Document 19
Asset Category – RTU – SCADA
LPN

Asset Stewardship Report 2014

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Document History

Version	Date	Details	Originator	Revision Class	Section Update
1.0	18/06/2013	Baselined July 2013 submission’	V Patrick		
1.1	14/02/2014	Document revised and includes NAMP to RiGs mapping	J Ford		
1.2	17/02/2014	Including reviewers comments	J Ford		
1.3	03/03/2014	Date in section 5.1 updated	J Ford		
2.0	27/03/2014	Final for publication	Regulation		

Contents

1.0 Executive Summary LPN SCADA

1.1 Scope

This document details UK Power Networks' NLRE replacement and inspection and maintenance for Supervisory Control and Data Acquisition (SCADA) equipment and systems in LPN for the RIIO-ED1 period. Indicative proposals for the ED2 period are also included. Although classified under NLRE, this expenditure is not asset replacement as is normally applied to power network equipment. SCADA replacement is based on equipment obsolescence rather than any physical fault and, as such, the fault levels for SCADA equipment are low.

There are 9,100 RTUs (180 primary RTUs and 8,920 secondary RTUs). There are 180 primary SCADA communications circuits and 8,920 secondary SCADA communications circuits.

Replacement and refurbishment costs for these assets are held in the Ofgem and UK Power Networks' investment planning documents in the locations outlined below.

Investment type	ED1	NAMP line
SCADA Capex SCADA I&M	CV105 £41.3m CV13 £6.23m	1.57 1.57, 2.28, 2.27, 2.41

Table 1 – Investment Details

NB, includes RTUs, communications and associated equipment. In addition there will be Operational IT&T expenditure related to specific projects in CV105

1.2 Investment Strategy

The SCADA system underpins any future innovation which would enable the power network and its associated equipment to be run closer to its limits. This is in terms of extracting additional capacity from the network through the use of smart grids and related technologies; by extending the working life of the assets on the network; and by improving asset management and monitoring to ensure intervention takes place before network assets fail.

Much of the SCADA equipment is now so old that it can no longer be supported. The network requires a significant upgrade to enable innovative technologies to be deployed to realise better asset information and enhance its management. This strategy proposes the replacement of a significant amount of SCADA equipment, including RTUs and communications systems.

1.3 ED1 Proposals

It is proposed to replace:

- 150 primary RTU processor cards (£300,000).
- 1,800 secondary RTUs (£6,428,000).
- 3,500 secondary SCADA communications (£3,503,000).
- Upgrade the primary SCADA communications network to operate using DSL over existing copper cables (£2,800,000).

Additional expenditure is also included to enhance the RTU and communication system investment:

- Monitoring of 1,800 secondary SCADA batteries (£542,000).
- Monitoring of weather and general environment (£28,000).
- Replacement of grid/primary substation voice communications at 150 sites (£150,000).

Expenditure is included to upgrade and enhance the NMS platform:

- Replacement and upgrade of IT hardware (£8,307,000).

See Appendix 9 for phased expenditure details.

1.4 Innovation

The upgrade of the SCADA system is the main driver to enable the adoption of innovative solutions for the power network as a whole. The improved technology will enable the trial and introduction of technologies such as:

- Improved asset management and monitoring technologies like online transformer DGA, cable partial discharge and circuit breaker health. This will facilitate an enhanced understanding of asset condition; in particular, more accurate trend analysis that will improve the decision processes on asset replacement and refurbishment.
- Smart grids and smart technologies to enable the connection of low-carbon technologies (generation, EVs, etc.) with reduced power network reinforcement.
- Monitoring of LV networks (feeder currents, volts, power flow, etc.).

1.5 Risks and Opportunities

	Description of similarly likely opportunities or risks arising in Ed1 period	Level of (uncertainties)/cost growth (£k)
Risk	If RTU fault rates were to increase, there is a risk that sites could be left without monitoring or control.	Customer Interruptions (CI) cost: £340,000/100 customers Customer minutes lost (CNL) cost: £830,000/customer
Opportunity	Improvement in the resilience in the communications to secondary RTUs will ensure automation schemes operate effectively thereby improving CIs and CMLs performance.	CI cost: (£340,000/100) customers CML cost: £830,000/customer

Table 2 – Risks and opportunities

2.0 Description of SCADA

SCADA is the name given to the systems that remotely monitor and control power networks. It provides the mechanism for capturing data about the power network; specifically controls, plant and equipment status, system demands and alarms. This is real-time information regarding the state of the network, which is fed back to the UK Power Networks' control centre. Therefore, SCADA is a critical tool to support UK Power Networks in operating the network in a safe, secure way, to meet and/or exceed Ofgem efficiency frontiers, and to ensure legislative and regulatory compliance, such as P2/6 compliance. SCADA supports P2/6 compliance in the following ways:

- It enables rapid remote switching by control engineers for load transfers between substation groups.
- It enables the use of automatic switching schemes.

A SCADA network can be broken down into three main areas:

- The Network Management System (NMS).
- The Remote Terminal Units (RTUs) in the substations.
- The communications network between the RTUs and the NMS.

SCADA systems use similar technology to IT systems but they differ in the following way:

- SCADA systems require very secure and predictable communications.
- IT systems can cope with ‘retries’; SCADA systems cannot (for safety reasons).
- IT systems typically have a three- to five-year lifespan; SCADA typically has a 10-year-plus lifespan.
- IT systems usually allow delays in processing data; SCADA requires real-time data.
- IT systems can re-route data; SCADA systems cannot.

The interface between the SCADA system and network plant and equipment is via the RTU. RTUs are computer-based equipment installed at remote sites, such as grid/primary substations, secondary substations, and with pole-mounted switches/circuit breakers, etc. The function of the RTU is to manage the control and monitoring of the equipment at the remote site. Traditionally, RTUs are split into two distinct types: primary RTUs and secondary RTUs.

Primary RTUs are installed at all grid and primary substations. The NMS continuously polls the RTUs, typically about every 10 seconds, for any changes, such as alarms, analogues and circuit breaker/switch indications, and to facilitate the operation of any equipment on-site, such as circuit breakers/switches, etc.

Secondary RTUs are installed at secondary (11kV distribution) substations, where benefit can be gained from the remote control and monitoring functionality. Under normal circumstances, there is no communication between the NMS and the RTU, or vice versa. If a change occurs on-site, such as alarms, analogues or circuit breaker/switch operation, the RTU will dial-up the NMS to communicate.

If an engineer wishes to operate a control at the remote site, or a script running on the NMS needs to operate equipment at the remote site, the NMS will dial-up the RTU. Once the NMS and RTU start to communicate, the NMS will continually poll for any changes in the RTU until the communication is terminated.

2.1 Existing Primary SCADA System

Primary SCADA RTUs are installed at grid (132kV/33kV, 132kV/11kV, 132kV/66kV) and primary (33kV/11kV, 33kV/6.6kV, 66kV/11kV) substations sites, and 33kV and 132kV switching stations.

