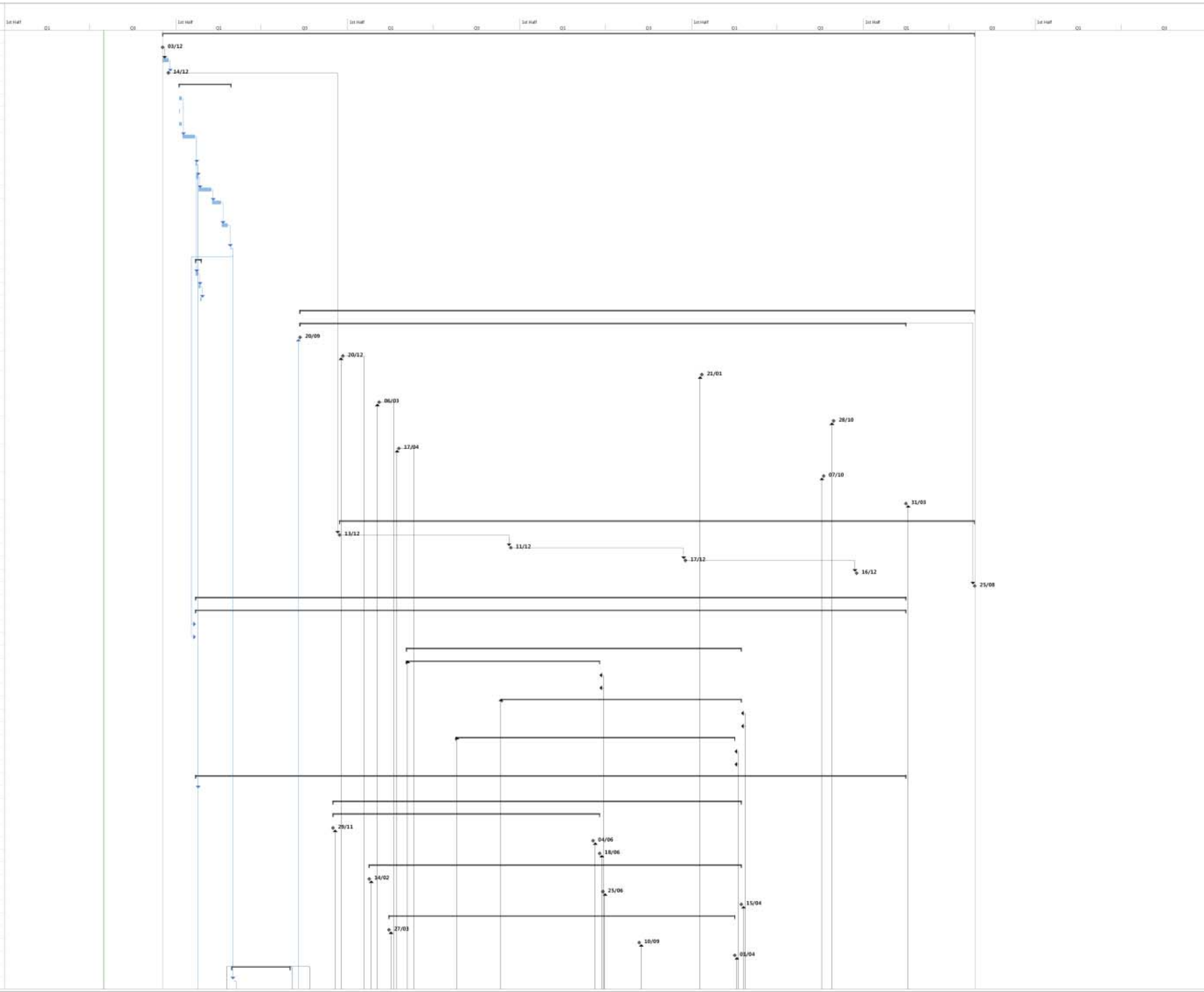
Bank of England interest rate		0.5%		**NIC FUNDING REQUEST £**					**11,103.06**
interest rate used in calculation		1.0%							
RPI adjustment	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	
Annual inflation	3.30%	3.00%	3.05%	3.20%	3.20%	3.20%	3.20%	3.20%	

n.b the NIC Funding Request calculation should use the Bank of England Base rate plus 0.5% on 30 June of the year in which the Full Submission is made.

Bank of England Base Rate: https://www.bankofengland.co.uk/boeapps/iadb/Repo.asp
RPI Forecast 2018/19-202223: https://www.gov.uk/government/statistics/forecasts-for-the-uk-economy-may-2018
RPI for 2023/24 and thereafter is an extension from 2022/23 as no further consistent forecast is available.

Appendix C Project Plan and Contingency Plan

ID	Task Name	Duration	Start	Finish
1	**REVISE**	**1169 days**	**Mon 03/12/18**	**Fri 25/08/23**
2	Award Notification	0 days	Mon 03/12/18	Mon 03/12/18
3	Produce Project Direction	10 days	Mon 03/12/18	Fri 14/12/18
4	Project Direction Sign-off	0 days	Fri 14/12/18	Fri 14/12/18
5	**Project Initiation**	**80 days**	**Mon 07/01/19**	**Fri 26/04/19**
6	Review Aims, Objectives and Deliverables	5 days	Mon 07/01/19	Fri 11/01/19
7	Update RAID log	1 day	Mon 07/01/19	Mon 07/01/19
8	Setup Project Bank Account	5 days	Mon 07/01/19	Fri 11/01/19
9	Confirm WPD team members, identify responsibilities and engage with other departments	20 days	Mon 14/01/19	Fri 08/02/19
10	WPD Team Kick-off Meeting	1 day	Mon 11/02/19	Mon 11/02/19
11	Confirm Project Strategy	4 days	Tue 12/02/19	Fri 15/02/19
12	Engage with Technical Consultant(s)	20 days	Mon 18/02/19	Fri 15/03/19
13	Prepare and establish contract with Technical Consultant	15 days	Mon 18/03/19	Fri 05/04/19
14	Technical Consultant Collaboration Agreement Process	10 days	Mon 08/04/19	Fri 19/04/19
15	Overall Team Kick-off Meeting	1 day	Fri 26/04/19	Fri 26/04/19
16	**Define governance requirements**	**10 days**	**Mon 11/02/19**	**Fri 22/02/19**
17	Establish governance requirements	5 days	Mon 11/02/19	Fri 15/02/19
18	Establish project tolerances	3 days	Mon 18/02/19	Wed 20/02/19
19	Confirm escalation process	2 days	Thu 21/02/19	Fri 22/02/19
20	**Reporting**	**969 days**	**Fri 20/09/19**	**Fri 25/08/23**
21	**Deliverables**	**865 days**	**Fri 20/09/19**	**Fri 31/03/23**
22	Deliverable 1 - Confirmation of Trial Area(s) and Detailed Methodology	0 days	Fri 20/09/19	Fri 20/09/19
23	Deliverable 2 - Detailed Design of the Advanced Connection Solution Method	0 days	Fri 20/12/19	Fri 20/12/19
24	Deliverable 3 - Trialling and Demonstrating the Advanced Connection Solution Method	0 days	Fri 21/01/22	Fri 21/01/22
25	Deliverable 4 - Detailed Design of the Dynamic Protection Systems Method	0 days	Fri 06/03/20	Fri 06/03/20
26	Deliverable 5 - Installation and Trialling the Dynamic Protection Systems Method	0 days	Fri 28/10/22	Fri 28/10/22
27	Deliverable 6 - Detailed Design of the Intelligent Network Reconfiguration Method	0 days	Fri 17/04/20	Fri 17/04/20
28	Deliverable 7 - Installation and Trialling the Intelligent Network Reconfiguration Method	0 days	Fri 07/10/22	Fri 07/10/22
29	Deliverable 8 - Knowledge capture and dissemination	0 days	Fri 31/03/23	Fri 31/03/23
30	**Ofgem Progress Reports**	**909 days**	**Fri 13/12/19**	**Fri 25/08/23**
31	1 - Annual Progress Report	0 days	Fri 13/12/19	Fri 13/12/19
32	2 - Annual Progress Report	0 days	Fri 11/12/20	Fri 11/12/20
33	3 - Annual Progress Report	0 days	Fri 17/12/21	Fri 17/12/21
34	4 - Annual Report	0 days	Fri 16/12/22	Fri 16/12/22
35	Closedown Report	0 days	Fri 25/08/23	Fri 25/08/23
36	**Meetings**	**1025 days**	**Mon 11/02/19**	**Fri 31/03/23**
37	**Project Team**	**1025 days**	**Mon 11/02/19**	**Fri 31/03/23**
38	Weekly Catch-up Call	1025 days	Mon 11/02/19	Fri 31/03/23
39	Monthly	1025 days	Mon 11/02/19	Fri 31/03/23
40	**Manufacturers/ Suppliers**	**480 days**	**Mon 04/05/20**	**Fri 15/04/22**
41	**ACS**	**280 days**	**Mon 04/05/20**	**Fri 18/06/21**
42	Weekly Progress Call	280 days	Mon 04/05/20	Fri 18/06/21
43	Progress Meetings	280 days	Mon 04/05/20	Fri 18/06/21
44	**DPS**	**335 days**	**Mon 23/11/20**	**Fri 15/04/22**
45	Weekly Call	335 days	Mon 23/11/20	Fri 15/04/22
46	Progress Meetings	335 days	Mon 23/11/20	Fri 15/04/22
47	**INR**	**395 days**	**Mon 17/08/20**	**Fri 01/04/22**
48	Weekly Call	395 days	Mon 17/08/20	Fri 01/04/22
49	Progress Meeting	395 days	Mon 17/08/20	Fri 01/04/22
50	**Progress Review Group**	**1025 days**	**Mon 11/02/19**	**Fri 31/03/23**
51	Quarterly	1025 days	Mon 11/02/19	Fri 31/03/23
52	**Gateway Reviews**	**580 days**	**Fri 29/11/19**	**Fri 15/04/22**
53	**ACS**	**380 days**	**Fri 29/11/19**	**Fri 18/06/21**
54	Design to Build	0 days	Fri 29/11/19	Fri 29/11/19
55	Build to Installation	0 days	Fri 04/06/21	Fri 04/06/21
56	Installation to Trials	0 days	Fri 18/06/21	Fri 18/06/21
57	**DPS**	**535 days**	**Fri 14/02/20**	**Fri 15/04/22**
58	Design to Build	0 days	Fri 14/02/20	Fri 14/02/20
59	Build to Installation	0 days	Fri 25/06/21	Fri 25/06/21
60	Installation to Trials	0 days	Fri 15/04/22	Fri 15/04/22
61	**INR**	**495 days**	**Fri 27/03/20**	**Fri 01/04/22**
62	Design to Build	0 days	Fri 27/03/20	Fri 27/03/20
63	Build to Installation	0 days	Fri 10/09/21	Fri 10/09/21
64	Installation to Trials	0 days	Fri 01/04/22	Fri 01/04/22
65	**Trial Area and Methodology Selection**	**90 days**	**Mon 29/04/19**	**Fri 30/08/19**
66	Review Original Site Assessments	5 days	Mon 29/04/19	Fri 03/05/19



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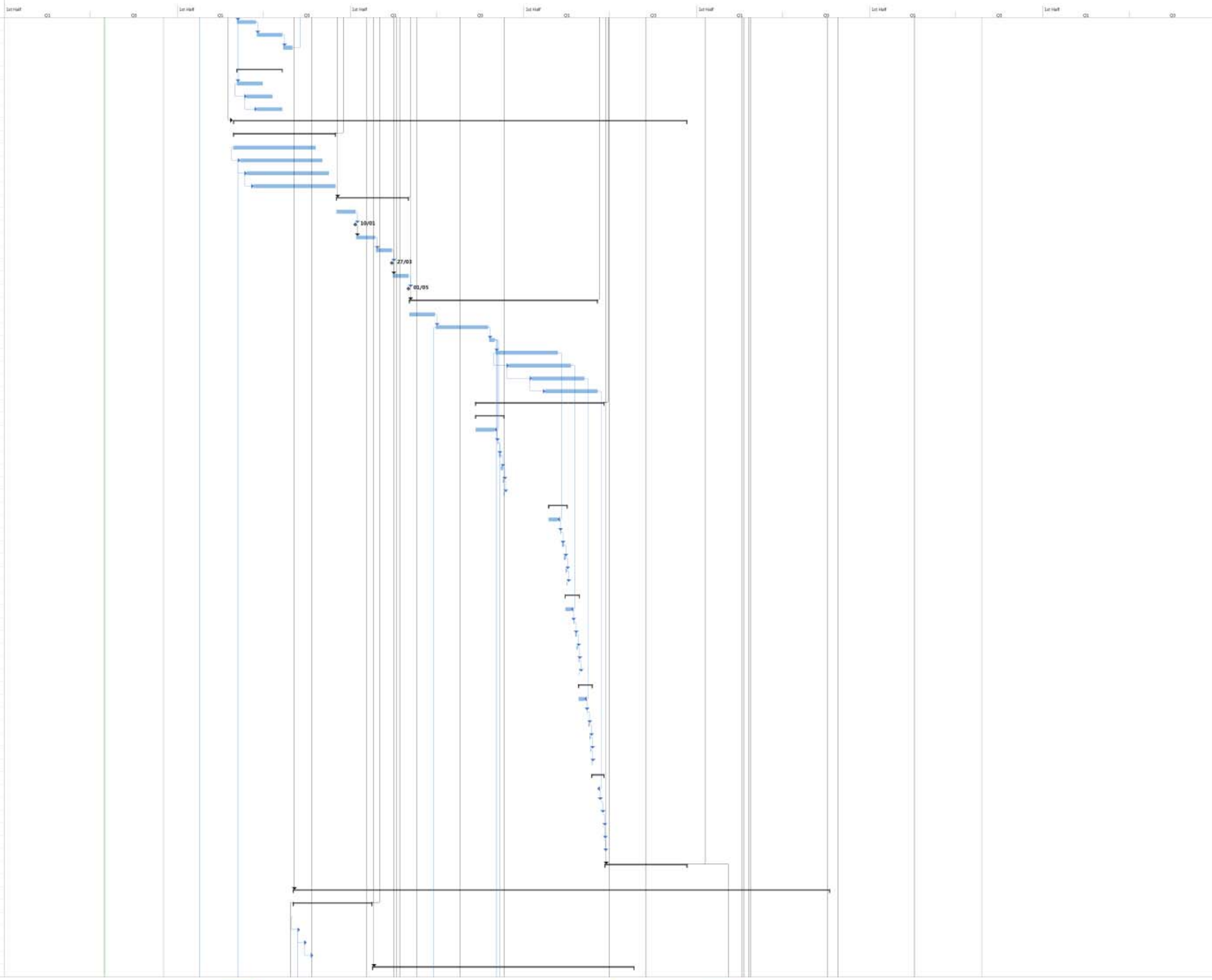
ID	Task Name	Duration	Start	Finish
67	Site Visits	30 days	Mon 06/05/19	Fri 14/06/19
68	Confirm Site Selection	40 days	Mon 17/06/19	Fri 09/08/19
69	Apply Site Selection and Capacity Release Methodology	15 days	Mon 12/08/19	Fri 30/08/19
70	**Technology Research**	**70 days**	**Mon 06/05/19**	**Fri 09/08/19**
71	Protection	40 days	Mon 06/05/19	Fri 28/06/19
72	Control	40 days	Mon 27/05/19	Fri 19/07/19
73	Cybersecurity	40 days	Mon 17/06/19	Fri 09/08/19
74	**Advanced Connection Solution**	**660 days**	**Mon 29/04/19**	**Fri 10/12/21**
75	**Design**	**155 days**	**Mon 29/04/19**	**Fri 29/11/19**
76	Network Integration Methods	125 days	Mon 29/04/19	Fri 18/10/19
77	Operational Philosophy	125 days	Mon 13/05/19	Fri 01/11/19
78	Technical Specifications	125 days	Mon 27/05/19	Fri 15/11/19
79	Method Designs	125 days	Mon 10/06/19	Fri 29/11/19
80	**Procurement**	**100 days**	**Mon 02/12/19**	**Fri 01/05/20**
81	Produce ITT	20 days	Mon 02/12/19	Fri 10/01/20
82	Release Tender	0 days	Fri 10/01/20	Fri 10/01/20
83	Tender Completion	30 days	Mon 13/01/20	Fri 21/02/20
84	Tender Evaluation	25 days	Mon 24/02/20	Fri 27/03/20
85	Tender Award	0 days	Fri 27/03/20	Fri 27/03/20
86	Form Contract	25 days	Mon 30/03/20	Fri 01/05/20
87	Sign Contract	0 days	Fri 01/05/20	Fri 01/05/20
88	**Build**	**270 days**	**Mon 04/05/20**	**Fri 04/06/21**
89	Design Submissions	40 days	Mon 04/05/20	Fri 26/06/20
90	Build - 1st Device	80 days	Mon 29/06/20	Fri 16/10/20
91	Factory Acceptance Testing	10 days	Mon 19/10/20	Fri 30/10/20
92	Build - 2nd Device	80 days	Mon 02/11/20	Fri 12/03/21
93	Build - 3rd Device	80 days	Mon 30/11/20	Fri 09/04/21
94	Build - 4th Device	80 days	Mon 18/01/21	Fri 07/05/21
95	Build - 5th Device	80 days	Mon 15/02/21	Fri 04/06/21
96	**Installation**	**180 days**	**Mon 21/09/20**	**Fri 18/06/21**
97	**Site1**	**44 days**	**Mon 21/09/20**	**Thu 19/11/20**
98	Site Preperation	30 days	Mon 21/09/20	Fri 30/10/20
99	ACS Delivery	1 day	Fri 06/11/20	Fri 06/11/20
100	ACS Installation	4 days	Mon 09/11/20	Thu 12/11/20
101	Cold Commissioning	2 days	Fri 13/11/20	Mon 16/11/20
102	Hot Commissioning	2 days	Tue 17/11/20	Wed 18/11/20
103	Energisation	1 day	Thu 19/11/20	Thu 19/11/20
104	**Site2**	**29 days**	**Mon 22/02/21**	**Thu 01/04/21**
105	Site Preperation	15 days	Mon 22/02/21	Fri 12/03/21
106	ACS Delivery	1 day	Fri 19/03/21	Fri 19/03/21
107	ACS Installation	4 days	Mon 22/03/21	Thu 25/03/21
108	Cold Commissioning	2 days	Fri 26/03/21	Mon 29/03/21
109	Hot Commissioning	2 days	Tue 30/03/21	Wed 31/03/21
110	Energisation	1 day	Thu 01/04/21	Thu 01/04/21
111	**Site3**	**22 days**	**Mon 29/03/21**	**Tue 27/04/21**
112	Site Preperation	10 days	Mon 29/03/21	Fri 09/04/21
113	ACS Delivery	1 day	Fri 16/04/21	Fri 16/04/21
114	ACS Installation	3 days	Mon 19/04/21	Wed 21/04/21
115	Cold Commissioning	2 days	Thu 22/04/21	Fri 23/04/21
116	Hot Commissioning	1 day	Mon 26/04/21	Mon 26/04/21
117	Energisation	1 day	Tue 27/04/21	Tue 27/04/21
118	**Site4**	**21 days**	**Mon 26/04/21**	**Mon 24/05/21**
119	Site Preperation	10 days	Mon 26/04/21	Fri 07/05/21
120	ACS Delivery	1 day	Fri 14/05/21	Fri 14/05/21
121	ACS Installation	2 days	Mon 17/05/21	Tue 18/05/21
122	Cold Commissioning	2 days	Wed 19/05/21	Thu 20/05/21
123	Hot Commissioning	1 day	Fri 21/05/21	Fri 21/05/21
124	Energisation	1 day	Mon 24/05/21	Mon 24/05/21
125	**Site5**	**20 days**	**Mon 24/05/21**	**Fri 18/06/21**
126	Site Preperation	10 days	Mon 24/05/21	Fri 04/06/21
127	ACS Delivery	1 day	Fri 11/06/21	Fri 11/06/21
128	ACS Installation	2 days	Mon 14/06/21	Tue 15/06/21
129	Cold Commissioning	1 day	Wed 16/06/21	Wed 16/06/21
130	Hot Commissioning	1 day	Thu 17/06/21	Thu 17/06/21
131	Energisation	1 day	Fri 18/06/21	Fri 18/06/21
132	**Trial**	**125 days**	**Mon 21/06/21**	**Fri 10/12/21**
133	Trial and Evaluation	125 days	Mon 21/06/21	Fri 10/12/21
134	**Dynamic Protection Scheme**	**770 days**	**Mon 02/09/19**	**Fri 07/10/22**
135	**Design**	**110 days**	**Mon 02/09/19**	**Fri 14/02/20**
136	Network Integration Methods	80 days	Mon 02/09/19	Fri 20/12/19
137	Operational Philosophy	80 days	Mon 16/09/19	Fri 17/01/20
138	Technical Specifications	80 days	Mon 30/09/19	Fri 31/01/20
139	Method Designs	80 days	Mon 14/10/19	Fri 14/02/20
140	**Procurement**	**380 days**	**Mon 17/02/20**	**Fri 20/08/21**