There are 180 primary SCADA RTUs installed on the LPN network.

There is one type of RTU on the LPN primary SCADA network: Converteam (180). The Converteam RTUs are equipped with three different generations of processor: the T5500 (45) processor is of a modern design, and the T5505 fast and T5505 slow processor (185) are of an old design and are not capable of supporting IP communications.

The communications for primary SCADA use old serial communications running over discrete cores of UK Power Networks-owned copper pilot cables. The modems are of a bespoke design and can no longer be supported due to the unavailability of components.

Age profile

One concern about primary RTUs is the age of the technology and its components. The T5500 processors are a modern design and the T5505 processors date from the mid to late 1990s.

NAMP lines and RiGs lines

Primary RTU Processors	1.57.07.8214
Primary SCADA Comms	1.57.02.8298
Environment Monitoring	1.57.07.8294
Emergency Voice Comms	1.57.07.8337
CV105 6	
IT - Control Centre Hardware & Software	1.57.20.8614
CV105 8	
Circuit routing - because of faults and diversions	2.27.13.9577
CV13 21	
Cable maintenance (tele) - gas cable routine attention	2.28.06.9580
CV13 43	
Telecontrol abnormality investigation	2.41.10.9711
CV13 31	
Optical fibre maintenance	2.28.10.9584
PCM Fault Repair	2.28.09.9583
CV13 47	
Telecontrol enhancement	2.41.11.9712
CV13 75	

2.2 Existing Secondary RTUs/LCUs (Local Control Units)

Secondary RTUs/LCUs are installed at distribution substations (11kV, 6.6kV).

There are 8,920 secondary RTUs/LCUs installed on the LPN network.

There are two types of RTU/LCU on the LPN secondary SCADA network: Remsdaq Callisto 1 and Talus T200E Series 2.

Communication to the majority of sites is provided by GPRS. Dial-up circuits provided by BT are used for a small number of sites without GRPS reception. The resilience of the GPRS network in the event of power outages has caused issues with RTUs going off-scan in the areas where they are required to assist with the restoration of the power.

Age profile

The relevant point with respect to secondary RTUs regarding asset age is the age of the technology and the components within the RTU. The Remsdaq and Schneider Talus 200E series 2 RTUs date back to the early to mid-1990s.

The communications used for secondary RTUs (GPRS) dates from the early 2000s. Due to the age of the technology there is a risk that it may be terminated by the service providers within the ED1 or ED2 period. There is a high risk that a large number of secondary SCADA RTUs would no longer communicate as it would be exceptionally challenging to change the communications to all 8,920 secondary SCADA sites.

NAMP lines and RiGs lines

Secondary RTUs	1.57.02.8217
Secondary SCADA Comms	1.57.02.8293
Secondary SCADA Battery Monitoring	1.57.07.8335
RTU Fault Rectification	2.28.01.9578
CV105 6	
IT - Communications for Switching & Monitoring	1.57.20.8611
CV105 7	
RTU fault investigation	2.41.09.9710
CV13 31	

2.3 Existing RTUs Asset Age

The Schneider Talus 200 and Remsdaq Secondary RTUs and the Converteam T5005 Primary RTU processors date back to the mid to late 1990s, and the Converteam T5500 Primary RTU processors are of a modern design. Asset age and volumes are shown in Tables 3 and 4.

LPN Primary RTUs	Approximate year	Volume
Converteam T5005	1995	135
Converteam T5500	2000	45

Table 3 – RTU Asset age

LPN Secondary RTU/LCU				
Control Unit	**Switchgear**	**Separate RTU**	**Approximate year**	**Volume**
SCH T200E Series 2	GM	No	1998	4,794
Remsdaq	GM	No	1990	8,919

Table 4 – RTU volumes

3.0 Investment Drivers

The government has set stringent targets for the UK to deliver CO_2 emission cuts of 18% on 2008 levels by 2020. To achieve this, it is proposed that 40% of the UK generation needs will be met by low-carbon generation by 2020 and 30% of which will be met by renewable generation. A significant amount will be connected onto UK Power Networks' distribution network at all voltage levels, from 132kV down to LV. To facilitate the connection of this generation at a reasonable cost, much greater use of SCADA and communications will need to be made, and the concept of smart grids will need to be introduced to ensure appropriate monitoring of the power network and to enable additional capacity to be leveraged at minimum cost.

With the anticipated increase in network monitoring and control and the requirement to support new network technologies, a review of SCADA RTU requirements will be carried out, and the traditional voltage split between primary SCADA and secondary SCADA will be removed. Instead, substation sites will be assessed on their own merits and given a classification to identify the minimum RTU requirements, therefore enabling any RTU type to be installed on any voltage level from 132kV down to LV.

UK Power Networks' Future Networks department has produced an Innovation Strategy which outlines that UK Power Networks is in a position to meet the efficiency challenges it has set by replacing assets reaching the end of their life with equipment that is more cost-efficient or that offers more capabilities for the same price. It also demonstrates that UK Power Networks is taking an innovative approach to support low-carbon transition, and is exploring levers at all stages in the value chain. This includes trialling financial incentives for customers able to suppress or shift their electricity demand, increasing flexibility within the existing network and building smarter or more capable networks when there is no alternative, all with the customer in mind. The policies in this document support the Innovation Strategy by upgrading UK Power Networks' SCADA network to operate using modern industry-standard protocols such as IP for communications and DNP3 and IEC61850 for applications.

3.1 SCADA Communications Investment Drivers

To assist in the delivery of the government's carbon reduction targets and to minimise the overall cost to the UK as a whole, the use of smart technologies will become more widespread during ED1. These technologies will leverage greater capacity out of the power network and enable the connection of increased levels of low-carbon generation by providing more accurate data, extracting additional capacity from network elements, such as transformers and circuits, and using fast-acting algorithms to keep a potentially volatile network stable. All of this will require larger volumes of data to be transferred, both between equipment in the field and between that equipment and the control centre site, and at greater speeds than is currently possible. The communications networks must also be able to operate during a power outage to swiftly and safely restore supplies. GPRS is currently used to provide communications to the secondary RTUs. The resilience of the GPRS network is not sufficient for modern automation schemes due to the lack of battery back-up on the base station sites. This has resulted in many automation schemes not operating correctly, resulting in CIs and CMLs.

3.2 Control Centre Hardware & Software Investment Drivers

The Network Management System (NMS) requires continual upgrading to enable reliable operation and to accommodate the ever increasing demands placed upon it. These include:

- Increasing volumes of RTUs installed on the network.
- Increasing volumes of automation.
- Increasing sophistication of automation schemes.
- Obsolescence of IT equipment.
- Increasing functionality required from the NMS.

3.3 Broadband Communications Investment Drivers

Asset management and monitoring techniques will become more widespread over the coming years, which will require a communications system with greater bandwidth to enable substation asset monitoring and management data to be transmitted effectively. This requirement spans the three license areas of UK Power Networks. Examples of asset management and monitoring data that will be required may include:

- Power quality monitoring.
- Partial discharge monitoring.
- CCTV.
- Card access to substations.
- Remote connection to IEDs.
- Access to the corporate IT network (for plans, email, intranet, etc.) from substations.