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Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

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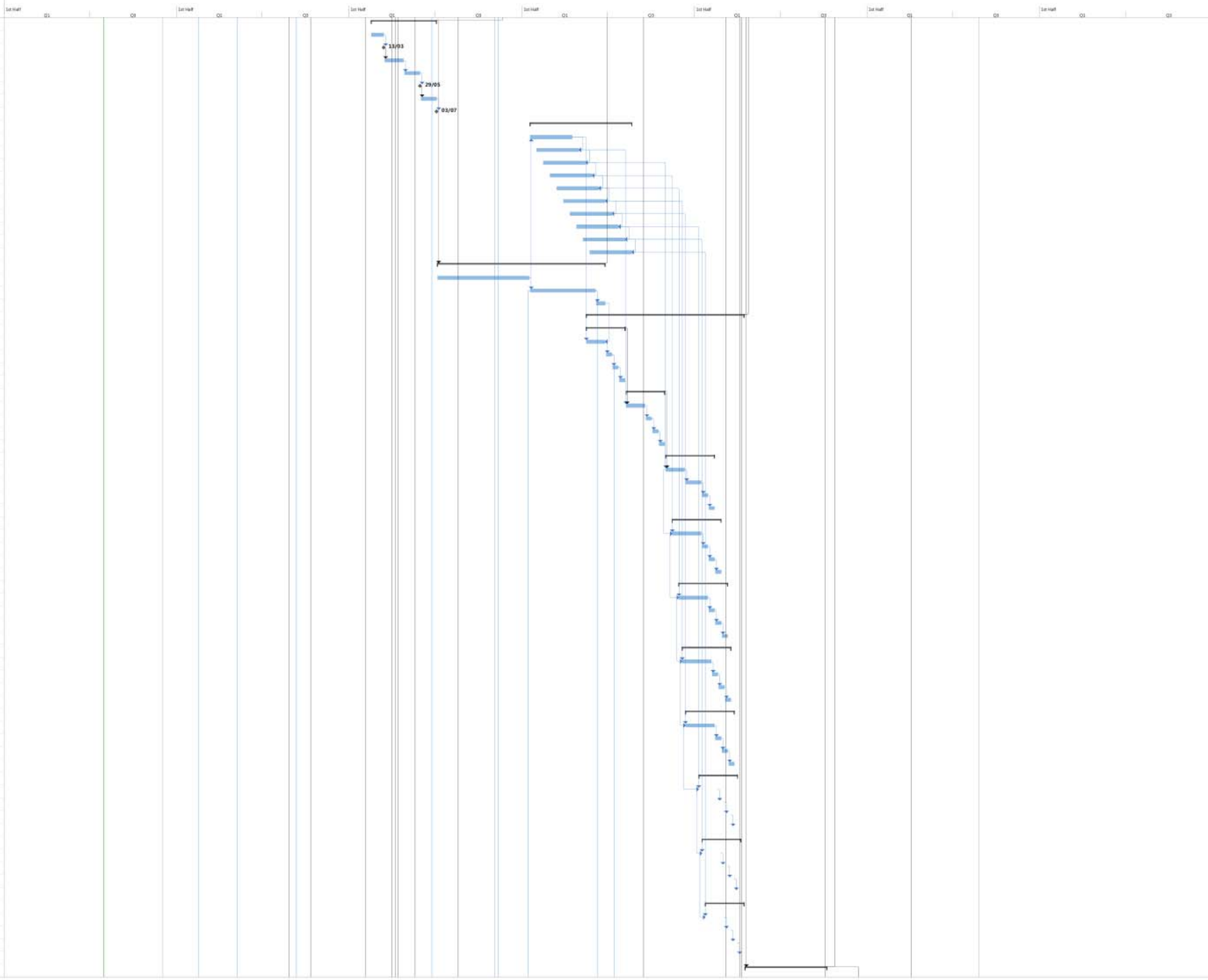
ID	Task Mode	Task Name	Duration	Start	Finish
141		**DPS System**	**100 days**	**Mon 17/02/20**	**Fri 03/07/20**
142		Produce ITT	20 days	Mon 17/02/20	Fri 13/03/20
143		Release Tender	0 days	Fri 13/03/20	Fri 13/03/20
144		Tender Completion	30 days	Mon 16/03/20	Fri 24/04/20
145		Tender Evaluation	25 days	Mon 27/04/20	Fri 29/05/20
146		Tender Award	0 days	Fri 29/05/20	Fri 29/05/20
147		Form Contract	25 days	Mon 01/06/20	Fri 03/07/20
148		Sign Contract	0 days	Fri 03/07/20	Fri 03/07/20
149		**Ancillary Equipment**	**155 days**	**Mon 18/01/21**	**Fri 20/08/21**
150		Relays and Comms System	65 days	Mon 18/01/21	Fri 16/04/21
151		Relays and Comms System	65 days	Mon 01/02/21	Fri 30/04/21
152		Relays and Comms System	65 days	Mon 15/02/21	Fri 14/05/21
153		Relays and Comms System	65 days	Mon 01/03/21	Fri 28/05/21
154		Relays and Comms System	65 days	Mon 15/03/21	Fri 11/06/21
155		Relays and Comms System	65 days	Mon 29/03/21	Fri 25/06/21
156		Relays and Comms System	65 days	Mon 12/04/21	Fri 09/07/21
157		Relays and Comms System	65 days	Mon 26/04/21	Fri 23/07/21
158		Relays and Comms System	65 days	Mon 10/05/21	Fri 06/08/21
159		Relays and Comms System	65 days	Mon 24/05/21	Fri 20/08/21
160		**Build**	**240 days**	**Mon 06/07/20**	**Fri 25/06/21**
161		Design Submissions	125 days	Mon 06/07/20	Fri 15/01/21
162		Build System For Test	100 days	Mon 18/01/21	Fri 04/06/21
163		Factory Acceptance Testing	15 days	Mon 07/06/21	Fri 25/06/21
164		**Installation**	**225 days**	**Mon 17/05/21**	**Fri 15/04/22**
165		**Site1**	**60 days**	**Mon 17/05/21**	**Fri 06/08/21**
166		Site Preperation	30 days	Mon 17/05/21	Fri 25/06/21
167		EPS Integration	10 days	Mon 28/06/21	Fri 09/07/21
168		System Integration Testing	10 days	Mon 12/07/21	Fri 23/07/21
169		System Acceptance Testing	10 days	Mon 26/07/21	Fri 06/08/21
170		**Site2**	**60 days**	**Mon 09/08/21**	**Fri 29/10/21**
171		Site Preperation	30 days	Mon 09/08/21	Fri 17/09/21
172		EPS Integration	10 days	Mon 20/09/21	Fri 01/10/21
173		System Integration Testing	10 days	Mon 04/10/21	Fri 15/10/21
174		System Acceptance Testing	10 days	Mon 18/10/21	Fri 29/10/21
175		**Site3**	**60 days**	**Mon 01/11/21**	**Fri 11/02/22**
176		Site Preperation	30 days	Mon 01/11/21	Fri 10/12/21
177		EPS Integration	10 days	Mon 13/12/21	Fri 14/01/22
178		System Integration Testing	10 days	Mon 17/01/22	Fri 28/01/22
179		System Acceptance Testing	10 days	Mon 31/01/22	Fri 11/02/22
180		**Site4**	**60 days**	**Mon 15/11/21**	**Fri 25/02/22**
181		Site Preperation	30 days	Mon 15/11/21	Fri 14/01/22
182		EPS Integration	10 days	Mon 17/01/22	Fri 28/01/22
183		System Integration Testing	10 days	Mon 31/01/22	Fri 11/02/22
184		System Acceptance Testing	10 days	Mon 14/02/22	Fri 25/02/22
185		**Site5**	**60 days**	**Mon 29/11/21**	**Fri 11/03/22**
186		Site Preperation	30 days	Mon 29/11/21	Fri 28/01/22
187		EPS Integration	10 days	Mon 31/01/22	Fri 11/02/22
188		System Integration Testing	10 days	Mon 14/02/22	Fri 25/02/22
189		System Acceptance Testing	10 days	Mon 28/02/22	Fri 11/03/22
190		**Site6**	**60 days**	**Mon 06/12/21**	**Fri 18/03/22**
191		Site Preperation	30 days	Mon 06/12/21	Fri 04/02/22
192		EPS Integration	10 days	Mon 07/02/22	Fri 18/02/22
193		System Integration Testing	10 days	Mon 21/02/22	Fri 04/03/22
194		System Acceptance Testing	10 days	Mon 07/03/22	Fri 18/03/22
195		**Site7**	**60 days**	**Mon 13/12/21**	**Fri 25/03/22**
196		Site Preperation	30 days	Mon 13/12/21	Fri 11/02/22
197		EPS Integration	10 days	Mon 14/02/22	Fri 25/02/22
198		System Integration Testing	10 days	Mon 28/02/22	Fri 11/03/22
199		System Acceptance Testing	10 days	Mon 14/03/22	Fri 25/03/22
200		**Site8**	**60 days**	**Mon 10/01/22**	**Fri 01/04/22**
201		Site Preperation	30 days	Mon 10/01/22	Fri 18/02/22
202		EPS Integration	10 days	Mon 21/02/22	Fri 04/03/22
203		System Integration Testing	10 days	Mon 07/03/22	Fri 18/03/22
204		System Acceptance Testing	10 days	Mon 21/03/22	Fri 01/04/22
205		**Site9**	**60 days**	**Mon 17/01/22**	**Fri 08/04/22**
206		Site Preperation	30 days	Mon 17/01/22	Fri 25/02/22
207		EPS Integration	10 days	Mon 28/02/22	Fri 11/03/22
208		System Integration Testing	10 days	Mon 14/03/22	Fri 25/03/22
209		System Acceptance Testing	10 days	Mon 28/03/22	Fri 08/04/22
210		**Site10**	**60 days**	**Mon 24/01/22**	**Fri 15/04/22**
211		Site Preperation	30 days	Mon 24/01/22	Fri 04/03/22
212		EPS Integration	10 days	Mon 07/03/22	Fri 18/03/22
213		System Integration Testing	10 days	Mon 21/03/22	Fri 01/04/22
214		System Acceptance Testing	10 days	Mon 04/04/22	Fri 15/04/22
215		**Trial**	**125 days**	**Mon 18/04/22**	**Fri 07/10/22**