- Online asset condition monitoring (transformers, circuit breakers, etc.).

These techniques require greater bandwidth, which cannot be provided with the existing SCADA systems. Furthermore, it may not be appropriate to combine SCADA with asset management and monitoring communications channels.

Dial-up modems could be deployed for some of these functions, but with large volumes this would be difficult to manage, be very inflexible and the communications are slow and unreliable. Also, dial-up modems are old technology and will be difficult to support in the short- to medium-term.

Therefore, the main issues from the above are poor communications speed and circuit capacity.

The provision of broadband communications to substations would satisfy the above functional requirements, and provide the additional benefit of broadband being available to provide back-up communications for the primary SCADA system to ensure SCADA communications to substations can be maintained at all times.

3.4 RTU Investment Drivers

Investment drivers for RTUs can be split into three main categories:

3.4.1 Availability of spares and components

Due to the age of the RTU equipment and the relatively short lifespan of IT equipment, some of the components within the RTU and RTU plant cards are no longer manufactured and/or supported by the manufacturer, and are therefore considered to be obsolete. Table 5 shows the type and volumes of RTUs which cannot be supported.

Control unit/RTU	Approximate year	Volume
Remsdaq	1990	8,919
SCH T200E Series 2	1998	1

Table 5 – Types and volumes of RTUs

These figures represent 98% of the total population of RTUs on the LPN network.

The stock of spares for these RTU/LCUs is almost exhausted and, due to the fact that they are obsolete, new spares can no longer be obtained.

3.4.2 Suitability of technology

Better technology is required to ensure the network can accommodate higher levels of volatile generation and unpredictable loads. The technology used by the old generation of RTU processors is insufficient to cope with new demands, and a case study demonstrating this is shown in Appendix 13.

Figure 1 shows a typical Converteam Primary RTU installed in a substation.

Figure 1 – RTU installation

3.4.3 RTU availability

The control and monitoring functionality provided by the RTUs is critical to UK Power Networks in the reduction of CIs and CMLs. If an RTU, or some of the functionality provided by an RTU, is unavailable when a fault occurs, the speed of the restoration of supply to customers, and hence the quality of supply, will be significantly reduced, leaving greater numbers of customers without electricity for a longer period of time.

An example of the importance of SCADA is illustrated in Appendix 14, which shows a case study of two faults on the same 11kV feeder: one with the SCADA system functioning correctly and one with the system not operating. When the scheme functioned correctly there were no CIs or CMLs; where the scheme failed, there were 3,814 CIs and 40,967 CMLs.

The reasons an RTU will be replaced with a modern RTU with increased functionality are:

- Substation equipment, such as the switchboard, is being replaced with modern equipment. The RTU will be replaced to enable improved facilities, such as serial/IP connection to IEDs and remote connection to equipment, and to reduce the small wiring required to install the switchboard and therefore reduce installation costs.

- There are insufficient spares in stock to ensure the ongoing maintenance of the remaining RTUs.
- An area of the power network becomes part of a smart network or similar so improved functionality of the RTUs is required, such as for IEC61850.

3.5 SCADA Condition Measurements

Although classified under NLRE, this expenditure is not asset replacement as is normally applied to power network equipment. SCADA replacement is mainly based on equipment and technology obsolescence, rather than any physical fault with the equipment, and as such the actual fault levels are low.

3.5.1 Fault volumes

The main source of identification of a SCADA system, component or card becoming unreliable is the volume of reported failures. This can be either equipment failing and recovering, which is identified through examination of logs or alarms, or permanent failure, which is identified through alarms generated on the Network Management System.

Fault volumes are shown in Appendix 5 and the graphical representation is shown in Figure 2.

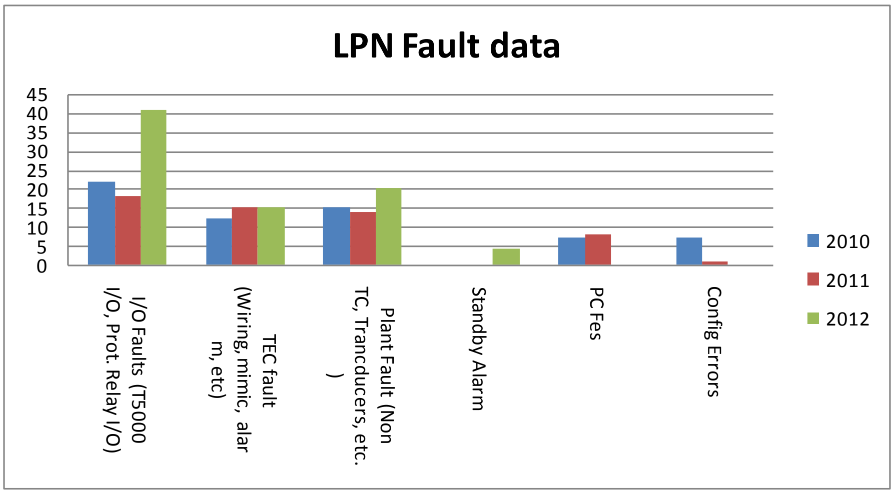


Figure 2 – LPN fault data

Figure 2 shows a general increase in failure rates over the period, particularly RTU faults.

3.5.2 Technology level

The replacement of SCADA equipment tends to be based on the level of functionality available, and the obsolescence of the technology and the components used within the equipment rather than the volume of faults.

4.0 Asset Assessment

4.1 Asset Health

Not Applicable. Health indices data does not apply to SCADA equipment as replacement is based on the level of functionality, the technology and the availability of spare components rather than any measurable condition points. As it is the age of technology that is the critical factor, rather than the age of the equipment, the RTUs can be grouped in ‘types’ based on technology age.

4.2 Asset Criticality

SCADA is a key component in the management and control of the network. While manual intervention is an option under conditions of RTU/SCADA failure, this would be delayed due to staff response times and could result in safety issues for staff and public when emergency intervention is demanded. Therefore, it is important that a very high level of availability is maintained for the SCADA systems.

4.3 Network Risk

The introduction of SCADA onto the LPN primary and secondary network over recent decades has clearly demonstrated the benefits of network visibility afforded by these systems.

While it can be argued that under healthy conditions the loss of SCADA may not be an immediate issue, it is the loss of visibility under abnormal or fault conditions that highlights the benefits and criticality of remote network visibility. Under these circumstances, the consequences of SCADA loss can result in overloaded networks, delayed restoration post-fault and, most importantly, lack of response to safety risk events.

4.4 SCADA Data Validation

As the age-related issues for SCADA equipment are based on technology (i.e. RTU type, serial communications, etc.) and the information regarding SCADA is extracted from the NMS, the data is considered to be accurate.

4.5 SCADA Data Verification

Sample checking was carried out to verify the quality of the data.