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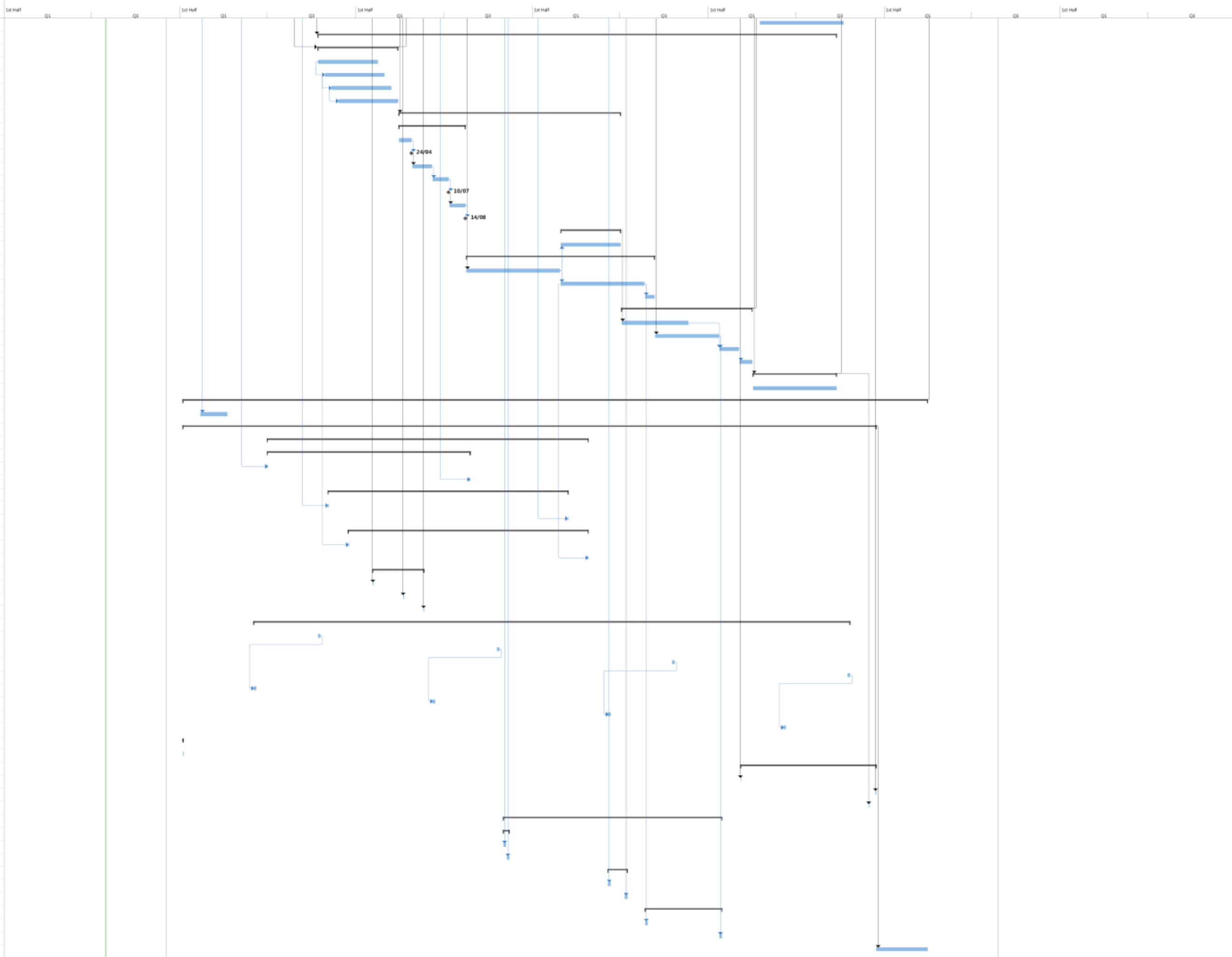
ID	Task Mode	Task Name	Duration	Start	Finish
216		Trial and Evaluation	125 days	Mon 18/04/22	Fri 07/10/22
217		**Intelligent Network Reconfiguration**	**730 days**	**Mon 14/10/19**	**Fri 23/09/22**
218		**Design**	**110 days**	**Mon 14/10/19**	**Fri 27/03/20**
219		Network Integration Methods	80 days	Mon 14/10/19	Fri 14/02/20
220		Operational Philosophy	80 days	Mon 28/10/19	Fri 28/02/20
221		Technical Specifications	80 days	Mon 11/11/19	Fri 13/03/20
222		Method Designs	80 days	Mon 25/11/19	Fri 27/03/20
223		**Procurement**	**315 days**	**Mon 30/03/20**	**Fri 02/07/21**
224		**INR System**	**100 days**	**Mon 30/03/20**	**Fri 14/08/20**
225		Produce ITT	20 days	Mon 30/03/20	Fri 24/04/20
226		Release Tender	0 days	Fri 24/04/20	Fri 24/04/20
227		Tender Completion	30 days	Mon 27/04/20	Fri 05/06/20
228		Tender Evaluation	25 days	Mon 08/06/20	Fri 10/07/20
229		Tender Award	0 days	Fri 10/07/20	Fri 10/07/20
230		Form Contract	25 days	Mon 13/07/20	Fri 14/08/20
231		Sign Contract	0 days	Fri 14/08/20	Fri 14/08/20
232		**Ancillary Equipment**	**90 days**	**Mon 01/03/21**	**Fri 02/07/21**
233		Sgear, Relays and Comms System	90 days	Mon 01/03/21	Fri 02/07/21
234		**Build**	**265 days**	**Mon 17/08/20**	**Fri 10/09/21**
235		Design Submissions	125 days	Mon 17/08/20	Fri 26/02/21
236		Build System For Test	125 days	Mon 01/03/21	Fri 20/08/21
237		Factory Acceptance Testing	15 days	Mon 23/08/21	Fri 10/09/21
238		**Installation**	**180 days**	**Mon 05/07/21**	**Fri 01/04/22**
239		Site Installation Activity	100 days	Mon 05/07/21	Fri 19/11/21
240		System Integration	80 days	Mon 13/09/21	Fri 21/01/22
241		System Integration Testing	30 days	Mon 24/01/22	Fri 04/03/22
242		System Acceptance Testing	20 days	Mon 07/03/22	Fri 01/04/22
243		**Trial**	**125 days**	**Mon 04/04/22**	**Fri 23/09/22**
244		Trial and Evaluation	125 days	Mon 04/04/22	Fri 23/09/22
245		**Knowledge Transfer and Dissemination**	**1050 days**	**Mon 07/01/19**	**Fri 31/03/23**
246		Prepare Detailed Dissemination Plan	40 days	Tue 12/02/19	Mon 08/04/19
247		**Stakeholder Engagement**	**988 days**	**Mon 07/01/19**	**Wed 14/12/22**
248		**DNO Workshops**	**451 days**	**Mon 01/07/19**	**Mon 26/04/21**
249		**ACS**	**291 days**	**Mon 01/07/19**	**Mon 24/08/20**
250		Design	1 day	Mon 01/07/19	Mon 01/07/19
251		Build	1 day	Mon 24/08/20	Mon 24/08/20
252		**DPS**	**331 days**	**Mon 04/11/19**	**Mon 15/03/21**
253		Design	1 day	Mon 04/11/19	Mon 04/11/19
254		Build	1 day	Mon 15/03/21	Mon 15/03/21
255		**INR**	**331 days**	**Mon 16/12/19**	**Mon 26/04/21**
256		Design	1 day	Mon 16/12/19	Mon 16/12/19
257		Build	1 day	Mon 26/04/21	Mon 26/04/21
258		**Webinars**	**76 days**	**Wed 05/02/20**	**Wed 20/05/20**
259		ACS	1 day	Wed 05/02/20	Wed 05/02/20
260		DPS	1 day	Wed 08/04/20	Wed 08/04/20
261		INR	1 day	Wed 20/05/20	Wed 20/05/20
262		**Conferences**	**845 days**	**Mon 03/06/19**	**Fri 21/10/22**
263		LCNI 2019	5 days	Mon 14/10/19	Fri 18/10/19
264		LCNI 2020	5 days	Mon 19/10/20	Fri 23/10/20
265		LCNI 2021	5 days	Mon 18/10/21	Fri 22/10/21
266		LCNI 2022	5 days	Mon 17/10/22	Fri 21/10/22
267		Technical Conference 1	5 days	Mon 03/06/19	Fri 07/06/19
268		Technical Conference 2	5 days	Mon 08/06/20	Fri 12/06/20
269		Technical Conference 3	5 days	Mon 07/06/21	Fri 11/06/21
270		Technical Conference 4	5 days	Mon 06/06/22	Fri 10/06/22
271		**Closedown Event**	**1 day**	**Mon 07/01/19**	**Mon 07/01/19**
272		Dissemination	1 day	Mon 07/01/19	Mon 07/01/19
273		**Site Tours**	**201 days**	**Wed 09/03/22**	**Wed 14/12/22**
274		ACS	1 day	Wed 09/03/22	Wed 09/03/22
275		DPS	1 day	Wed 14/12/22	Wed 14/12/22
276		INR	1 day	Wed 30/11/22	Wed 30/11/22
277		**Training**	**295 days**	**Mon 02/11/20**	**Fri 28/01/22**
278		**ACS**	**10 days**	**Mon 02/11/20**	**Fri 13/11/20**
279		Technology	5 days	Mon 02/11/20	Fri 06/11/20
280		Site	5 days	Mon 09/11/20	Fri 13/11/20
281		**DPS**	**30 days**	**Mon 07/06/21**	**Fri 16/07/21**
282		Technology	5 days	Mon 07/06/21	Fri 11/06/21
283		Site	5 days	Mon 12/07/21	Fri 16/07/21
284		**INR**	**100 days**	**Mon 23/08/21**	**Fri 28/01/22**
285		Technology	5 days	Mon 23/08/21	Fri 27/08/21
286		Site	5 days	Mon 24/01/22	Fri 28/01/22
287		Project Evaluation	62 days	Thu 15/12/22	Fri 31/03/23



Project: 2018-05-17 Project REV
Date: Tue 31/07/18

C.1 Contingency Plan

A contingency plan has been written for the significant risks on the Risk Register. All risks will be monitored throughout the Project and in the event of the escalation of these risks, the contingency process will be followed.

If the Project Manager deems that this is not sufficient to deal with the issue, it will be escalated as described in Section 6.

R002	**Dynamic Protection Systems and Intelligent Network Reconfiguration Methods cannot be integrated with the existing NMS**

Mitigation

We will engage with the team responsible for NMS updates at an early stage of the project to identify any issue(s) and plan for an upgrade of the NMS (if required).

Contingency

If the DPS and INR Methods cannot be integrated using a new system, update the Methods so that they can interface with an alternative system already deployed by WPD.

R004	**Unforeseen updates to the existing telecoms infrastructure are required for the Project Methods**

Mitigation

We have costed for studies to take place during the research and design phases to understand the telecoms requirements for each of the Methods. This will inform the changes that are required to be made to the telecoms system to ensure it is compatible with the Methods.

Contingency

Consider modifying the requirements of the Methods to enable integration with existing infrastructure.

R016	**Manufacturers have severely underestimated the costs to design and build the Project Methods**

Mitigation

We have benchmarked the costs of the Methods against similar equipment that has previously been installed by WPD. We have also included additional margin to cover costs that could arise during the detailed design phase of each of the Methods.

Contingency

Re-evaluate the technical specifications and review the installation methodology to mitigate additional spend.

R011	Sections of the network within the trial area become unavailable

Mitigation

In the bid stage we have identified a number of suitable trial areas in the West Midlands where the Methods would release significant benefits. At the start of the project we will implement a rigorous trial area selection process which will select a number of backup trial areas for each of the Methods to mitigate for this risk.

Contingency

In the unlikely event that the backup trial areas are unavailable in the West Midlands, we would carry out a further trial area selection process in another one of our licence areas. For example, the East Midlands licence area has a number of sites that would also be suitable.

R006	The cybersecurity requirements for the Project are more stringent than anticipated

Mitigation

There will be a thorough study to determine the appropriate cybersecurity measures that will be required as part of the project. These measures will be captured in WPD policy documentation that will enhance the existing policies.

Contingency

If the cybersecurity requirements are more onerous than could have been reasonably expected and the requirements go beyond the time and money allocated, we will consider simplifying the requirements of the Methods to ensure the network remains secure.

Appendix D Project Partners

No Project Partners for REVISE have been confirmed to date, however, we recognise the importance of considering key audiences and organisations who will contribute to the Project and/or benefit from the learning outcomes generated. Therefore, potential Project Partners for REVISE have been identified during Project Definition as indicated in Figure D-1.

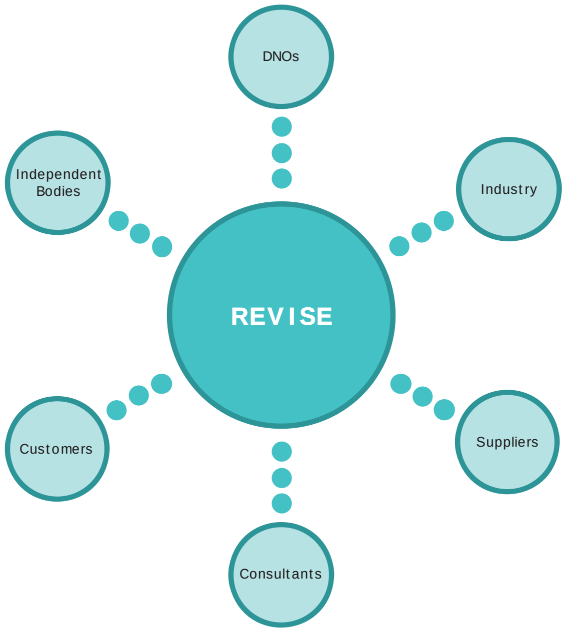


Figure D-1 – Potential Project Partners for REVISE

RFIs, interviews and forums have been used to identify and engage with service providers, manufacturers, existing and future generating customers.

Our experience in delivering several large scale innovation projects has shown that a competitive tender process to select Partners after Project award delivers the best value for money. Adopting this approach allows us the time to develop robust tender documentation whilst also giving suppliers the confidence that the Project is not just speculative. We are confident that the Project has sufficient support and we are able to select Project Partners after the funding decision has been announced.

We will operate an open and competitive procurement process for the services and equipment required to deliver REVISE as demonstrated in Figure D-2 below.

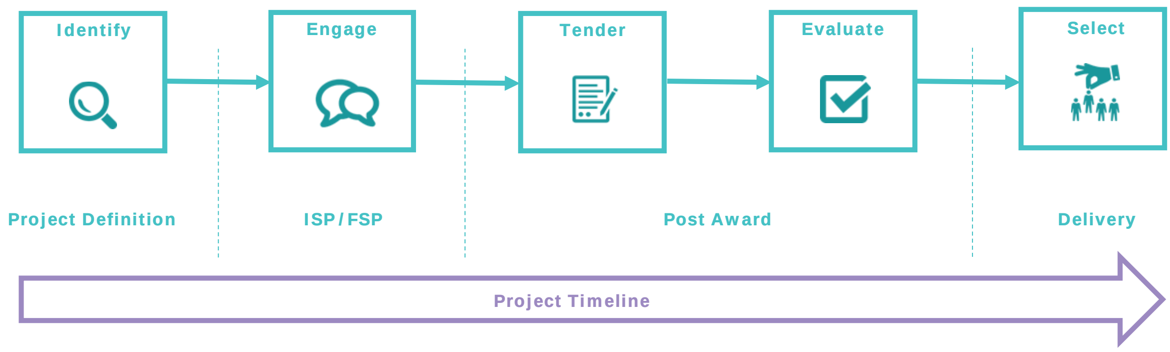


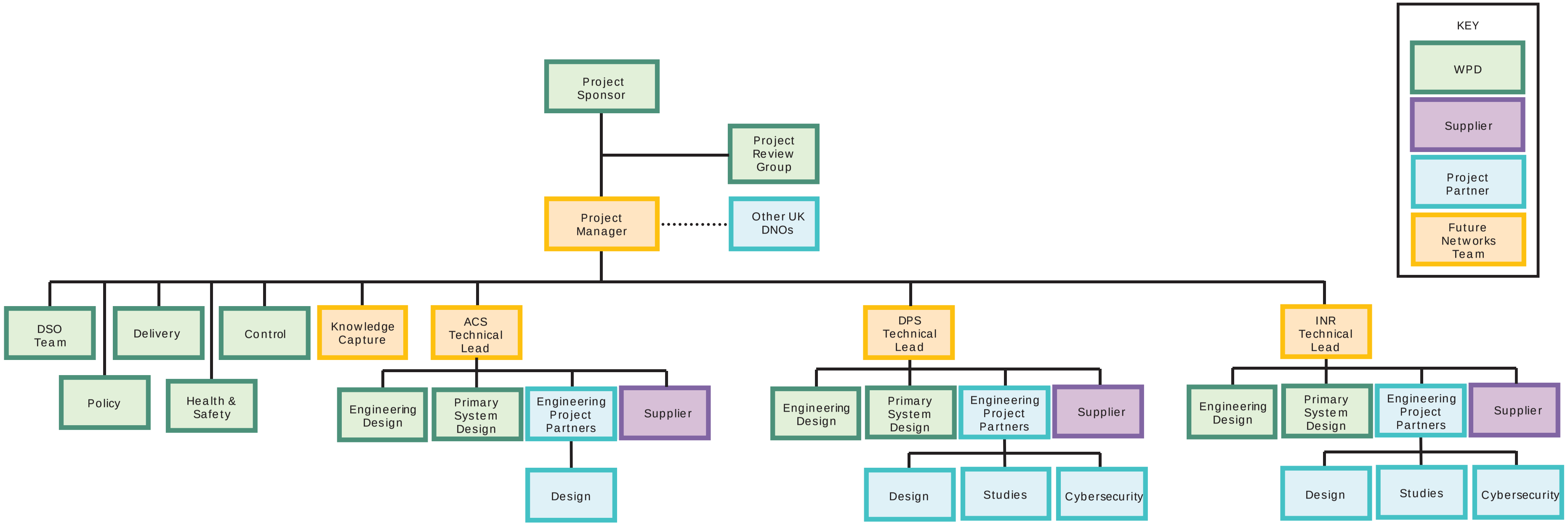
Figure D-2 – Project Partner Selection Process

This process has been used on previous large scale innovation Projects and will be adopted for the selection of the following Project Partners:

- **Manufacturers** – The key manufacturers for each Method will be selected based on a competitive tender against detailed technical specifications. The tenders will be circulated on the appropriate tender portals which were also used for RFI purposes during the FSP stage.
- **Consultancy Services** – We will tender for consultancy services where we identify the need for specialist engineering knowledge and experience to help deliver the Project.

The Project budget has been calculated using cost information from previous innovation Projects where Project Partners have been used.