4.6 SCADA Data Completeness

As the volume data is extracted from the NMS the data is complete.

5.0 Intervention policies

5.1 SCADA Communications Interventions

With the anticipated increase in the requirement for network monitoring and control and the introduction of smart grids, a review of SCADA communications requirements will be carried out. The traditional voltage split between primary (11kV bars and above) and secondary (11kV distribution network) will be removed, and instead substation sites will be assessed on their own merits and given a classification to identify their minimum communications requirements. From this classification an appropriate communications medium can be installed. This classification work will be completed in Q4 2014.

Notwithstanding this, a hierarchy of some SCADA being continuously polled and some SCADA being reported by exception will be retained.

Additional communications networks will be developed to match the classification criteria and to provide some diversity in available communications. This will involve approaching the market to identify potential communications networks and systems. With the introduction of new communications networks, consideration will be given to separating mission-critical control data and less critical asset management data.

5.1.1 Primary SCADA communications

The communications for LPN primary SCADA will be upgraded to use IP as the transport protocol. As the UK Power Networks' fibre/DSL network is installed for the EPN/SPN BT21CN project, and when the fibres connect into Fore Hamlet, primary and grid substation RTUs should be moved onto the DSL/fibre network. This will improve the speed of communications to substations and provide greater bandwidth to substations for asset management and monitoring data and smart grids, etc.

Before any RTUs can be connected to the UK Power Networks' fibre/DSL network, it must be verified that it has sufficient mains independence. Also, some fibre circuits may be required in addition to those installed for BT21CN to provide connectivity to Fore Hamlet.

It should be noted that there is no specific BT21CN mitigation works planned in the LPN area, as all protection signalling pilot circuits are owned by UK Power Networks.

5.1.2 Secondary SCADA communications

The secondary SCADA network has been upgraded to operate using IP as the transport protocol and DNP3 as the application protocol. Currently GPRS provides the communications, but problems have been experienced with its resiliency as communications to RTUs have been lost in the event of a power outage. GPRS is now a mature technology and, as such, it is likely that service providers will terminate the service in favour of modern alternatives such as 4G.

During ED1 and ED2, GPRS will be replaced with an appropriate communications medium to mitigate the risks associated with the termination of the system. The exact type of communications will be decided on a site-by-site basis using the classification and following procurement of additional IP-compliant communications mediums.

5.2 RTU Interventions

5.2.1 Upgrade primary RTU processors

The T5005 processors with be upgraded with the modern T5500 processors to enable the use of IP communications. The protocol will also be upgraded to DNP3 to provide a common protocol across UK Power Networks.

5.3 Environment Monitoring Interventions

As smart grids – associated technologies to extract additional capacity from the existing power network and dynamic plant asset condition data – become more widespread, UK Power Networks will require more detailed information regarding the environment in which its network equipment is installed (such as transformers, switchgear, circuits, etc.). Specifically, for equipment installed outdoors, information such as ambient temperature, wind speed/direction and rainfall rate, which is relevant for communications, is required. For equipment installed indoors, information such as ambient temperature and humidity is required. This information can be used for a 'first level' smart grid by applying environmental data to provide increased equipment ratings based on the actual conditions.

While not a primary driver for SCADA improvements and RTU replacements, facilitating the data recovery from environment monitoring will contribute to a reduction in network costs and capital expenditure. This will be realised through dynamic network operation based on actual environment data, which will enable equipment to be operated closer to its limits (such as conductors, transformers, etc.), thereby extracting additional capacity without the need to replace the asset. Environment monitoring will be installed at 4 substation sites.

5.4 Voice Communications Interventions

All primary and grid substations are equipped with a BT phone line. A UK Power Networks fibre/DSL network is planned to be installed for the BT21CN project and the LPN SCADA primary communications project, and when the fibres connect into the Network Control Centre at Fore Hamlet, this will be used to provide voice communications to substations. The existing BT phones can then be removed, thereby saving the costs of the phone lines. As with 5.3 this is not a primary driver for RTU replacement, but is a secondary benefit.

5.5 Control Centre Hardware & Software

The Control Centre Hardware and Software will be upgraded or replaced as required to enable continuous and reliable operation for this mission critical system, and enable new features improve the management and reliability of the network to be developed and added as required.

6.0 Innovation

Much of the proposed work in the ED1 period is to upgrade the technology on the SCADA network in both the RTUs and the communications systems. This work will bring the SCADA system into the 21st century and enable the deployment of innovative, intelligent systems to allow the connection of increased levels of low carbon generation and deployments of EVs, heat pumps, etc. This will be at a reduced cost by allowing the power network to be operated closer to its limits, therefore releasing capacity and deferring the need to reinforce the power network.

The upgraded SCADA systems will make allowance for the use of innovative asset management and monitoring technologies. The communications will make allowance of the transfer of large volumes of data, such as equipment condition monitoring data (online transformer DGA, cable partial discharge, circuit breaker health, etc). Where sufficient bandwidth cannot be achieved, innovative technologies will be used to carry out analysis and processing of the data at the substation site to reduce the size of data by only transmitting the processed results. This technology will enable equipment health and remaining life to be more accurately ascertained. Costs will be reduced by allowing equipment to safely remain in service longer and allowing intervention before equipment fails.

SCADA will need to be deployed beyond the 11kV distribution network, down to the LV level. To enable monitoring of the LV network, innovative methods of retrofitting monitoring equipment will be developed, such as using Rogowski coils to measure LV feeder currents. This will enable existing LV boards to remain in service and reduce the costs of installing LV monitoring.

7.0 ED1 Expenditure Requirements for SCADA

7.1 Method

During ED1, 135 of the Converteam primary RTU T5005 processors will be replaced, and 1,800 of the Schneider Talus 200 and Remsdaq Secondary RTUs will be replaced.

Communications to 3,500 secondary RTUs will be replaced with IP-compliant communications.

The EPN/SPN BT21CN fibre network will be expanded to connect the LPN DSL network to Fore Hamlet (the UK Power Networks control centre).

Battery monitoring will be installed on all existing secondary SCADA sites. Where batteries are replaced as part of the battery replacement programme, this functionality will be included if not already available. Substation battery replacement is detailed in Document 21.

Environment monitoring equipment will be installed at four substation sites to provide a good level of monitoring across the LPN area.

The inspection and maintenance expenditure for primary SCADA is split into 13 categories:

- RTU fault rectification.
    - Identification and rectification of faults with secondary RTUs. It is anticipated that the fault level will reduce slightly as RTUs are replaced.
- Base station check and repair.
    - Identification and rectification of faults with the old secondary SCADA VHF radio network that has now been replaced with the IP/GPRS network.
- Circuit routing (owing to faults and diversions).
    - Re-routing of SCADA services in the event of a cable fault or diversion.
- RTU fault investigation.
    - Detailed investigation into RTU failures and faults.
- Telecontrol abnormality investigation.
    - Technical investigations into SCADA issues.
- Telecontrol enhancement.
    - General development and enhancement of existing SCADA equipment.
- RTU fault repair.
    - Line now superseded by the RTU fault rectification line.
- RTU refurbishment.
    - General refurbishment programme for a number of older RTUs. This programme has been completed.
- UK Power Networks' Primary Telecontrol Circuit Faults.