Appendix E Organogram



![ofgem logo] ![RIIO NIC Network Innovation Competition logo]

Appendix F RAID Log

Risk Ref. No.	Risk Status	Risk Frequency	Owner	High Level Definition: "There is a risk that..."	Impact	Probability	Proximity	Rating	Raised by	Raised on	Risk Start Date	Target Date	Last Updated	Review Date	Cause: "...because of..."	Effect: "...leading to..."	Mitigation Action Plan	Signs that the risk is about to occur or become an Issue
Risk No.	Dropdown list	1=Timebound/One-off 2=Ongoing/Recurring 3=Not started	Responsible for mgmnt	Details of the Risk	Score 1-5 (see guide)	Score 1-5 (see guide)	Score 1-5 (see guide)	Auto Calculated	Who raised the Risk?	when was it raised?	When does this risk become relevant (eg: installation risks will not occur until the after the procurement process)	Target Date for Resolution	Last date the risk was updated	Date risk rating should be reviewed	What will Trigger the Risk?	What will happen if it occurs?	How will this Risk be avoided?	Signs that the risk is about to occur or become an Issue
R002	Raised	1	JB	Dynamic Protection Systems and Intelligent Network Reconfiguration methods cannot be fully integrated with the existing NMS.	3	3	3	27	JB	18/05/2018	01/04/2019	01/05/2019	24/07/2018	14/08/2018	The design of DPS and/or INR system is not fully compatible with the current NMS version	Delay to the Project whilst a workable solution is found	We will engage with the team responsible for NMS updates at an early stage of the project to identify any issue(s) and plan for an upgrade of the NMS (if required).	Solution providers indicate incompatibility short comings in current NMS version.
R004	Raised	1	JB	Unforeseen updates to the existing telecoms infrastructure are required for the project methods.	3	3	3	27	JB	18/05/2018	01/04/2019	01/05/2019	24/07/2018	14/08/2018	Requirements for transfer of data for DPS and INR exceeds existing telecoms capabilities	Increased costs and delays to project programme	We have costed for studies to take place during the research and design phases to understand the telecoms requirements for each of the Methods. This will inform the changes that are required to be made to the telecoms system to ensure its suitability.	The Dynamic Protection Schemes and Intelligent Network Reconfiguration methods cannot be integrated using existing telecoms equipment.
R016	Raised	2	JB	Manufacturers have severely underestimated the costs to design and build the Project Methods	3	3	3	27	NM	24/05/2018	01/07/2019	31/07/2019	24/07/2018	21/08/2018	Manufacturers do not understand the scope of the Project	An increase in project costs and a need to review project finances	We have benchmarked the costs of the Methods against similar equipment that has previously been installed by WPD. We have also included additional margin to cover costs that could arise during the detailed design phase of each of the Methods.	The cost of the equipment is higher than stated in the RFI received during proposal phase.
R011	Raised	1	JB	Section(s) of the network in the trial area become unavailable	3	3	3	27	DH	18/05/2018	01/04/2021	01/05/2021	24/07/2018	14/08/2018	A network fault	Delay to the Project whilst a workable solution is found	A number of suitable trial areas in the West Midlands where the Methods would release significant benefits have been identified in the bid stage. At the start of the project we will implement a rigorous trial area selection process which will select a number of backup trial areas for each of the Methods to mitigate for this risk.	A fault on the network in close proximity to the trial area.
R006	Raised	1	JB	The cybersecurity requirements for the Project are more stringent than anticipated	3	4	2	24	AS	18/05/2018	30/04/2020	30/05/2020	24/07/2018	14/08/2018	The Project design phase identifies additional requirements	Delay to the project programme whilst the policy changes are approved and updated.	There will be a thorough study to determine the appropriate cybersecurity measures that will be required as part of the project. These measures will be captured in WPD policy documentation that will enhance the existing policies.	Problems observed during the design phase.
R010	Raised	2	JB	The innovation required by the Method(s) is beyond the scope of the project.	3	2	3	18	JB	18/05/2018	01/10/2019	31/10/2019	24/07/2018	21/08/2018	The bid team underestimated the design required to deliver the project	Delay to the Project whilst a workable solution is found	A robust methodology for site and trial area selection will be used to ensure that project sites are suitable for the project.	Problems observed during the design phase.
R012	Raised	2	JB	High workload of required WPD internal resource delays project/ internal resource becomes unavailable during the course of the project.	3	2	3	18	JB	18/05/2018	01/04/2019	01/05/2019	24/07/2018	21/08/2018	Staff required for emergency repair work/urgent business as usual work	Delay to the Project whilst a workable solution is found	Liaise with internal resource at commencement of project and outline roles and requirements for project in line with agreed project baseline.	Delays incurred during the selection of project team.
R014	Raised	2	JB	Terms and conditions cannot be agreed with suppliers.	3	2	3	18	JB	24/05/2018	01/11/2019	01/12/2019	24/07/2018	21/08/2018	Manufacturers do not understand the NIC IPR requirements	Delay to the Project whilst a workable solution is found	Ensure that manufacturers and suppliers are sufficiently briefed on the NIC as well as the requirements for the project methods	Manufacturers are slow to sign contract.
R015	Raised	2	JB	Changes to key project personnel.	3	3	2	18	JB	24/05/2018	01/04/2019	01/05/2019	24/07/2018	21/08/2018	Changes to staff due to internal and external career moves	Delay to the Project whilst a workable solution is found	Ensure that there is up-to-date summary documentation to bring new starters to the project up to speed in the event of project changeover	Staff announce departure from current role.
R018	Raised	2	JB	The proposed solutions do not generate the expected benefits and/or outputs.	3	3	2	18	DH	24/05/2018	05/04/2023	05/05/2023	24/07/2018	21/08/2018	Unable to implement the methods or methodologies as designed	Useful project learning and information that can still be disseminated to other DNOs	Ensure that aims and objectives are reviewed by partner DNO to ensure that targeted learning is feasible	Results during trial phase are not as initially expected during proposal.
R021	Raised	2	JB	The build of the Advanced Connection Solution takes longer than expected.	3	3	2	18	DH	24/05/2018	05/04/2021	05/05/2021	24/07/2018	21/08/2018	Manufacturer has misunderstood the design requirements of the methods	Delay to testing and subsequent installation phase	Ensure that manufacturer is aware of project milestones and delivery dates. Build some slip time into project plan	The lead time specified for equipment delivery is longer than previously stated.
R003	Raised	1	JB	The technologies that are proposed for use in the project require longer approval period than anticipated.	3	2	2	12	AS	18/05/2018	01/04/2019	01/05/2019	24/07/2018	21/08/2018	Technologies require significant changes to current policies	Increased costs and delays to project programme	Where possible use approved or known technologies. Involve and consult the Engineering Design and Policy teams early in the project and at regular intervals thereafter to ensure all parties are aware of the technology requirements.	Deadlines cannot be met for production of policies.
R022	Raised	2	JB	Missing site information required for project.	2	2	3	12	NM	18/05/2018	01/04/2019	01/05/2019	24/07/2018	21/08/2018	Systems not updated	Delay to the Project whilst a workable solution is found	Site visits will be conducted and if problem is not resolved, alternative trial area locations will have been identified prior to project commencement.	Insufficient information discovered during design phase.
R005	Raised	2	JB	The Methods require refinements during the trial.	3	3	1	9	JB	18/05/2018	31/05/2021	30/06/2021	24/07/2018	31/05/2024	Trials reveal unforeseen scenarios which cannot be dealt with using the new Methods	Increased costs and delays to project programme	Each of the Methods will undergo rigorous test regimes for a multitude of scenarios prior to the trials.	Problems observed during trial phase.
R017	Raised	2	JB	Manufacturers do not want to be involved in NIC Projects due to publication and shared IPR.	3	3	1	9	JB	24/05/2018	01/04/2020	01/05/2020	24/07/2018	21/08/2018	Lack of awareness of the aims and objectives of the NIC	Delay to the Project whilst a workable solution is found	Ensure that the information is given on the NIC in the RFI, specifically the IPR requirements	Manufacturers do not submit tender.
R020	Raised	2	JB	Project cost and scope begins to creep.	3	3	1	9	JB	24/05/2018	01/10/2019	31/10/2019	24/07/2018	21/08/2018	Lack of understanding during design phase of the requirements to deliver the methods	Delay to project in order to quantify cost increases and determine source of problem	Closely monitor project progress against budget and allocate contingency funds	A number of additional actions are required to be allocated.
R001	Raised	2	JB	The available project team do not have the knowledge or experience to deliver the project.	3	2	1	6	NM	24/05/2018	01/06/2019	01/07/2019	24/07/2018	21/08/2018	Lack of continuity or disconnect between the bid and delivery phase	Delay to the Project whilst a workable solution is found	As far as possible ensure continuity between bid team and delivery team	Problems observed during the design phase.
R007	Raised	1	JB	The solution cannot be fully demonstrated during trials of the system.	3	2	1	6	JB	18/05/2018	01/04/2024	01/05/2024	24/07/2018	21/08/2018	Limitations have been imposed on the trial area	Delay to the Project whilst a workable solution is found	A suitable duration for system trialling will be incorporated into the project programme with sufficient contingency to allow for the full demonstration of the Methods.	Problems observed during the install phase.
R008	Raised	1	JB	The technology footprint for the Advanced Connection Solution is too large.	3	1	2	6	NM	18/05/2018	30/04/2020	30/05/2020	24/07/2018	21/08/2018	The manufacturers have underestimated the size of the device	Fewer installations of larger equipment at suitable sites. The project may not be able to deliver the same learning at sites that were not initially chosen	A detailed functional specification will be developed that emphasises the minimisation of the Advanced Connections Solution as far as is reasonably practicable without compromising the installation, operation and maintenance of the internal equipment as well as the safety of the device. Additional alternative locations for Advanced Connections Solution installation will also be identified during the site selection stage.	The designs provided by the manufacturer are larger than the available space at site.
R009	Raised	2	JB	Unable to secure wayleaves for the rollout of the Advanced Connection Solution devices.	3	2	1	6	JB	18/05/2018	30/04/2020	30/05/2020	24/07/2018	21/08/2018	A number of chosen trial locations could not be used and other sites are not suitable	Delay to the Project whilst a workable solution is found	Alternative locations for the installation of Advanced Connections Solution shall be identified during the site selection stage.	Delays in receiving correct documents prior to install phase.
R013	Raised	1	JB	Both traditional and new solutions have to be implemented for the project.	3	2	1	6	JB	18/05/2018	01/08/2021	31/08/2021	24/07/2018	21/08/2018	Design of the implemented solutions is not reliable	Delay to the Project whilst a workable solution is found	Ensure that delivery team is up to speed on project objectives and ensure that the tender design reflects all project requirements	The design phase indicates that backup equipment is required.
R019	Raised	2	JB	Project Partners and/or supporting DNO withdraws support for the project.	3	2	1	6	JB	24/05/2018	01/07/2019	31/07/2019	24/07/2018	21/08/2018	Project Partners are no longer able to support the project	No other DNO to validate project outcomes	Ensure Project Partners is sufficiently invested in the project and it suitably aware of the key aims and objectives	Project partner calls meeting to discuss their involvement.
R023	Raised	2	JB	Equipment procurement delays project.	2	3	1	6	JB	18/05/2018	01/07/2020	31/07/2020	24/07/2018	21/08/2018	Equipment is delayed/ arrives later than expected in Project Plan.	Delay to the Project whilst a workable solution is found	Select alternative manufacturer/ technology.	Equipment lead time is specified as longer than previously indicated by manufacturers.
R024	Raised	2	JB	WPD staff require additional training in order to use the new technology when it is deployed.	1	1	1	1	AS	18/05/2018	01/04/2022	01/05/2022	24/07/2018	21/08/2018	Staff unavailable during training event before equipment is installed on the network.	Delay to the Project whilst a workable solution is found	Ensure that training is a requirement of the procurement contracts and is factored into the project programme	WPD staff are unsure how to operate the equipment safely.

Appendix G Trial Area Schematics and Maps

G.1 West Midlands Trial Areas

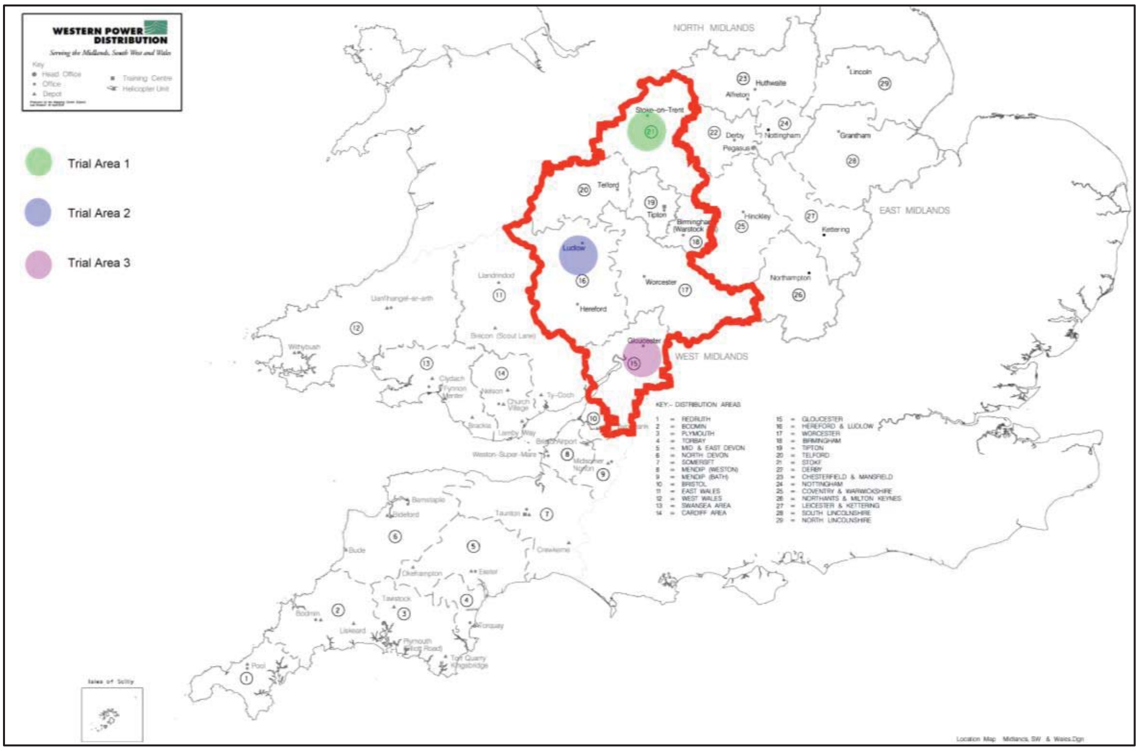


Figure G-1 – WPD West Midlands Map

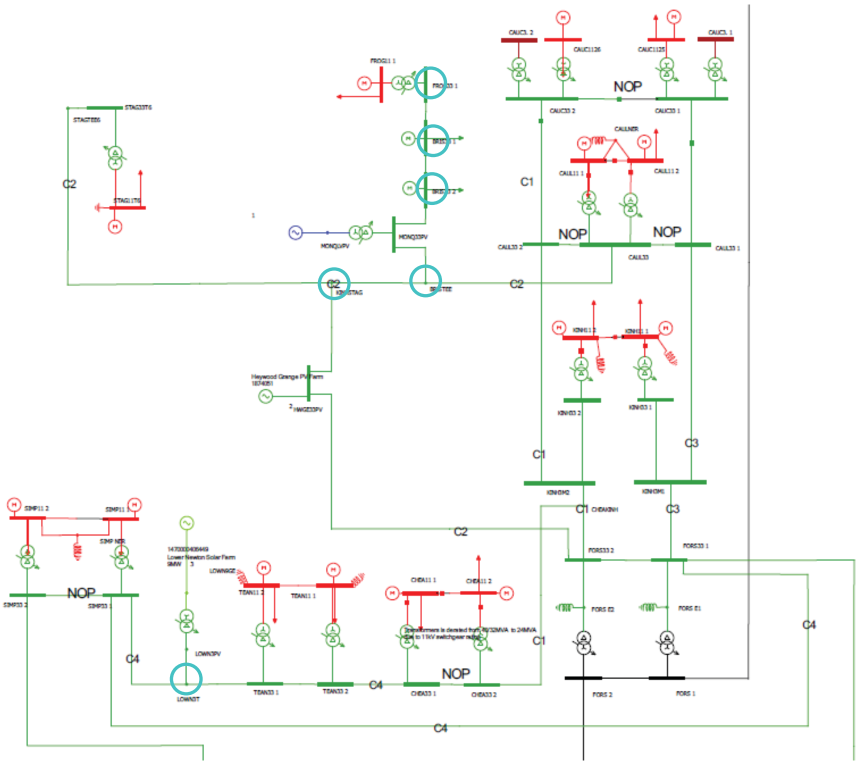


Figure G-2 – Schematic Diagram Trial Area 1

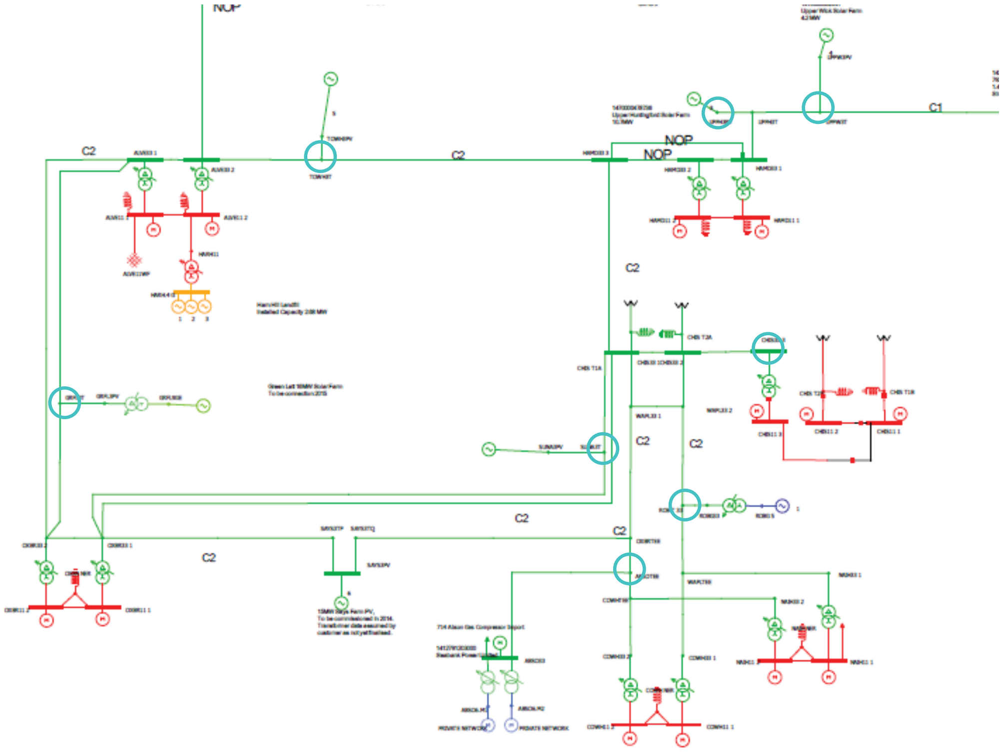


Figure G-3 – Schematic Diagram Trial Area 2

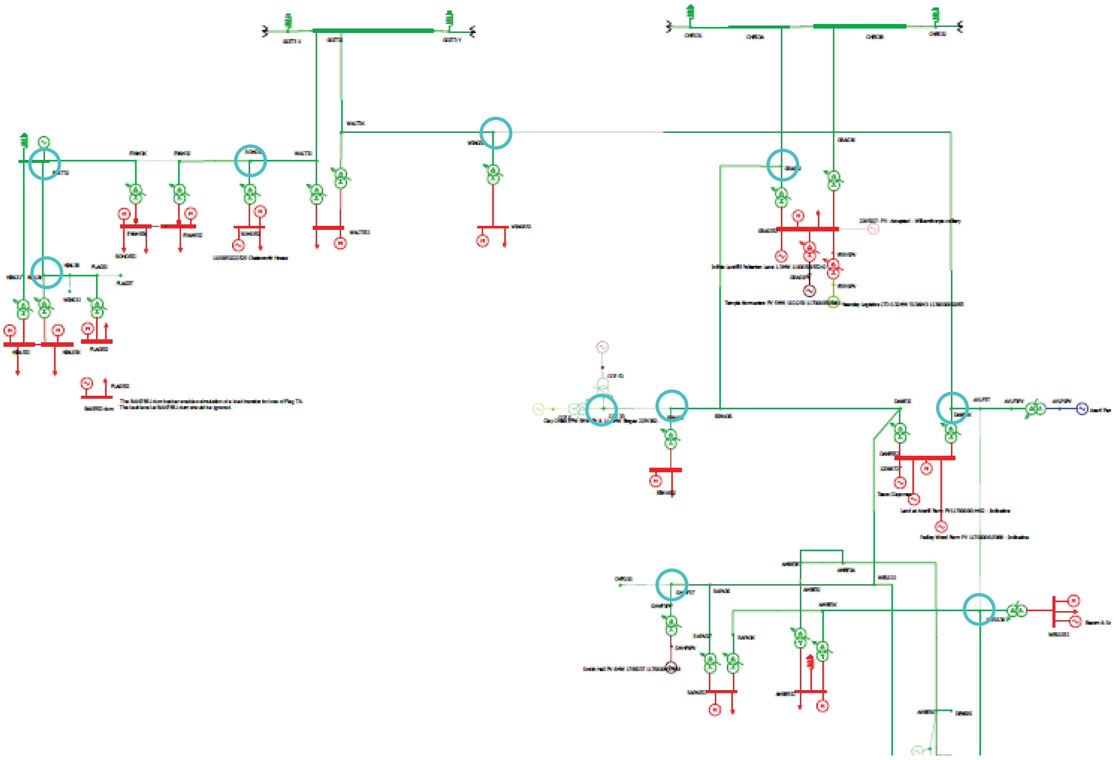


Figure G-4 – Schematic Diagram Trial Area 3

Appendix H Base Case Costs

H.1 ACS

The counterfactual to the ACS Method is the t-connection which is currently the most common way of connecting new DG on the 33kV network. The t-connection connects DG via a single spur branching off the main 33kV circuit as shown in Figure H-1. The main advantage of this arrangement is that it is a low cost solution typically involving a new termination pole and Air Break Isolator (ABI) at the spur-off point. The generator is usually cable connected to the new termination pole. The significant drawback of this solution is that it is a non-firm connection which means that the connected generator is disconnected for every outage event on the main 33kV circuit. The design of the t-connection is therefore low cost but it has inherent inflexibility which leads to significant amounts of low carbon energy being disconnected from the distribution network under outage periods.

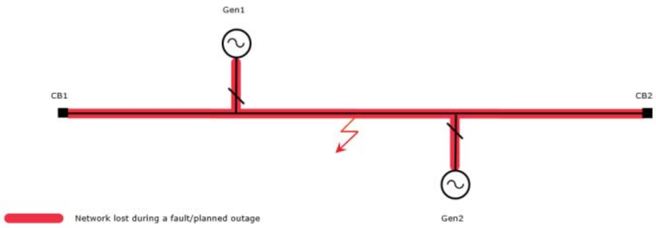


Figure H-1 – The ACS Base Case (t-connection)

The Base Case cost is defined by the following formula:

Base Case (BC) Cost = BC Lost Revenue + BC Capex + BC Opex

In our business case analysis the Base Case cost is the summation of the lost revenue, Capex element and the Opex element for each year over the asset's life. The asset lifetime is specified as 40 years. A detailed description of the methodology for calculating the Base Case lost revenue for the average 33kV connected generator is given in Appendix K. The Capex cost of the t-connection has been determined by investigating the cost breakdown of three new DG customers recently connecting to our network. The average Capex cost was found to be £21k. It is to be noted that this is the cost to install the equipment at the spur point off the main circuit and does not include the cable from the new termination pole to the generator as this would be required in both Base Case and Method scenarios. The Opex cost of the t-connection was calculated using the methodology in our "Statement of Methodology and Charges for Connection to Western Power Distribution (West Midlands) PLC's Electricity Distribution System". This cost largely relates to the maintenance of the termination pole and ABI.

H.2 DPS

The DPS Method is required to ensure that there remains a high level of protection system performance when the 33kV network is constantly reconfiguring with INR. There are currently no Solutions which are practicable and therefore cannot be implemented on the distribution network as they would reduce the security of supply for customers and jeopardise the integrity of the network. Therefore, the Base Case cost against the DPS Method is zero however, the DPS Method is a necessary facilitator to the ACS and INR Methods.

H.3 INR

The Base Case is traditional reinforcement supported by ANM. Traditional reinforcement creates new network capacity through the installation of new assets (or the replacement of assets with new assets with a higher electrical rating). The main disadvantage of traditional reinforcement is the delivery timescales which are longer than the needs for connecting customers.

The costs associated with ANM have not been included within the Base Case as the roll-out of ANM is assumed to be consistent for both Base Case and Method roll-outs.

The Base Case cost of traditional reinforcement is therefore defined by the following formula:

Base Case (BC) Cost = BC Lost Revenue + BC Capex + BC Opex

The Base Case cost is the summation of the lost revenue, Capex element and the Opex element for each year over the asset's life. The asset lifetime is specified as 40 years. A detailed description of the methodology for calculating the Base Case lost revenue for the connection of a new generator is given in Appendix K. The Base Case Capex cost of traditional reinforcement has been defined as the installation cost of a new 'average' 33kV circuit. The average 33kV section length was calculated as 3.48km from data contained in our 2017 Long Term Development Statement (LTDS) and the associated Opex costs have been based on data contained within our "Statement of Methodology and Charges for Connection to Western Power Distribution (West Midlands) PLC's Electricity Distribution System". This is further detailed in Appendix K. The Capex cost of a new average 33kV circuit has been calculated as £801k and this circuit releases 29.3MVA of network capacity.

H.4 Base Case Cost Graphs (Post-trial Solution)

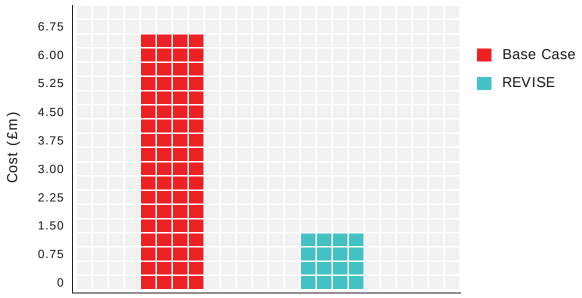


Figure H-2 – ACS Base Case cost comparison

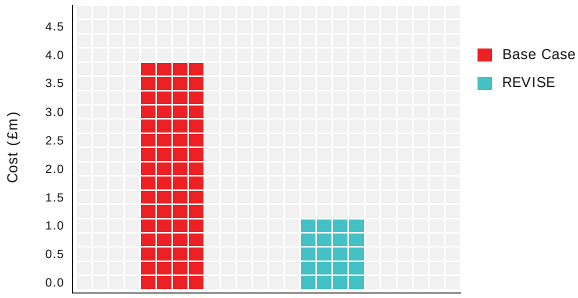


Figure H-3 – INR Base Case cost comparison

Appendix I NPV Analysis and Break-even Analysis

I.1 Overview

This Appendix summarises the NPV analysis. The benefits have been presented in NPV terms with a discount rate of 3.5% applied for the first 30 years, reducing to 3.0% thereafter. The figures have been presented in real terms using 2018/19 prices. The benefits have also been presented on a cumulative basis in £m.

NPV Summary

A summary of the NPV analysis is provided in Table I-1.

Table I-1 – Summary of NPV analysis

Scale	Method	2030 (£m)	2040 (£m)	2050 (£m)
Post-trial Solution (individual deployment)	ACS	-0.010	1.007	1.759
	DPS	-1.215	-1.251	-1.277
	INR	2.189	2.221	2.244
	Total	**0.965**	**1.977**	**2.726**
Licensee Scale (if applicable, indicate the number of relevant sites on the Licensees' network)	ACS	-7.646	15.314	40.139
	DPS	-12.012	-20.187	-26.501
	INR	22.001	37.404	49.027
	Total	**2.342**	**32.530**	**62.665**
GB rollout scale (If applicable, indicate the number of relevant sites on the GB network)	ACS	-19.314	33.311	97.263
	DPS	-41.884	-84.056	-115.280
	INR	74.831	151.369	209.183
	Total	**13.633**	**100.624**	**191.166**

Break-even Analysis

A summary of the break-even analysis is given in Table I-2.

Table I-2 – Summary of break-even analysis

Scale	Method	Year
Post-trial Solution (individual deployment)	ACS	2031
	DPS	-
	INR	2024
	Project	**2024**
Licensee Scale (if applicable, indicate the number of relevant sites on the Licensees' network)	ACS	2034
	DPS	-
	INR	2024
	Project	**2029**
GB rollout scale (If applicable, indicate the number of relevant sites on the GB network)	ACS	2035
	DPS	-
	INR	2024
	Project	**2026**

The break-even year for DPS is not applicable as the DPS Method does not have a Base Case cost. The detailed justification for this is given in Appendix H and K.

WESTERN POWER DISTRIBUTION

Key Facts

Value: £12.5M

Area: West Midlands

Duration: 2019—2023

REVISE

Flexible Solutions for an Evolving Network

Our new Network Innovation Competition bid for 2018, REVISE, is focussed on delivering technical solutions that facilitate quicker and more sustainable connections to the network for generators and low carbon loads. The project is looking to develop its three solutions on the 33kV network, which is where we and other DNOs have seen the greatest level of generator connections, in West Midlands and will cost £12.5M delivering a benefit of over £190m a carbon saving of 1.3MtonnesCO_2 and releasing in excess of 11GW of connection capacity if rolled out across the country.

REVISE is looking to solve two significant issues; the first is that the standard connection to the existing 33kV network for new generators is an inflexible but relatively cheap t-connection. A t-connection is a single, solid connection, to the network which for any fault or issue on the wider network is likely to be disconnected. This is an issue as we and other DNOs now have to regularly change how we configure our network to enable maintenance activities and to proactively respond to faults. REVISE will investigate a new technology to enable customers to connect to the network, both faster and more flexibly, meaning that when these maintenance activities and faults effect the network the generator will be able to stay connected; this will also have a wider societal benefit of increasing the amount of low carbon generation providing power to all customers.

The second is the availability of the existing network to accept additional generation and low carbon loads. When looking to connect new customers to the network often new network construction is required, this can be expensive and take a long time to deliver, often several years. REVISE will investigate and trial how we can maximise the availability of the existing network, rather than having to replace or build new parts, by constantly monitoring the state of the network and rather than leaving it in one fixed condition, as is currently how networks are operated, we will reconfigure the system releasing capacity as required. To do this lots more information about the network is required and how we protect the network will have to dramatically change. This is similar to smart motorways, where if its seen that more cars need to use a certain part of the motor how it operated and is configured, such as making use of the hard shoulder, and additional protection is employed by reducing the speed limit. REVISE will demonstrate that it is possible, with the use of new technologies and solution, on the electricity network enabling considerable reinforcement work to be avoided.

FINANCIAL SAVINGS	EMISSION SAVINGS	CAPACITY RELEASED
£191 million	1,343,653 Tonnes of CO_2	11.8GW
Equates to network charges to over 1m customers a year	Equivalent to planting 2.4 million trees	Equal to 20% of current peak UK electricity demand

FLEXIBLE SOLUTIONS FOR AN EVOLVING NETWORK

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Appendix K Business Case Supplement

K.1 Overview

This Appendix provides supplementary information that has been used for the production of the Business Case for REVISE. The Appendix has been structured individually per Method providing a description of how the Business Case was formed and the assumptions used. The documents used to inform the assertions made are as follows:

Table K-1 – Reference Documentation

Author(s)	Title
All UK DNOs	Long Term Development Statement
BEIS	The Clean Growth Strategy
Circular Ecology	Inventory of Carbon and Energy Database
NGET	Future Energy Scenarios
Ofgem	Electricity Distribution Price Control Cost, Volume and Revenue Reporting
WPD	Shaping Subtransmission to 2030
WPD	Statement of Methodology and Charges for Connection to Western Power Distribution's (West Midlands) PLC's Electricity Distribution System
WPD	Engineering Policy Documentation (Various)
WPD	Connection Quotations (Various)

K.2 Advanced Connection Solution

The primary driver for the ACS implementation is to develop a next generation connection Solution for DG that is able to maximise low carbon energy transfer over the distribution network. The following section provides details on the methodology used to calculate the benefits attributed to the ACS.

K.2.1 Forecasts

To derive the required capacity of DG connecting on the 33kV network, we have calculated the percentage of DG (>1MW) connected to the 33kV network in the present day and used this value to determine the fraction of forecast DG capacity connecting to the 33kV network per year up to 2050. The typical size of existing generators on the 33kV network was calculated in order to determine the average number of generators that would connect by 2030 and 2050 to meet the required forecasts.

K.2.2 Benefits

Financial

The principal financial benefit of the ACS has been calculated based on the revenue that DG customers receive from the additional energy that is transferred across the network when compared to the Base Case. The increase in energy transferred was calculated by multiplying the average generator size by the average outage time per year. The average outage time was determined by our detailed outage planning records and experience of managing these events on our network. The additional DG revenue was determined by multiplying the energy by the price per MWh (£/MWh) for the average sized generator.

The £/MWh revenue figure was estimated based on a review of the average £/MWh levelised costs associated with electricity generation which has been compiled by The Department for Business, Energy and Industrial Strategy (BEIS). A factor was applied to the average levelised cost in order to estimate the £/MWh revenue which is assumed to be above cost i.e. that generators make a net profit.

Carbon

The carbon benefit of the ACS is calculated from the increase in energy transfer that was used in the financial calculations. In the Base Case scenario the DG would be disconnected for the duration of the outage, therefore the energy that would have been supplied by the renewable DG is now supplied from the transmission connected generation mix with higher carbon emission levels. With the deployment of ACS, the generators now remain connected during the outage and this energy is sourced from local renewable DG. Therefore, the carbon benefit is the carbon emissions equivalent ($kgCO_2e$) of the energy that is lost in the Base Case scenario. The carbon emissions associated with this energy were gathered from the average of the four projections in the NG FES; this value is 186 $kgCO_2$/MWh.

To ensure a robust approach to the carbon benefit calculation, the embodied carbon of both the Base Case and ACS device was included. The embodied carbon of a piece of equipment can be calculated by knowing its mass and material where the mass can be determined from the equipment volume. The embodied carbon of the ACS unit was estimated by summing the embodied carbon of the enclosure and the switchgear (the largest components within the enclosure). The volume of the average enclosure size could be determined from the responses to our RFI. The enclosure material was selected to be concrete for the purposes of this analysis as this was the most carbon intensive material proposed in the RFI. The embodied carbon of the switchgear was estimated by assuming it was similarly dimensioned to an off-the-shelf 33kV circuit breaker and made from predominantly steel. A factor was then applied to account for other materials as well as transport and construction activities. All material embodied carbon figures were sourced from the Inventory of Carbon and Energy (ICE).

K.2.3 Roll-out Methodology

The deployment of ACS Method is split into three distinct roll-out scenarios:

1. **Post-trial (individual Method deployment)** – A single ACS Method (five units) is deployed across the West Midlands licence area;
2. **Licensee scale** – The ACS Method is rolled-out across all four of our licence areas; and
3. **GB scale** – The ACS Method is rolled-out across GB.

The post-trial roll-out occurs in 2024. In this period a single ACS Method is deployed which represents five ACS units.

The ACS business case calculations for the licensee and GB scale roll-outs have incorporated three levels of roll-out: minimum, medium and maximum. These levels have been used to determine the sensitivity of the business case to different roll-out penetrations. The minimum roll-out for the ACS Method corresponds to a total of eight ACS Methods across WPD's four licence areas and 28 Methods across GB up to 2050; this represents two Method roll-outs across each licence area. The maximum roll-out is based on the forecast numbers of DG connecting to the 33kV network. This corresponds to 77 ACS Methods across our four licence areas and 199 Methods across GB by 2050. The maximum number of ACS Methods has been capped at 70% of the total number of new DG connections. This is to take into account that there will still be small numbers of DG that will still utilise the Base Case to connect to the network. The medium roll-out level is the median number of units per year between the minimum and maximum projections for each roll-out scale. All of the ACS financial, carbon and capacity benefits stated in this document are based on the medium roll-out level. The GB roll-out projections for ACS are shown in Figure K-1.

K.3 Dynamic Protection System

K.3.1 Forecasts

The DPS Method is a facilitator for the INR Method and therefore the forecasts used for INR roll-out have been replicated for DPS.

K.3.2 Intangible Benefits

The benefits of DPS have been included within the INR Method. The following additional benefits have not been measured but nonetheless provide value to the network and customers.

Performance

The DPS Method will help to mitigate customer interruptions by ensuring the minimum section(s) of the network is disconnected when faults occur, which is not achievable using existing protection technologies.