- Faults associated with the primary SCADA communications system.

- Optical fibre maintenance.
    - Maintenance of the optical fibre cables and equipment.
- Cable maintenance (tele) – gas cable routine attention.
    - Maintenance of the gas-filled communications cables.
- Cable repairs telecoms.
    - General repair of the copper pilot communications cables.
- PCM fault repair.
    - Repair of the old PCM communications network. This will be replaced during ED1/2 by the proposed IP/DSL network.
- IT - Control Centre Hardware & Software.
    - The NMS will require continual upgrading to ensure reliable and efficient operation and to enable the introduction of additional RTU and RTUs with enhanced features.
- IT - Communications for Switching & Monitoring.
    - The costs for switching and monitoring will increase as additional control and monitoring equipment is installed on the network.

7.2 Constructing the plan

In constructing the plan the following criteria have been taken into account:

- Spares not available due to age of equipment/product obsolescence.
- Risk of no spares and being unable to complete repairs.
- Loss of SCADA functionality.
- Impact on CI/CMLs.
- RTUs selected based on age and obsolescence.
- Increased levels of functionality required for 'smart' networks.
- Improved communications networks resilience.

The main constraints are with regard to qualified personnel to complete the work. A resource plan is being developed for ED1 delivery, which will look at options such as:

- Suppliers carrying out additional build/configuration work prior to delivery.
- Identifying the additional resource requirements and securing the resource (both contractor and employed).

The volumes planned for ED1 are significantly increased when compared to DR4/5 because the technology is becoming unsupportable and requires upgrading.

The additional IP-compliant communications mediums to be used, above those already in use, are yet to be identified and will be carried out during the remainder of DPCR5. The budget for this is based on simply replacing the communications device on-site (GPRS modem) with a new device (3/4G modem, etc.). The budget unit cost for this is low (£1,000 per site), but the overall cost is high due to the large volume of replacements required.

The replacements will be targeted at sites where other power network equipment is being replaced and sites where additional benefits can be gained from the improved level of technology offered by the new SCADA equipment.

7.2.1 Approach to network risk (providing sufficient spares to maintain the installed fleet)

Replacing 1,800 of the combined fleet of Schneider Sprit II and Remsdaq secondary RTUs will provide sufficient spares for the remaining RTUs to remain in service during the ED1 period.

7.2.2 SCADA inspection and maintenance

The SCADA inspection and maintenance costs have been derived using a combination of historic fault data to predict the future costs for faults and contract cost data for rented/contracted services.

The historic data dates from 2008 because in 2007 the primary SCADA network in EPN and SPN was upgraded to use the new UK Power Networks satellite system and IP communications. Future inspection and maintenance expenditure takes into account the capex to replace old SCADA equipment and to install additional equipment as the SCADA system expands.

7.2.3 HI profile at end of ED1 with investment

Not relevant: intentionally left blank.

7.2.4 Policy changes, e.g. to asset lives.

Not relevant: intentionally left blank.

7.3 Additional Considerations

Not relevant: intentionally left blank.

7.4 Asset Volumes and Expenditure

7.4.1 SCADA investment and volumes.

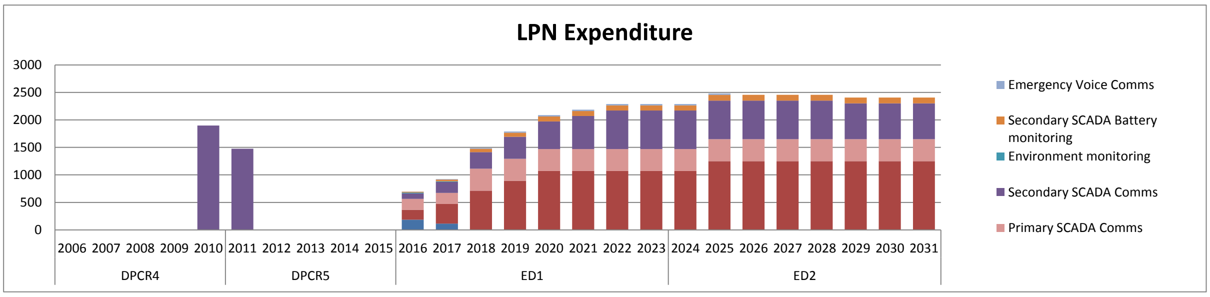


Figure 3 – SCADA expenditure (£k)

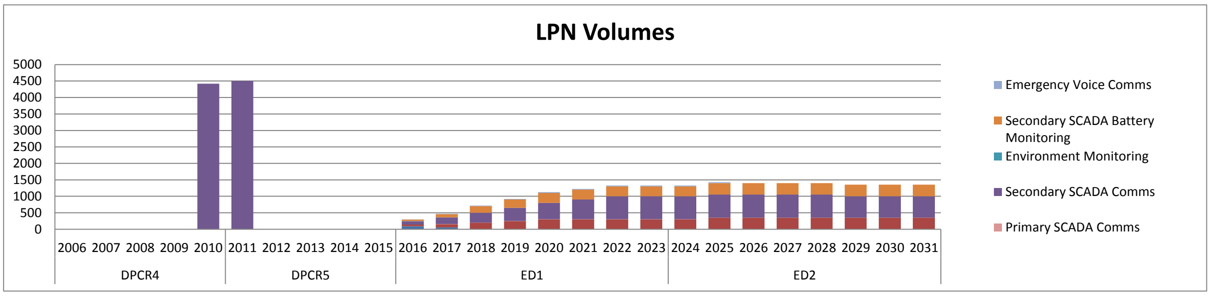
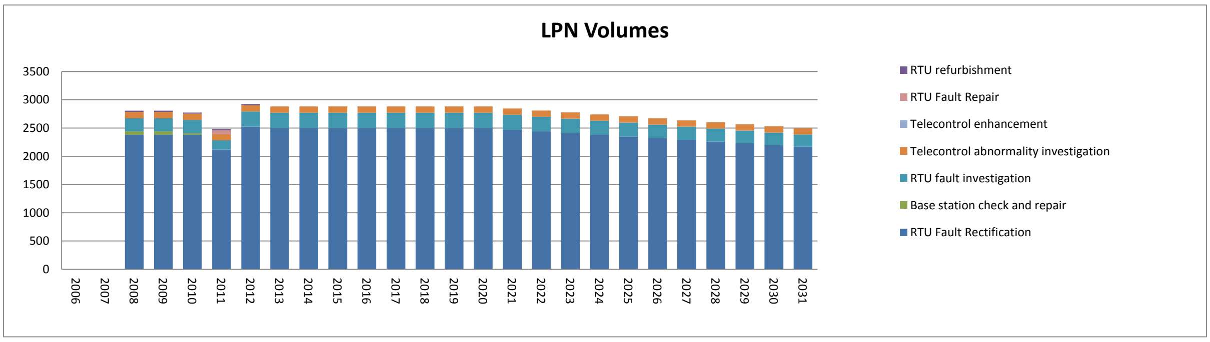


Figure 4 – SCADA replacement volumes and interventions

7.4.2 SCADA inspection and maintenance.

SCADA I&M volumes is shown in figure 5 (below).