Scheme Flexibility

The combination of software and hardware used for the DPS Method will have the capability to seamlessly transition between various protection functions as required. The system will have the ability to determine and enable the optimum scheme when the configuration or parameters of the network change. This will save significant time and effort as the system will perform the studies and calculations autonomously without the requirement for manual intervention.

K.3.3 Roll-out Methodology

The deployment of DPS Method has been calculated to align with the INR Method as detailed in Section K.4.3 and is split into three distinct roll-out scenarios:

1. **Post-trial (individual Method deployment)** – A single Method (10 units) is deployed across the West Midlands licence area;
2. **Licensee scale** – The DPS Method is rolled-out across all four of our licence areas; and
3. **GB scale** – The DPS Method is rolled-out across GB.

The GB roll-out projections for DPS are shown in Figure K-2.

K.4 Intelligent Network Reconfiguration

The primary driver for the installation of INR is the release of network capacity that can be used to connect the forecast levels of DG on the 33kV network. The following sections describe how we have determined the benefits from the INR Method as part of this business case.

K.4.1 Forecasts

The same forecast data that was used for the ACS Method has been used for the INR business case.

K.4.2 Benefits

Financial

There are two financial benefits associated with the INR Method. The principal financial benefit of INR is the reduction in cost of releasing capacity compared with the equivalent cost of implementing traditional reinforcement.

The secondary financial benefit is that a new generating customer will be able to start selling energy earlier with INR when compared to the Base Case. This is because the INR system is faster to deploy than the Base Case. It has been calculated that the roll-out of INR will take approximately 12 months compared to 15 months to install a new average 33kV feeder circuit.

The INR Method is a highly innovative automated control system that will utilise the latest computing and machine learning techniques. Therefore the development cost of the technology during the project will be high. However, this is a 'one-off' development cost and has not been factored into the Method costs. The Method costs are therefore split as following:

1. **Initial roll-out cost** – every DNO that installs INR will have to install the system architecture for INR and integrate the system to their NMS.
2. **Subsequent install roll-out cost** – the cost of rolling-out the INR at additional sites after the initial cost of setting up the system architecture. This has been calculated as 25% of the Initial roll-out cost.

The results from the power system studies along with our data calculation were used to compare the INR implementation with the counterfactual for WPD's four licence areas and GB. We have proactively considered the implementation of ANM in the roll-out methodology and determined that the utilisation of ANM is assumed to be consistent for both Base Case and Method roll-outs.

It is to be noted that the financial benefit calculations have been determined based on reinforcement of a single 33kV circuit. In reality, the installation of a new 33kV circuit would usually involve the installation of two circuits to take into account the N-1 condition for line outages. Therefore, the calculation has been conservative in this respect.

Carbon

There are two sources of carbon benefit associated with the INR Method. The principal carbon benefit is due to new generating customers being able to connect to the network in faster timescales when compared to the Base Case. This accelerated connection time will translate to an increase in low carbon energy produced by renewable DG. Therefore, the carbon benefit is the carbon emissions equivalent ($kgCO_2e$) of the energy that is lost in the Base Case scenario due to the connection delay of traditional reinforcement. The carbon emissions associated with this energy were gathered from the average of the four projections in the NG FES; this value is 186 $kgCO_2$/MWh.

The secondary carbon benefit is calculated from the embodied carbon content of the traditional reinforcement that would be required to match the capacity released by INR.

The average 33kV circuit length was used to calculate the embodied carbon of the Base Case. The overhead line section is assumed to be an aluminium conductor and the cable section is assumed to be copper conductor. The dimensions and sizes of the overhead line and cable were taken from our policy documentation. It was assumed that for each new circuit there would also be the requirement for a new circuit breaker. The embodied carbon of a circuit breaker was previously calculated for the ACS Method. Using the embodied carbon for copper and aluminium (documented in the ICE table of material embodied carbon), the total carbon content could be estimated. Finally, the number of average circuits was found by dividing the INR capacity release by the capacity release of the average circuit.

Capacity

The capacity released by INR was calculated using the output from studies on the trial area networks. The average capacity release from the trial area networks was used to determine the capacity release per roll-out (i.e. BSP) across WPD and GB.

Table K-2 provides the results of the capacity release calculations which were carried out for trial areas using a power system analysis tool:

Table K-2 – INR capacity release results

Description	Value (MVA)
Generation Capacity per INR Unit (MVA)	41.73
Load Capacity per INR Unit (MVA)	49.51
Generation Capacity per Method (MVA)	83.47 (2 x unit capacity)
Load Capacity per Method (MVA)	99.02 (2 x unit capacity)

K.4.3 Roll-out Methodology

The deployment of INR Method is split into three distinct roll-out scenarios:

4. **Post-trial (individual Method deployment)** – a single Method (two units) is deployed across the West Midlands licence area;
5. **Licensee scale** – the INR Method is rolled-out across all four of our licence areas; and
6. **GB scale** – the INR Method is rolled-out across GB.

The post-trial roll-out occurs in 2024. In this period a single INR Method is deployed which represents two INR units.

The INR business case calculations for the licensee and GB scale roll-outs have incorporated three levels of roll-out: minimum, medium and maximum. These levels have been used to determine the sensitivity of the business case to different roll-out penetrations. The minimum roll-out for the INR Method corresponds to a total of eight INR Methods across WPD's four licence areas and 28 Methods across GB up to 2050.

There is a single INR unit installation per 132/33kV BSP therefore the maximum theoretical number of unit installations is the total number of BSPs in all four of our licence areas and the total number of BSPs in GB for the GB scale deployment. In reality it will not be possible to install INR at every BSP, therefore, the maximum deployment has been capped at 70% of the total number of licensee and GB BSPs. A linear interpolation between the post-trial individual deployment and the maximum number of INRs fixed at 2050 was then implemented to generate the maximum INR roll-out projection.

The medium roll-out level is the median number of units per year between the minimum and maximum projections for each roll-out scale. All of the ACS financial, carbon and capacity benefits stated in this document are based on the medium roll-out level. The GB roll-out projections for INR are shown in Figure K-3.

The forecast data was used to check that the capacity released of the maximum number of cumulative INR installations did not exceed the total amount of installed DG capacity over the analysis period.

K.4.4 Roll-out Graphs

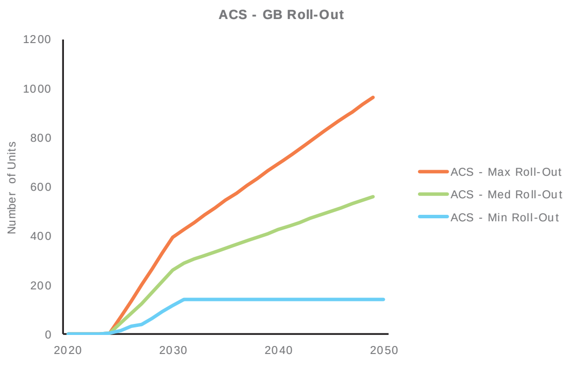


Figure K-1 – ACS GB roll-out

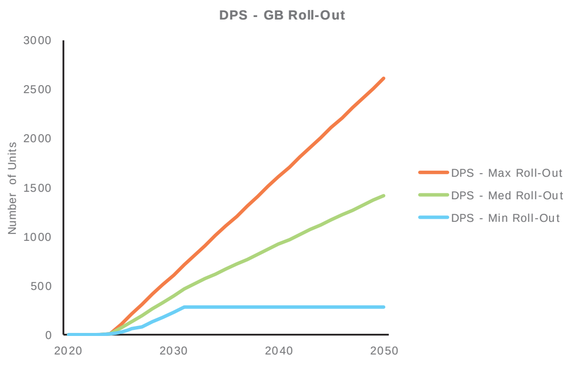


Figure K-2 – DPS GB roll-out

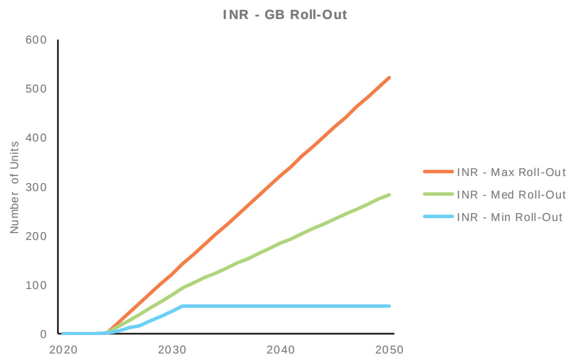


Figure K-3 – INR GB roll-out

K.4.5 Intangible Benefits

INR has a number of benefits that haven't been quantified in the business case but nevertheless will provide further value to the roll-out of this Method.

Reducing Losses: the INR system will have significant capacity to reduce electrical losses on the electricity network. By reconfiguring the network to link local loads and local distributed generation, energy transfers across the distribution network will be promoted over transfers from higher voltage levels.

In addition, based on its advanced algorithms, the INR system could increase meshing of the 33kV network over the area where it is installed. Meshing of the 33kV network will again reduce the reliance on energy transfers from higher voltage levels and therefore reduce the losses because the energy has been transmitted over shorter distances. The advanced INR algorithms would only increase meshing of the network provided it is safe to do so based on the various network parameters that it is monitoring in real time.

Low Carbon Network Efficiency: one of the key aspects of INR will be the ability of the system to intelligently connect renewable DG with local distribution load. Exploiting the low carbon energy that these generators produce is important in the transition to a low carbon economy and the need will increase as significant numbers of renewable DG are forecast to connect to the 33kV network in the coming years.

Appendix L Technical Description of Project Methods

L.1 Overview

The following Appendix provides a technical description for each of the three Methods for REVISE.

L.2 Advanced Connection Solution

L.2.1 Design objectives

The ACS will be designed with safety and space efficiency at the forefront. The ACS will be contained in a single, ultra-compact housing so that it can be transported to site safely and with minimal work required to integrate it with the network. This ultra-compact housing will be possible with the use of state-of-the-art digital systems making the ACS appear similar in size to an 11kV/LV package substation as shown in Figure L-1. Using modern digital systems will also translate to significant capex and opex cost savings. The ACS will adopt a 'plug-and-play' design to ensure customer connection times are as fast as possible. This will be achieved by implementing the testing and commissioning of the device in the factory prior to delivery at the site. In addition, the design of the ACS will be modular and standardised so that it is able to connect to any 33kV network. This 'one size fits all' approach is paramount to allow wider roll-out of the Method across GB and to reduce the costs associated with bespoke designs.

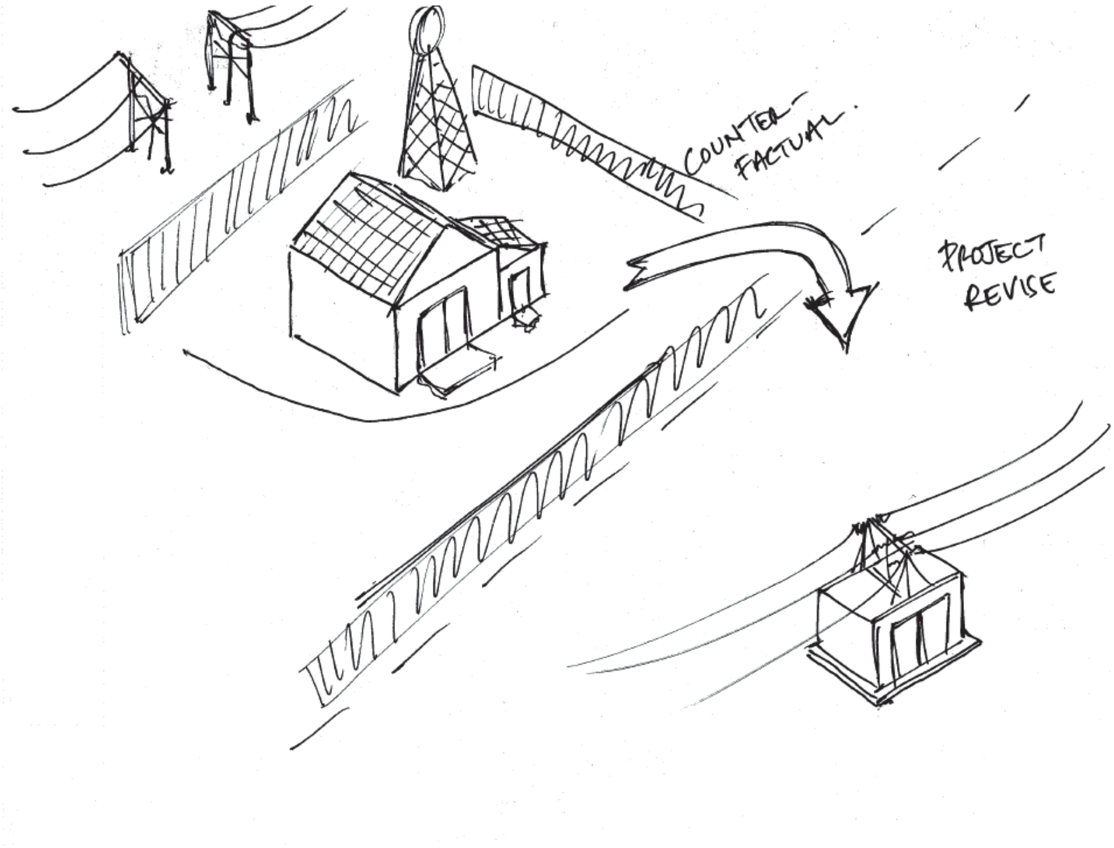


Figure L-1 – BAU versus. REVISE

L.2.2 BAU Solution

The BAU Solution that provides the flexible, or “looped”, 33kV DG connection begins with a bespoke design which would use standardised equipment normally utilised at a large 132/33kV Bulk Supply Point (BSP). The types of equipment found in BSPs have been designed with high levels of resilience and redundancy. This is due to security of supply being paramount due to the high numbers of customers that are supplied from these types of substations. Equipment with this level of resilience and redundancy is not required by DG connections but it is utilised because viable equipment alternatives are very limited and untested.

The standardised equipment used for a BAU connection Solution is typically installed in a purpose built switch house. The building is designed such that all the equipment has sufficient clearances around it with a separate dedicated area for telecommunication equipment. The building including the provision for telecommunications requires a footprint of approximately 65m². This footprint is likely to be much larger when access requirements are taken into account.

The timescales for installing and energising the BAU Solution can take up to 15 months when considering the time required for finalising the design, obtaining approvals, ordering equipment and constructing the building.

L.2.3 The ACS Technical Innovation

The ACS Method will provide a brand new approach for connections to the network and demonstrate several advantages over the BAU Solution, the main one being the condensed size as shown in Figure L-1. The advantages of the ACS will be demonstrated through:

- **Consolidation of devices and equipment** – The ACS will aim to reduce the number of individual components that are normally provided in the BAU Solution:
  - *Auxiliary voltage* – the BAU Solution has at least four separate devices that derive different voltages: 110V DC battery and charger, 48V DC battery and charger, LVAC switchboard and 33kV VT. The ACS will be designed to reduce the number of different auxiliary voltage levels and provide a single unit which can provide all supplies and voltage references for the equipment.
  - *Protection* – The ACS will combine separate relays that are currently used for different functions, into one multifunction relay that can integrate with the Dynamic Protection System. The wiring for the scheme will also be simplified to reflect the nature of the connection.
- **Digital Substation** – The ACS will be designed as a Digital Substation, again to reduce size, but also with the following benefits:
  - *Operability and visibility* – existing equipment is controlled through many individual switches and generates analogue information for sending back to the control centre. Introducing digital technology will streamline controls allowing for increased operability and more granular data will improve the visibility of the network being controlled.
  - *Installation and commissioning time* – interfaces between existing equipment is typically hardwired using significant volumes of multicore cables which require manual labour to install. The “plug and play” characteristics of a digital substation will significantly reduce installation and commissioning time from weeks to hours.

   - *Diagnostics and repairs* – fault finding both within substation equipment and out on the network can be difficult due to the lack of data and various locations that need to be investigated. Integrating the latest digital technology will allow operators to pin-point faults remotely and enable fixes to be carried out much quicker than in the BAU Solution.
- **Standardised and pre-commissioned** – the benefits of consolidating devices and implementing digital substation technology will mean that the ACS can be:
   - *Standardised* – the ACS will be designed such that a single Solution can be used in a number of different network configurations (overhead line, underground cable, main network connection, connection to a spur etc.
   - *Pre-commissioned* – the equipment will come in a pre-fabricated enclosure already pre-commissioned and ready to be delivered to site. Only minor preparatory works will be required at site before the EHV connections can be made and final commissioning is performed.

Based on the RfI returns that were received from manufacturers, the footprint of ACS would be **less than 20%** of the BAU Solution.

L.3 Dynamic Protection System

L.3.1 Design objectives

The DPS will provide new protection systems that are a necessity for ensuring that low carbon networks of the future are safely protected. Protection schemes need to advance hand-in-hand with distribution networks as the number and complexity of the connected devices increases so that the benefits of flexible network can be realised. An analogy of this is mobile communications where mobile networks had to advance in step with increasingly complex mobile handsets, the result of this feedback mechanism was the creation of myriad new applications, services and markets. The comparison of mobile phone and electrical distribution networks is illustrated in Figure L-2.