Details of the volumes and expenditure for ED1 and ED2 are shown in Appendix 9 NLRE Expenditure Plan.

7.5 Commentary

7.5.1 Explanation of trends and variances from DPCR5

There is a significant increase in the expenditure on replacing SCADA in the ED1 period due to the obsolescence of the technology and the reasons described within this document.

The installation and maintenance volumes and expenditure decrease during ED1/ED2 due to the replacement of old maintenance-intensive equipment and systems with more modern equipment. This replacement will also reduce the fault rate.

7.6 Sensitivity Analysis and Plan Validation

7.6.1 Average life sensitivity

This is not relevant for SCADA. Replacement is based on the age of the technology and the availability of spares as described within this document. As such, the age of individual SCADA components is largely irrelevant – the technology age is the critical factor.

7.6.2 Network risk sensitivity

Much of the RTU replacement programme will be linked to the replacement of switchgear due to condition, reinforcement, quality of supply, etc, or other programmes of work where a common resource can be shared. Any delays could have an effect on the delivery of the SCADA replacement programmes.

The SCADA programme will require a significant increase in the number of competent and suitably trained staff. A detailed resource plan will be produced prior to the expenditure programmes detailing how the resource will be provided.

7.6.3 Asset defect analysis

Delays in the delivery of the SCADA replacement programmes could result in critical spares to support the existing equipment being unavailable. There is sufficient flexibility in the plan to enable replacement sites to be changed at short notice to enable the plan volumes to be delivered.

Availability of spares is reviewed during the quarterly Contract Review Meetings and assessed accordingly.

8.0 Deliverability

8.1.1 Network access and outage availability

For sites where the SCADA equipment is being replaced and does not form part of a project to replace other equipment, the new equipment will be installed and run in parallel with the existing equipment where possible. This will enable the functionality to be cut over in a controlled and planned manner with no loss of functionality to the control engineer.

For sites where SCADA equipment is being replaced as part of a bigger project to replace other network equipment on site (such as switchgear), the SCADA equipment replacement will be subject to the planned outages for that project and the cut-over strategy will be driven by the requirements of that project.

Any additional fibre circuits will be linked in with the BT21CN delivery project.

8.1.2 Consistency of delivery volumes and explanations of how increases will be managed.

This plan proposes a significant increase in work in ED1/2, and one of the biggest risks to delivery is access to sufficient labour to carry out the installation work.

The increase in the volume of SCADA replacements will be managed by targeting the replacements at sites where other significant work is already taking place, and the labour resource on-site can carry out the majority of the installation work. As much work will be done off-site by suppliers prior to delivery of the equipment, much of the work on-site can be completed by fitters and electricians as opposed to specialist SCADA engineers.

The Operational Telecoms department is working on a resource and delivery plan for ED1 work to identify any additional resources required and ensure the programmes can be delivered.

8.1.3 Explanation of how asset volumes are converted into approved projects

Asset volumes are converted into approved projects in three main ways:

- Replacement of SCADA equipment at sites where other work is planned.
- Replacement of SCADA equipment at sites where additional functionality offered by the new SCADA equipment is required, such as sites which will form part of a smart grid or sites that require broadband communications.
- Replacement of SCADA equipment which contain components which are no longer available.

Appendices

Appendix 1 Age Profiles

The technology used in much of the SCADA equipment dates back to the early 1990s and is incompatible with modern equipment. Computers from that date are no longer fit for use and do not have sufficient processing power (286 and 386 processors, for example), and the software (windows 3.1) and systems (serial and modem-connected) cannot be supported. The SCADA equipment is similar.

Primary RTUs: The Converteam RTU T5005 processors date to the mid to late 1990s and the Converteam RTU T5500 processors are a modern design.

Secondary RTUs: The Remsdaq and Schneider Talus 200 RTUs date to the early to mid-1990s.

Secondary SCADA communications: The communications used for secondary SCADA is GPRS, which dates back to the early 2000s.

Primary SCADA communications: The primary SCADA communications use modem-based serial communications, which date back to the 1980s.

Appendix 2 HI Profiles

Not relevant: intentionally left blank.

Appendix 3 Condition Reports

Not relevant: intentionally left blank.

Appendix 4 Risk Assessments

The cost saving in the risk assessment table is based on the following assumption:

- 10% of the RTU replacements will align with other major project work. This will enable 20% cost savings from reduced project management, site set-up costs and reduced cabling/wiring etc.).

Appendix 5 Fault Data

2010	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10
Fault Type	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed
I/O faults (TS000 I/O, Prot. Relay I/O)	0	3	3	3	3	1	3	3	0	1	1	1
TEC fault (wiring, mimic, alarm, etc)	0	0	0	0	2	1	2	2	2	1	1	1
Plant Fault (non-TC, Transducers etc)	2	1	1	1	6	2	1	0	0	0	0	1
Standby Alarm	0	0	0	0	0	0	0	0	0	0	0	0
PC FES	0	0	0	0	1	0	3	1	0	1	1	0
Config errors (CIDA, Cstn Dbase)	0	1	1	1	1	0	1	0	0	1	1	0
Totals	2	5	5	5	13	4	10	6	2	4	4	3

2011	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11
Fault Type	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed
I/O faults (TS000 I/O, Prot. Relay I/O)	0	0	1	4	3	1	1	1	3	0	1	3
TEC fault (wiring, mimic, alarm, etc)	2	2	0	3	2	1	0	0	4	0	0	1
Plant Fault (non-TC, Transducers etc)	1	1	0	1	0	0	1	1	2	1	2	4
Standby Alarm	0	0	0	0	0	0	0	0	0	0	0	0
PC FES	0	0	1	0	0	0	2	2	2	1	0	0
Config errors (CIDA, Cstn Dbase)	0	0	0	0	0	0	0	0	0	0	1	0
Totals	3	3	2	8	5	2	4	4	11	2	4	8

2012	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
Fault Type	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed	Number completed
I/O faults (TS000 I/O, Prot. Relay I/O)	5	8	2	1	5	1	0	3	7	4	5	0
TEC fault (wiring, mimic, alarm, etc)	1	2	0	0	0	0	4	1	4	2	1	0
Plant Fault (non-TC, Transducers etc)	0	0	5	0	2	1	4	3	0	2	0	3
Standby Alarm	0	0	0	0	0	0	0	0	2	0	1	1
PC FES	0	0	0	0	0	0	0	0	0	0	0	0
Config errors (CIDA, Cstn Dbase)	0	0	0	0	0	0	0	0	0	0	0	0
Totals	6	10	7	1	7	2	8	7	13	8	7	4

Table 6 – SCADA fault data

Appendix 6 Maintenance History

Primary SCADA

No maintenance is carried out on the primary SCADA network.