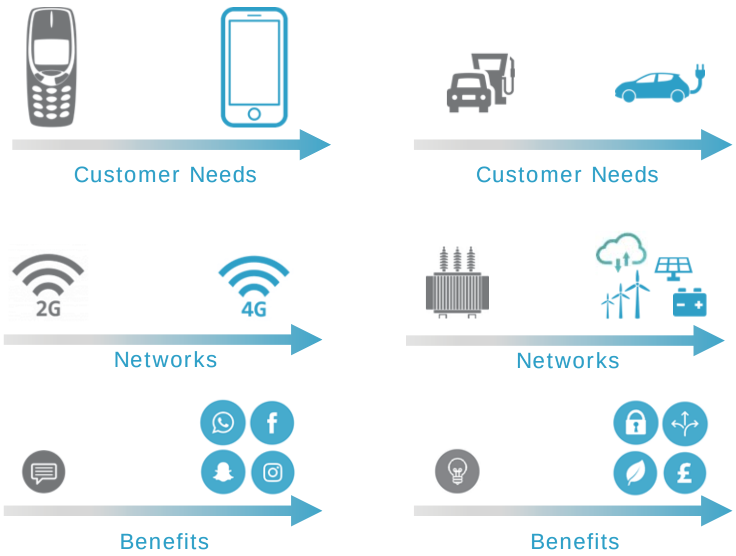


Figure L-2 – Advances in technology

DPS aims to overcome the limitations of static protection schemes which are often limited to protecting a specific network area. New technologies will be trialled that can respond to real-time changes in a constantly changing network and provide a tailored protection Solution for every configuration.

L.3.2 BAU Solution

Static protection schemes which are currently commonplace on the 33kV network can introduce barriers for the connection of new customers or changes in operational configuration. This is typically due to a limit in functions which are available and/or the capability of the device. For each new connection point or a new operational configuration, the protection of the main circuit requires careful consideration by designers and operational engineers. For example, the protection scheme would first of all require studies to be performed by a planning engineer, the impact of those studies would then be assessed by the design engineer, modifications proposed as required, then for these modifications to be deployed and tested by an operational engineer. This process can be long and drawn out especially due to the limitations in existing technologies and where equipment needs to be replaced. As the distribution network is moving rapidly into a new era where the network becomes more complex and connections increase, a new approach to protection schemes is urgently required. Figure L-3 shows a number of counterfactual operating conditions with INR enabled which demonstrates that a new approach is needed.

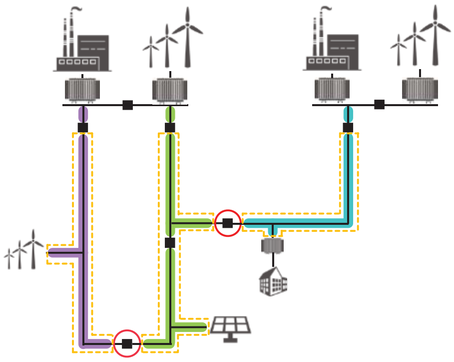
L.3.3 The DPS Technical Innovation

The DPS Method will enable networks to be safely protected whilst permitting the much needed flexibility as we balance load and DG. The advantages of the DPS will be demonstrated through:

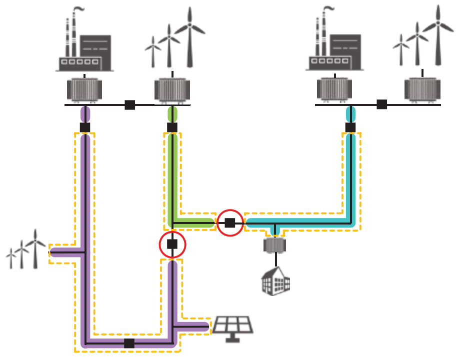
- **Consolidating devices** – The DPS will implement new technology which will allow for the selection of any number of protection functions and settings. The BAU Solution will typically be equipped with distance, overcurrent and earth fault, busbar protection and auto-reclose relays, in addition to a number of auxiliary relays which monitor the status of equipment. The DPS will refine and consolidate these individual relays and provide a system which will be equipped with all protection functions will be enabled and disabled depending on the requirements of the network.
- **Control System** – The DPS will have the ability to control how functions and settings are calculated and deployed depending on the complexity of the network configuration. The list below indicates the expected levels of control the DPS will offer:
    - *Level 1: Multiple settings and functions that the device will select depending on the basic inputs* – This is the simplest configuration where the DPS selects specific functions and settings that have been predefined for the network configuration;
    - *Level 2: Multiple settings and functions that the device will select depending on the advanced inputs* – Similar to Level 1, with the exception that DPS will use advanced information such as real-time current, voltage and the status of surrounding protection schemes to assist in the optimal predefined function and setting;
    - *Level 3: Self-setting calculation and functions based on advanced inputs* – this level is where the DPS refines the required protection functions and settings based on the advanced inputs as described in Level 2;
    - *Level 4: Central calculation and dispatch of functions and settings based on whole system* – this is the most advanced DPS level where a central system uses all available information to accurately coordinate and dispatch functions and settings to all DPS enabled sites.
- **Optimised communications** – the DPS will utilise existing channels and develop point to point Solutions on the network that, unlike existing practices, do not

require expensive, matched, systems to be implemented, such as fibre and microwave.

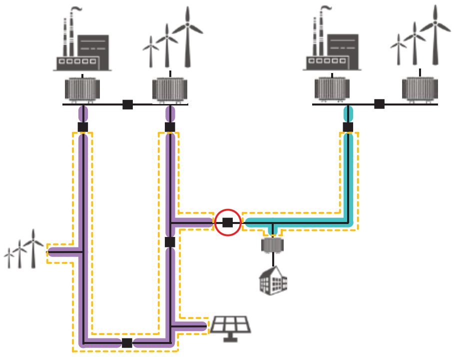
Through the installation of DPS equipment at the trial sites, the system will ensure a high level of optimised network protection whilst allowing the deployment of INR on a large scale.



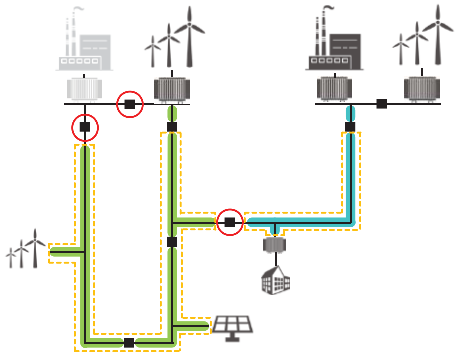
Counterfactual Operating Condition 1 – "Static" network



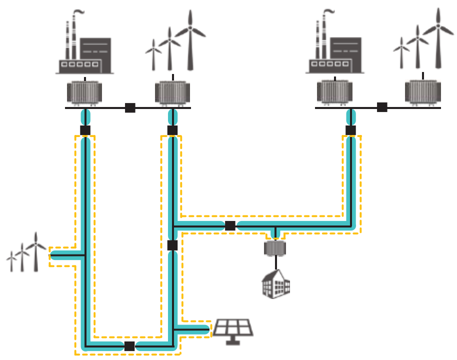
Operating Condition 2



Operating Condition 3



Operating Condition 4



Operating Condition 5

Figure L-3 – Protection considerations during Intelligent Network Reconfiguration

L.4 Intelligent Network Reconfiguration

L.4.1 Design objectives

For the first time on the 33kV network, INR will demonstrate full active control over a large trial area to release capacity and extract the most out of installed assets and highlight the benefits to DNOs, DSOs and customers. Systems already exist that can calculate the optimal running arrangement. However, the intelligence in the INR system is that it can do this in real-time but also incorporates the latest technological advances to learn, create trends and predict how the network should be running. In addition, INR will be equipped with the facility to allow the operator to decide how they want to optimise the network (for DG, load, losses etc). This new pro-active approach to network management will fully exploit the potential of the network and release significant benefits to customers.

L.4.2 BAU Solution

The traditional BAU Method for creating capacity on the network for new customers involves reinforcement. Installation of new transformers, overhead lines, cables and switchgear to overcome limitations in the existing networks will create the required levels of capacity, however, it is known to be very expensive and time consuming. ANM was developed as a convenient way to avoid reinforcing the network, instead, customers would forfeit having capacity available 100% of the time and use existing network capacity when it is available. ANM allows customers to obtain access to the network much quicker than waiting for a reinforcement scheme to be completed, however, it relies heavily on the flexibility of the customer to be curtailed when capacity is not available.

A new Solution is required as the network is set to see a substantial increase in the connection of renewable DG. Reinforcing the network to provide the additional capacity required for the new levels of DG will not be economically viable. Relying on the flexibility of customers through ANM would allow for faster connection times, however, curtailments would increase, mitigating the low carbon benefits and creating further lost revenue for customers.

L.4.3 The INR Technical Innovation

The INR Method will be a financially attractive alternative to traditional reinforcement to release network capacity for customers. Once developed, INR will be able to be deployed rapidly for networks where capacity needs to be released and will not need to rely on the flexibility of the customer. The technological advances for the INR system are detailed below:

- **Central Autonomous Control** – INR will be developed as a Central Control System and will be integrated into our NMS using Methods that are already well understood through previous Projects. Principally, the system will be designed to be operate fully autonomously without the need for an operator. However, as this technique is untested, for REVISE development purposes the system will be designed with several levels of control capability:
    - o *INR Disabled:* - Full operator control
    - o *INR Stage 1:* Arrangement calculated and checked autonomously – verified and applied by operator
    - o *INR Stage 2:* Arrangement calculated and checked autonomously – verified and applied by operator by exception
    - o *INR Stage 3:* Arrangement calculated, checked and applied autonomously

- **Selectable Priority** – INR will have the ability to allow operators to select from a range of priorities for calculation of the network arrangement. For example, the configuration of the network will be different depending on the desired system output such as; achieving maximum generation output, reduction in losses or increasing network security.
- **Machine learning** – the INR system will be designed to capture and learn from feedback that has been collated during the various different network configurations and scenarios. This feature will consistently update assumptions and decision tools to revise and improve the optimisation process and create configuration templates. Trending and analysis will also be used to understand forward forecasting assumptions for operation based on; patterns in load and generation, times of day and year, climate etc.
- **Cybersecurity** – the key to the success of INR will be secure infrastructure as the system will communicate both with our central NMS system and the assets at various trial sites. During the Project cybersecurity measures will be investigated to establish the suitable and appropriate levels of security that are required. The work will also explore how these are tested and implemented for different interactions between systems. The volume and the type of data will be categorised to assist in determining the correct levels of cybersecurity required. Standards will be developed as part of the scope to ensure an efficient roll-out of the Solutions.

The technical innovation of INR is described diagrammatically in Figure L-4. The left-hand figure shows a 33kV network that has become constrained on the circuit that is highlighted in red i.e. the circuit is over capacity due to the power flowing from the solar park and wind farm. On the adjacent circuit, however, there is minimal power flow and the circuit is under capacity. The right-hand figure shows the network with INR now applied. INR has correctly determined the state of the network and takes action to remove the imbalance. The innovative algorithms calculate the optimum configuration of the network based on the real-time data inputs. The INR system then issues the relevant commands to shift the solar park generation onto the under capacity circuit. The network is now balanced and capacity has been released by taking this control action.

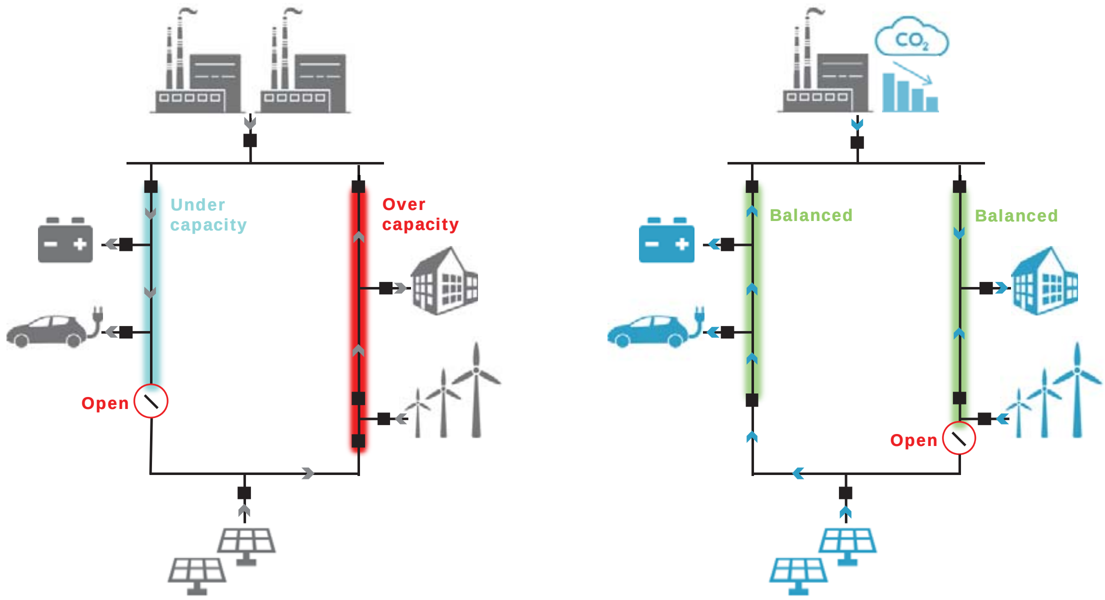


Figure L-4 – BAU vs. REVISE

M.1 ACS Technical Specification

Advanced Connection Solution				
Item	**Description**	**Unit**	**Requirement**	**Offered**
1.0 General Information				
1.1	Type of installation		Outdoor	
1.2	Maximum ambient service temperature	°C	40	
1.3	Service lifetime	yr	40	
1.4	Maximum service altitude	m	<1000	
1.5	No. of Phases		3	
1.6	Rated Frequency	Hz	50	
1.7	Enclosure Material		Steel/Concrete/ GRP	
1.8	Enclosure IP rating	IP	23D	
1.9	Enclosure dimensions (HxWxD)	m	3x3x2	
2.0 Switchgear (Ratings)				
2.1	Standard		IEC 62271	
2.2	Nominal voltage	kV	33	
2.3	Rated voltage	kV	36	
2.4	Rated current (busbar & feeder)	A	400	
2.5	Rated power frequency withstand voltage	kV	70	
2.6	Rated lightning impulse withstand voltage	kV	170	
2.7	Rated short-circuit duration	s	3	
2.8	Rated short-circuit withstand current	kA	31.5	

Item	Description	Unit	Requirement	Offered
3.0 Measurements				
3.1	Current	A		
3.2	Voltage	V		
3.3	Power (S, P & Q)	W, VAr		
3.4	Power Quality	THD %		
3.5	Wind speed and direction	m/s		
3.6	Solar radiation	W/m^2		
3.7	Ambient temperature	°C		
3.8	Relative humidity	%		
4.0 Auxiliary Equipment				
4.1 Battery Ratings				
4.1.1	Nominal voltage	V	24 - 240	
4.1.2	UPS Capability		Yes	
4.1.3	UPS Capacity	hr	8	
4.2 RTU				
4.2.1	Ethernet		4 x 10/100Base-TX & 1 × 100Base-FX	
4.2.2	Compliant Protocols		DNP3.0 IEC 61850 IEC 60870-5-101/104	
4.2.3	Digital I/O		Min 32 bits (Expandable)	
4.2.4	Analogue I/O		Minimum 16 channels	

M.2 DPS Technical Specification

Dynamic Protection System				
Item	**Description**	**Unit**	**Requirement**	**Offered**
1.0 General Information				
1.1	Maximum ambient service temperature	°C	40	
1.2	Maximum service altitude	m	<1000	
1.3	IP rating	IP	52	
1.4	Protection function(s) supplied		Unit Distance OCEF DOC Under/Over V NVD AR	
1.5	Max No. Relays supplied		2	
2.0 Relay Ratings				
2.1	Rated input voltage	V	24 – 240	
2.2	Rated output current	mA	0 – 40	
2.3	Rated input current	A	1 - 10	
2.4	Rated power	W	1 - 20	
3.0 Telecoms				
3.1	Ethernet		4 x 10/100Base-TX & 1 × 100Base-FX	
3.2	Compliant Protocols		DNP3.0 IEC 61850 IEC 60870-5-101/104	

Intelligent Network Reconfiguration				
Item	**Description**	**Unit**	**Requirement**	**Offered**
1.0 General				
1.1	Reliability	%	99.9	
1.2	Availability	%	99.7	
1.3	Failover mechanism		Automated	
1.4	Calculation time	s	<10	
1.5	Comms failure withstand	mins	5	
1.6	State estimation accuracy	%	90	
2.0 Hardware				
2.1	No. servers		Min 3 units	
2.2	Server 1 function		Primary	
2.3	Server 2 function		Secondary	
2.4	Server 3 function		Test	
3.0 Software				
3.1	Min Operating System		Windows 7 Ultimate Windows Server 2008	
3.2	Local system user interface		Yes	
3.3	Remote web based user interface		Yes	
3.4	Firewall		Yes	
3.5	Remote access platform		VPN	
3.6	Historian		Yes	
3.7	Historian storage time	months	12	
3.8	Historian resolution	s	1	

Appendix N Key Project Differentiators

N.1 Innovation Projects

The key objective of REVISE is to release capacity and enable flexibility of the 33kV distribution network through the implementation of new technology, novel protection schemes and intelligent network management. Furthermore, REVISE aims to produce new standards and methodologies that will help facilitate transition to DSO.

Table N-1 provides an overview of innovation Projects where network management has formed a major part of the deliverables.