Secondary SCADA

The only maintenance of secondary SCADA is checking the operation of the 'dummy' circuit breaker once a week and replacement of the batteries when required.

Appendix 7 WLC Case Studies

Risk, Cost, Performance and Condition Profiles for Various Options

Not relevant: intentionally left blank.

Appendix 8 Model Validation Test Results

Not relevant: intentionally left blank.

Appendix 9 SCADA Expenditure by activity

ED1 expenditure

Primary RTU Processors								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	93	57	0	0	0	0	0	0

Secondary RTUs								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	50	100	200	250	300	300	300	300

Primary SCADA Comms								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	1	1	2	2	2	2	2	2

Secondary SCADA Comms								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	100	200	300	400	500	600	700	700

Environment Monitoring								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	2	2	0	0	0	0	0	0

Secondary SCADA Battery Monitoring								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	50	100	200	250	300	300	300	300

Emergency Voice Comms								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	5	10	15	20	25	25	25	25

IT - Control Centre Hardware & Software								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Forecast Expenditure £k	458	1060	1242	1091	1065	1079	1156	1156

RTU Fault Rectification								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	2500	2500	2500	2500	2500	2470	2440	2410

Circuit routing - because of faults and diversions								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	36	36	36	36	36	35	34	33

RTU fault investigation								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	270	270	270	270	270	265	260	255

Telecontrol abnormality investigation								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	111	111	111	111	111	111	111	111

Telecontrol enhancement								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

UKPN Primary Telecontrol Circuit Faults								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	73	73	73	73	73	73	73	73

Optical fibre maintenance								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	12	12	12	12	12	12	12	12

Cable maintenance (tele) - gas cable routine attention								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	90	90	90	90	90	90	90	90

Cable Repairs telecoms								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	28	28	28	28	28	28	28	28

PCM Fault Repair								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	12	12	12	11	10	9	8	7

IT - Communications for Switching & Monitoring								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	875	2023	2371	2082	2033	2060	2206	2206

ED2 expenditure

Primary RTUs								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	0	0	0	0	0	0	0	0

Secondary RTUs								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	300	350	350	350	350	350	350	350

Primary SCADA Comms								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	2	2	2	2	2	2	2	2

Secondary SCADA Comms								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	700	700	700	700	700	650	650	650

Environment Monitoring								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	0	0	0	0	0	0	0	0

Secondary SCADA Battery Monitoring								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	300	350	350	350	350	350	350	350

Emergency Voice Comms								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	25	25	0	0	0	0	0	0

IT - Control Centre Hardware & Software								
ED1 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Forecast Expenditure £k	1156	1156	1156	1156	1156	1156	1156	1156

RTU Fault Rectification								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	2380	2350	2320	2290	2260	2230	2200	2170

Circuit routing - because of faults and diversions								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	32	31	30	29	28	27	26	25

RTU fault investigation								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	250	245	240	235	230	225	220	215

Telecontrol abnormality investigation								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	111	111	111	111	111	111	111	111

Telecontrol enhancement								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

UKPN Primary Telecontrol Circuit Faults								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	73	73	73	73	73	73	73	73

Optical fibre maintenance								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	12	12	12	12	12	12	12	12

Cable maintenance (tele) - gas cable routine attention								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	90	90	90	90	90	90	90	90

Cable Repairs telecoms								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	28	28	28	28	28	28	28	28

PCM Fault Repair								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	6	5	4	3	2	1	0	0

IT - Communications for Switching & Monitoring								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	2206	2206	2206	2206	2206	2206	2206	2206

Appendix 10 Sensitivity Analyses

Not relevant: intentionally left blank.

Appendix 11 Full Optimised Plan

Individual sites for replacement will be identified between now and ED1 and during ED1. Replacements will be targeted at sites where other work is planned and sites where additional functionality, such as smart grids, is required.

Projects where SCADA equipment replacement can be combined with the work planned for a site will be identified before ED1; however, this approach must remain flexible as other influences can change both the potential projects that may be identified and the drivers behind the replacement of SCADA equipment.

Appendix 12 Audit Trail of Changes

Not relevant: intentionally left blank.

Appendix 13 Named Scheme Case Study 1

Flexible Plug and Play Project (FPP)

As part of the Ofgem Low Carbon Network (LCN) fund, UK Power Networks is carrying out a project to trial new technologies to enable the connection of additional low carbon and renewable generation in an area which based on traditional network technologies cannot accommodate any further generation. Part of this project is to trial the use of smart technologies to enable additional capacity to be safely released from the existing power network infrastructure. This requires integrating and embedding the new technology within the network which involves using modern open standard application protocols and modern communications systems and protocols.

The existing RTUs in the area which were required to form part of the 'smart' system were unable to communicate using the modern protocols and systems, and could not be upgraded to the age and obsolesce of the technology used in them. They therefore had to be replaced with new RTUs.

Appendix 14 Named Scheme Case Study 2

Distribution network automation

On 7 February 2013 a fault (FREP-51192-J) occurred on the Panel 12 feeder out of Dermody Road. The fault was identified by the SCADA system and an automated restoration script running on the NMS was triggered. The automation script interrogated the RTUs at the defined section points along the feeder to establish which section the fault was located in. It then carried out remote switching operations to restore supply to as many customers as possible. The resulting CIs and CMLs associated with this fault were zero.

On 25 February 2013 a fault (FREP-52404-J) occurred on the Panel 12 feeder out of Dermody Road. The fault was identified by the SCADA system and an automated restoration script running on the NMS was triggered. The automation scheme was unable to connect to one of the RTUs due to a problem with the communications network, and the automation script therefore failed to run. The control engineer restored supplies to as many customers as possible using the SCADA network. The resulting CIs and CMLs associated with this fault were 3,814 CIs and 40,967 CMLs (total cost: £68,000).

These case studies show that a failure of the automation system, which is dependent on the SCADA system, will incur significantly increased CIs and CMLs. In the case study where the automation system failed, the SCADA system was used to restore supplies by remote switching.