Table N-1 – Previous Innovation Funded Network Management Projects

Solution Area	Innovation Project																
	CLASS	C_2C	Smart Street	RESPOND	CLNR	My Electric Avenue	ARC	LEAN	FITNESS	FPP	Low Carbon London	FUN-LV	FALCON	SoLA B.R.I.S.T.O.L	Low Carbon Hub	Network Equilibrium	**REVISE**
Network Management	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Generator connections & availability		•		•	•		•			•							•
Enhanced Protection				•						•							•
Voltage (33kV)	•	•		•	•		•	•		•						•	•
DSO technologies	•	•		•	•				•	•	•				•	•	•

A multitude of Projects have explored network management and they cover a broad range of subject areas with some overlap with the objectives of REVISE. Projects with the most relevant learning have been summarised in Table N-2.

Table N-2 – Key Project Differentiators by Project

Electricity North West **Capacity 2 Customers (C_2C)** **Key differentiator –** REVISE goes beyond solely retrofitting equipment and manipulating the network as it operates today. REVISE will install new, more flexible technology and revise the network operational methodologies; together these will build on what was achieved by C_2C.	– Tier 2 LCNF Project, 2011-2015 – Aimed to release capacity on the 33kV and 11kV network through incentivising customers to reduce their demand following a fault on the network – Trialled a combination of enhanced automation technology, increased network interconnection and commercial contracts – Adaptive network automation through moving NOPs to release capacity and retrofitting equipment specifically RTUs and actuators

Electricity North West **RESPOND** **Key differentiator –** REVISE will not only seek to alleviate generation constraints but it will also explore network flexibility through frequent, dynamic reconfiguration. REVISE will seek to balance power flows however it is recognised that even more can be achieved through a novel connection achieved with new, more flexible equipment.	– LCNF Tier 2 Project, 2015 – 2018 – Explored decentralised fault level management – Explored the balancing of load and generation on the network through the management of fault level to release network capacity on the 6.6kV, 11kV and 33kV networks – Project explored the deployment of adaptive protection and commercial fault level mitigation techniques in conjunction with existing assets
Northern Powergrid **Customer Led Network Revolution (CLNR)** **Key differentiator –** REVISE will also explore the relationship between new methodologies and the limiting factors imposed by the current network standards however, REVISE will not aim to update the standards; the output from CNLR will be used.	– LCNF Tier 2 Project, 2010 – 2014 – Trialled smart meters and customer-side interactions with new network technologies and commercial arrangements – Data gathered to enhance understanding of existing customer generation/ demand profiles and flexibility of different customer types – The Project was carried out on the 11kV and 33kV network – Policy documentation and revised methodologies were also explored
SP Energy Networks **Accelerating Renewables Connections (ARC)** **Key differentiator –** REVISE will explore and trial methods to facilitate the connection of DG and LCTs however the Project will actively seek to create alternatives to traditional reinforcement solutions and ANM schemes.	– LCNF Tier 2 Project, 2013 – 2017 – Explored methods to facilitate and accelerated the connection of DG and LCTs on the 11kV and 33kV networks – Enhance customer visibility of the network constraint, more informed connection request applications – Aimed to identify flexible and implement connection solutions benefitting both the customer and the network – Flexible connection solutions were supported by traditional reinforcement and uprating of a number of existing sites

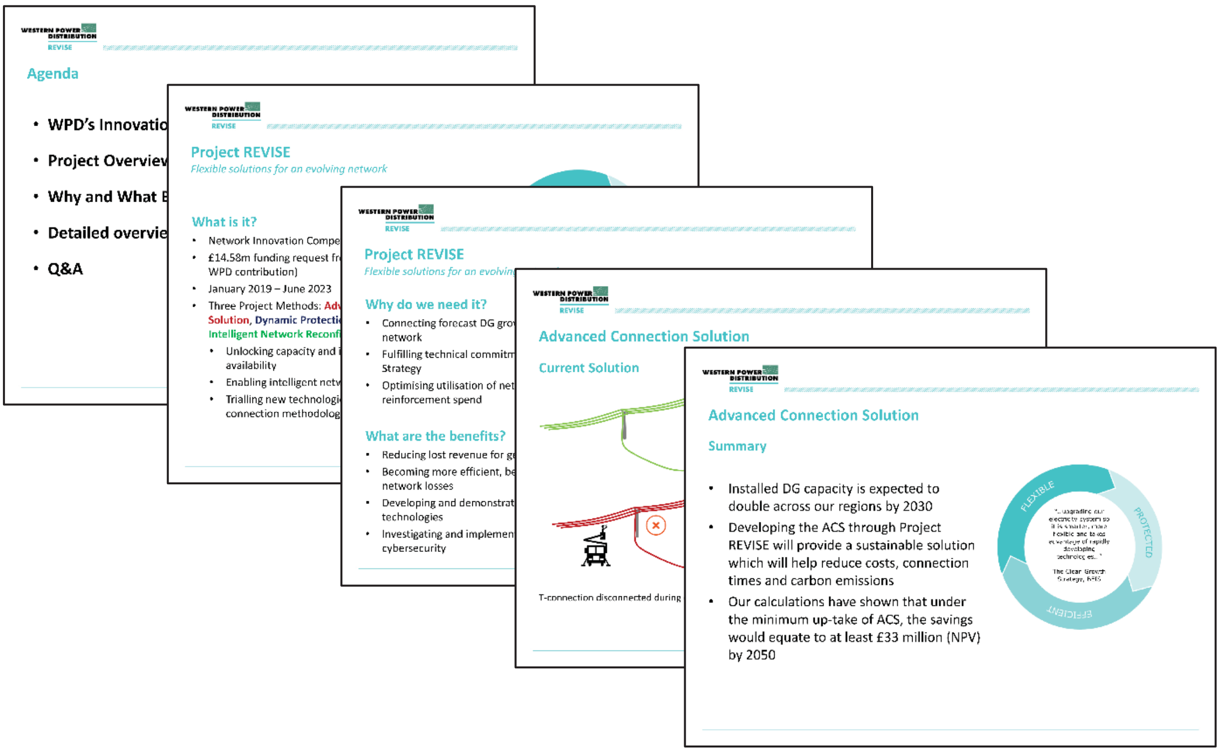
SP Energy Networks **Future Intelligent Transmission Network Substation (FITNESS)** **Key differentiator** – REVISE will implement an Advanced Connection Solution which will have similar features to the digital substation however the compact unit will not contain a transformer; the transformer will be external to the ACS enclosure. The equipment requirements for the 33kV ACS are also substantially different to what is required at transmission level.	– NIC Project, 2016 – 2020 – Designed, trialled and tested digital substations for transmission and distribution applications – Aimed to demonstrate that through enhanced monitoring, protection, automation and control, substations can be deployed faster with improved safety, greater controllability, a reduced footprint and at a lower cost than the conventional design.
UK Power Networks **Flexible Plug and Play (FPP)** **Key differentiator** – REVISE will aim to overcome the same limitations and will overlap with the learning generated by FPP however the focus will be on synchronising new flexible generator connections, adaptive protection with a novel control philosophy.	– LCNF Tier 2 Project, 2011 – 2015 – Project aimed to overcome the limitations of thermal constraints, reverse power flows, limited generator control, absence of commercial framework for flexible generator connections – Install new more flexible equipment and piloted new methodologies on the 33kV, 11kV and LV network – Smart technologies include ANM, Dynamic Line Rating (DLR) monitors, Automatic Voltage Control (AVC), novel protection relays, quadrature-booster and a Project communications platform
Scottish & Southern Energy **Modular Approach to Substation Construction (MASC)** **Key differentiator** – REVISE will implement the Advanced Connection Solution to increase network flexibility, maintain generator connections and provide a base for a more intelligent network. The Advanced Connection Solution is distinctly different from a modular substation in that it will is purely switching.	– NIC Project, 2015 – 2019 – Explored a novel approach to permanent substation design at 132kV – Main objectives were to reduce the time in deploying new substations, increased flexibility for network configurations, reduce the environmental impact through a more considered design and improve the whole life asset value

Appendix O DG Forum Presentation and Engagement

O.1 DG Forum Presentation

We presented an overview of REVISE to the DG owner/operator forum on 19 July 2018. This forum is organised by WPD to promote interaction with DG customers and generate discussion on practices and procedures in relation to the operation of DG on the network. The forum also provides a platform for customers to discuss network constraints and outages.

This Appendix includes a selection of slides from the presentation along with four letters of support for REVISE from DG operators that attended on the day.



O.2 Lightsource BP – DG Forum Presentation Letter

lightsource bp

Jonathan Berry
Western Power Distribution
Toll End Road
Tipton
West Midlands
DY4 0HH

Dear Jonathan,

As an established market leader for the development and operation of solar PV generation, Lightsource BP was particularly interested to learn about Western Power Distribution's 2018 NIC proposal for Project REVISE at the recent Distributed Generation Owner/Operators Forum in Bristol.

Lightsource BP currently operate over 1 GW of solar PV generation assets across the UK and one of our key areas of concern is the availability of generation to connect and remain connected to the distribution network. Curtailment or disconnection of generation for maintenance and construction activities on the network can result in significant lost revenue and disruption for operators. As such, we were delighted to hear about the proposed trials for Project REVISE and believe that this could offer numerous benefits to owner/operators if successful.

We wish you the best of luck with your submission and look forward to learning more about the project, especially proposed trial sites, should the project be awarded funding.

Yours sincerely

Harry Smith

Grid Connections Manager

Lightsource Asset Management Limited , a subsidiary of Lightsource BP Renewable Energy Investments Limited, is registered in England and Wales
Company number 09294289
7th Floor, 33 Holborn, London, UK, EC1N 2HU

O.3 Becon – DG Forum Presentation Letter

Becon
A BayWa r.e. Company

Jonathan Berry
Western Power Distribution
Toll End Road
Tipton
West Midlands
DY4 0HH

Dear Jonathan,

As an established market leader for the operation of wind and solar generation, Becon Project Management & Consultancy Services Limited were particularly interested to learn about Western Power Distribution's 2018 NIC proposal for Project REVISE at the recent Distributed Generation Owner/Operators Forum in Bristol.

Becon Project Management & Consultancy Services Limited currently operate 450 MW of wind and solar generation across the UK and one of our key areas of concern is the availability of generation to connect and remain connected to the distribution network. Curtailment or disconnection of generation for maintenance and construction activities on the network can result in significant lost revenue and disruption for operators. As such, we were delighted to hear about the proposed trials for Project REVISE and believe that this could offer numerous benefits to owner/operators if successful.

We wish you the best of luck with your submission and look forward to learning more about the project, especially proposed trial sites, should the project be awarded funding.

Yours sincerely

Stuart Beattie
Managing Director

Becon Project Management & Consultancy Services Ltd, Viewfield Chambers, Viewfield Place, Stirling, FK8 1NQ
Telephone: 01786 358049, email: info@beconconsultancy.co.uk
Registered in Scotland: SC362623

O.4 Ecotricity – DG Forum Presentation Letter

ecotricity

Jonathan Berry
Western Power Distribution
Toll End Road
Tipton
West Midlands
DY4 0HH

Dear Jonathan,

As an established market leader for the development and operation of Wind and solar, Ecotricity were particularly interested to learn about Western Power Distribution's 2018 NIC proposal for Project REVISE at the recent Distributed Generation Owner/Operators Forum in Bristol.

Ecotricity currently operate 87MW of wind generation across the UK and one of our key areas of concern is the availability of generation to connect and remain connected to the distribution network. Curtailment or disconnection of generation for maintenance and construction activities on the network can result in significant lost revenue and disruption for operators. As such, we were delighted to hear about the proposed trials for Project REVISE and believe that this could offer numerous benefits to owner/operators if successful.

We wish you the best of luck with your submission and look forward to learning more about the project, especially proposed trial sites, should the project be awarded funding.

Yours sincerely

Steve Ellis
Head of Generation

Lion House, Rowcroft, Stroud, Gloucestershire, GL5 3BY
tel: 01453 756 111 | fax: 01453 756 222 | email: info@ecotricity.co.uk | web: www.ecotricity.co.uk
Ecotricity Group Limited – Registered in England and Wales: 3521776

O.5 British Solar Renewables – DG Forum Presentation Letter

British Solar Renewables

British Solar Renewables Limited
35 and 35a The Maltings
Lower Charlton Trading Estate
Shepton Mallet, Somerset, BA4 5QE
E: info@britishrenewables.com
T: +44 (0)1458 224 900

Jonathan Berry
Western Power Distribution
Toll End Road
Tipton
West Midlands
DY4 0HH

Dear Jonathan,

We were interested to recently learn about Western Power Distribution's 2018 NIC proposal for Project REVISE at the recent Distributed Generation Owner/Operators Forum in Bristol.

As a market leader for the development and operation of solar power generation, and battery storage solutions British Solar Renewables Ltd, who currently operate 560MW throughout the UK our key area of concern relating to the electricity network is the availability of generation to connect and remain connected to the distribution network. Curtailment or disconnection of generation both for maintenance and construction activities on the network regularly result in significant lost revenue and disruption for operators. As such, we were delighted to hear about the proposed trials for Project REVISE and believe that this could offer numerous benefits to operators and owners of generation assets if successful.

We wish you the best of luck with your submission and would welcome the opportunity to be involved in the project if awarded funding.

Yours sincerely

Helen Hardaker

Helen Hardaker
Account Manager

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Registered address: 35 and 35a The Maltings, Lower Charlton Trading Estate, Shepton Mallet, Somerset, BA4 5QE

Company number 07315867
QMF1374-2

[redacted]

24 July 2018

Summary:

"The proposed outputs from the REVISE innovation project could be beneficial for ENW and we would be keen to engage further with WPD if the project was funded. We also believe that there will be benefits and learning for all DNOs for each of the technical Methods. ENW are keen to embrace new equipment and techniques that could save time, improve accuracy and maintain a safe and secure network"

[redacted]

23 July 2018

Summary:

"SSEN have seen significant volumes of DG connecting to the 33kV network in recent years, especially in the South-West Region. In some areas the 33kV network is becoming saturated, consequently resulting in expensive reinforcement schemes to connect DG which could require connections directly to a BSP or even the 132kV network. The methods of REVISE could help maximise the output from DG and we would suggest to continue engaging with DG customers if the project is successfully funded."

[redacted]

26 July 2018

Summary:

"Designs for DG connections to our 33kV network are normally t-connections due to the drive for a minimum cost scheme. The volume of these 33kV DG connections has had a substantial impact in some areas and it may be difficult to accommodate further generation. The Methods of REVISE could increase DG (and battery storage) availability helping meet the future requirements Grid and Distribution System Operators. We also believe that the Advanced Connection Solution could offer opportunities to create a standardised underground connection solution for our growing 33kV network in London."

[redacted]

30 July 2018

Summary:

"Our 33kV network in the West Midlands has a number of areas comprising of meshed circuits and Distributed Generation with t-connections. Having already seen further increases in applications for large PV connections in this area and considering the complexities of the network, we believe that investigating new ways to improve the performance of the network is timely. The 33kV network in the West Midlands is an ideal area to trial REVISE and demonstrate the benefits that could be achieved. We believe that the trials could have benefits for both network operators and customers if successful."

Appendix Q Results from RFI

We received six fully compliant responses following our RFI and these have been summarised below:

Criteria	Manufacturer 1	Manufacturer 2	Manufacturer 3	Manufacturer 4	Manufacturer 5	Manufacturer 6
Enclosure						
Length (mm)	3000	4000	3000	3789	3100	5000
Width (mm)	3500	3500	2438	2355	2500	3500
Height (mm)	2500	3000	2000	3377	3500	3000
Technology						
Rated Voltage (kV)	36	36	38	36	36	36
Cont. Busbar Current Rating (A)	-	-	1250	1250	1250	2500
Digital substation compatibility	✓	✓	✓	✓	-	✓
Optimised commissioning	✓	✓	-	✓	-	✓
Reduced maintenance	-	-	✓	✓	-	✓
Self-powered	✓	✓	✓	✓	✓	✓

The average cost for a single ACS was approximately £250,000.00 from the RFI returns. This figure has been used for compiling the Method cost in the Full Submission Spreadsheet.

Appendix R Glossary of Terms

ABI	Air Break Isolator
ACS	Advanced Connection Solution
ANM	Active Network Management
AVC	Automatic Voltage Control
BAU	Business As Usual
BEIS	Dept for Business, Energy and Industrial Strategy
BSP	Bulk Supply Point
Capex	Capital Expenditure
CB	Circuit Breaker
CO2e	Carbon Dioxide Emissions Equivalent
DG	Distributed Generation
DNO	Distribution Network Operator
DC	Direct Current
DLR	Dynamic Line Rating
DPS	Dynamic Protection System
DSO	Distribution System Operator
EHV	Extra High Voltage
ENA	Energy Networks Association
FAT	Factory Acceptance Testing
FES	Future Energy Scenarios
FSP	Full Submission Pro-forma
GW	Gigawatt
GWh	Gigawatt Hour
ICE	Inventory of Carbon and Energy

INR	Intelligent Network Reconfiguration
ISP	Initial Screening Process
KPI	Key Performance Indicator
LCNF	Low Carbon Networks Fund
LCT	Low Carbon Technology
LTDS	Long Term Development Statement
LV	Low Voltage
LVAC	Low Voltage Alternating Current
MVA	Megavolt-ampere
MW	Megawatt
MWh	Megawatt Hour
NGET	National Grid Electricity Transmission
NIA	Network Innovation Allowance
NIC	Network Innovation Competition
NMS	Network Management System
NPV	Net Present Value
Opex	Operating Expenditure
PPL	Pennsylvania Power and Light
RACI	Responsible, Accountable, Consulted and Informed
RAID	Risks, Assumptions, Issues and Dependencies
RFI	Request For Information
TRL	Technology Readiness Level
VT	Voltage Transformer