Asset Stewardship Report 2014

LPN SCADA

Version 2.0

Appendix 15 Asset Stewardship Report – RIGs Table (Volumes)

Document Name	SCADA
Document Author	J Ford
DNO	LPN

This data is taken from Master Tables_LPN_07022014_Unscaled_RV

Outputs	**Asset Stewardship reports**									
Investment destription	NAMP Line	2015/6	2016/7	2017/8	2018/9	2019/20	2020/21	2021/22	2022/23	**Total**
Primary RTU Processors	1.57.07.8214	93	57	0	0	0	0	0	0	150
Secondary RTUs	1.57.02.8217	50	100	200	250	300	300	300	300	1,800
Primary SCADA Comms	1.57.02.8298	1	1	2	2	2	2	2	2	14
Secondary SCADA Comms	1.57.02.8293	100	200	300	400	500	600	700	700	3,500
Environment Monitoring	1.57.07.8294	2	2	0	0	0	0	0	0	4
Secondary SCADA Battery Monitoring	1.57.07.8335	50	100	200	250	300	300	300	300	1,800
Emergency Voice Comms	1.57.07.8337	5	10	15	20	25	25	25	25	150
RTU Fault Rectification	2.28.01.9578	2,500	2,500	2,500	2,500	2,500	2,470	2,440	2,410	19,820
CV105 6		**2,801**	**2,970**	**3,217**	**3,422**	**3,627**	**3,697**	**3,767**	**3,737**	**27,238**
IT - Communications for Switching & Monitoring	1.57.20.8611	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0
CV105 7		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
IT - Control Centre Hardware & Software	1.57.20.8614	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0
CV105 8		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Circuit routing - because of faults and diversions	2.27.13.9577	36	36	36	36	36	35	34	33	282
CV13 21		**36**	**36**	**36**	**36**	**36**	**35**	**34**	**33**	**282**
Cable maintenance (tele) - gas cable routine attention	2.28.06.9580	90	90	90	90	90	90	90	90	720
CV13 43		**90**	**90**	**90**	**90**	**90**	**90**	**90**	**90**	**720**
RTU fault investigation	2.41.09.9710	270	270	270	270	270	265	260	255	2,130
Telecontrol abnormality investigation	2.41.10.9711	111	111	111	111	111	111	111	111	888
UKPN Primary Telecontrol Circuit Faults	2.28.05.9579	73	73	73	73	73	73	73	73	584
Cable Repairs telecoms	2.28.07.9581	28	28	28	28	28	28	28	28	224
CV13 31		**482**	**482**	**482**	**482**	**482**	**477**	**472**	**467**	**3,826**
Optical fibre maintenance	2.28.10.9584	12	12	12	12	12	12	12	12	96
PCM Fault Repair	2.28.09.9583	12	12	12	11	10	9	8	7	81
CV13 47		**24**	**24**	**24**	**23**	**22**	**21**	**20**	**19**	**177**
Telecontrol enhancement	2.41.11.9712	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0
CV13 75		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total		**3,433**	**3,602**	**3,849**	**4,053**	**4,257**	**4,320**	**4,383**	**4,346**	**32,243**

	RIG Table										
Investment destription	RIG Table	RIG Row	2015/6	2016/7	2017/8	2018/9	2019/20	2020/21	2021/22	2022/23	**Total**
Primary RTU Processors	CV105	6	2,801	2,970	3,217	3,422	3,627	3,697	3,767	3,737	**27,238**
Secondary RTUs	CV105	7	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**0**
Primary SCADA Comms	CV105	8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**0**
Secondary SCADA Comms	CV13	21	872	872	872	872	871	871	870	810	**6,910**
Environment Monitoring	CV13	43	95	95	95	95	95	95	95	95	**762**
Secondary SCADA Battery Monitoring	CV13	31	5,317	5,317	5,317	5,317	5,317	5,316	5,311	5,012	**42,224**
Emergency Voice Comms	CV13	47	121	121	120	120	119	118	117	116	**952**
RTU Fault Rectification	CV13	75	264	264	264	264	264	264	264	264	**2,112**
Total			**9,470**	**9,639**	**9,885**	**10,090**	**10,293**	**10,361**	**10,424**	**10,034**	**80,198**

The volumes in the ASR documents may not match those in the RIGs tables because additional NAMP lines not included within the ASR documents may be mapped in the same RIGs Tables/Lines.

Appendix 16 Asset Stewardship Report – RIGs Table (Costs)

Document Name	**SCADA**
Document Author	**J Ford**
DNO	**LPN**

CV105 data is taken from CV105 - 12 02 2014
CV13 data is taken from Master Tables_LPN_07022014_Unscaled_RV

					Cost in £m								
Asset Type	**Asset Name**	**RIGs Table**	**RIGs Row**	**Total investment by Asset Type**	**2015/16**	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**Total**
Primary RTU Processors		CV105	6		0.186	0.114	0.000	0.000	0.000	0.000	0.000	0.000	0.300
Secondary RTUs		CV105	6		0.179	0.357	0.714	0.893	1.071	1.071	1.071	1.071	6.428
Primary SCADA Comms		CV105	6		0.200	0.200	0.400	0.400	0.400	0.400	0.400	0.400	2.800
Secondary SCADA Comms		CV105	6		0.100	0.200	0.300	0.400	0.500	0.601	0.701	0.701	3.503
Environment Monitoring		CV105	6		0.014	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.028
Secondary SCADA Battery Monitoring		CV105	6		0.015	0.030	0.060	0.075	0.090	0.090	0.090	0.090	0.542
Emergency Voice Comms		CV105	6		0.005	0.010	0.015	0.020	0.025	0.025	0.025	0.025	0.150
RTU Fault Rectification		CV105	6		0.427	0.427	0.427	0.427	0.426	0.423	0.417	0.417	3.393
Total		**CV105**	**6**	**28.78**									**17.144**
IT - Communications for Switching & Monitoring		CV105	7		0.875	2.023	2.371	2.082	2.033	2.060	2.206	2.206	15.857
Total		**CV105**	**7**	**15.84**									**15.857**
IT - Control Centre Hardware & Software		CV105	8		0.458	1.060	1.242	1.091	1.065	1.079	1.156	1.156	8.307
Total		**CV105**	**8**	**8.37**									**8.307**
Circuit routing - because of faults and diversions		CV13	21		0.018	0.018	0.018	0.018	0.018	0.018	0.017	0.017	0.141
Total		**CV13**	**21**	**3.67**									**0.141**
Cable maintenance (tele) - gas cable routine attention		CV13	43		0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.490
Total		**CV13**	**43**	**1.34**									**0.490**
RTU fault investigation		CV13	31		0.041	0.041	0.041	0.041	0.041	0.041	0.040	0.040	0.324
Telecontrol abnormality investigation		CV13	31		0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.560
UKPN Primary Telecontrol Circuit Faults		CV13	31		0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.298
Cable Repairs telecoms		CV13	31		0.515	0.515	0.515	0.515	0.515	0.515	0.515	0.515	4.119
Total		**CV13**	**31**	**9.08**									**5.302**
Optical fibre maintenance		CV13	47		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.010
PCM Fault Repair		CV13	47		0.025	0.025	0.023	0.023	0.021	0.019	0.017	0.017	0.170
Total		**CV13**	**47**	**0.72**									**0.180**
Telecontrol enhancement		CV13	75		0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.120
Total		**CV13**	**75**	**1.96**									**0.120**
	Total			**69.77**	**3.24**	**5.22**	**6.31**	**6.17**	**6.39**	**6.53**	**6.84**	**6.84**	**47.54**

The costs in the ASR documents may not match those in the RIGs tables because additional NAMP lines not included within the ASR documents may be mapped in the same RIGs Tables/Lines.