UK Power Networks

**Document 19
Asset Category – RTU – SCADA
EPN**

Asset Stewardship Report 2014 | James Ford

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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		

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1.0 Executive Summary EPN 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 EPN 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 physical fault and, as such, the fault levels for SCADA equipment are low.

There are 7,565 RTUs (671 primary RTUs and 6,894 secondary RTUs). There are 1,342 primary SCADA communications circuits (main and standby) and 6,894 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
CV105	£35.7	1.57
CV13	£3.1m	1.57, 2.28

Table 1 – Investment Details

NB, includes RTUs, communications and associated equipment.

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.

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1.3   ED1 Proposals

It is proposed to replace:

- 198 primary RTUs (£7,920,000).

- 1,680 secondary RTUs (£5,999,000).

- 915 secondary SCADA communication links. (£916,000).

- 13 primary SCADA communications links as an enhancement of the BT21CN fibre network (£2,600,000).

- 600 primary SCADA routers (£301,000).

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

- Monitoring of 1,680 secondary SCADA batteries (£506,000).

- Monitoring of weather and general environment (£68,000).

- Replacement of grid/primary substation voice communications at 190 sites (£190,000).

Expenditure is included to upgrade and enhance the NMS platform:

- Replacement and upgrade of IT hardware (£3,500,000).

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.).

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1.5 Risks and Opportunities

	Description of similarly likely opportunities or risks arising in ED1 period	Level of (uncertainties)/cost growth
Opportunity	Combine work wherever possible with other planned power network projects or work resulting from faults on the power network to reduce costs and labour requirements.	(£150,000)
Risk	If RTU fault rates were to increase, there is a risk that sites could be left without any monitoring or control.	Customer interruptions (CI) cost: £530,000/100,000 customers. Customer minutes lost (CML) cost: £1,290,000/customer
Opportunity	Improvement in the resilience in the communications to secondary RTUs will ensure automation schemes operate effectively, thereby improving CIs and CMLs.	CI cost: (£530,000/100,000) customers CML cost: £1,290,000/customer
Risk	If the proposed ED1 secondary communications replacements are not achieved, there is a risk that, should Vodafone decide to terminate the PAKNET system (which is already old technology), UK Power Networks will not be able to replace the communications to the RTUs (6,894 units) in time. Vodafone need only give UK Power Networks 24 months' notice, so this could result in a loss of communications and SCADA. Assuming it could be achieved, the replacement programme would be accelerated with resulting increased costs.	£1,000,000

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 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

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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 ways:

- 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 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

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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 671 primary SCADA RTUs installed on the EPN network.

There are three types of RTU on the EPN primary SCADA network: Schneider (294), Ferranti (293) and Converteam (84).

Primary SCADA has been upgraded to use Internet Protocol (IP) during DPCR5. The vast majority of primary and grid substation RTUs use the UK Power Networks' VSAT network for main communications, and GPRS for back-up communications.

A small number use Cable & Wireless DSL circuits for main communications and GPRS for back-up communications, but this is not ideal as the Cable & Wireless DSL circuits have very limited availability in the event of a power outage. A small number of RTUs (28) have been or will be replaced in DPCR5 to enable the remaining fleet to be maintained until the ED1 period.

Age profile

One concern about primary RTUs is the age of the technology and its components. The Schneider RTUs date from the early 1990s and the Converteam RTUs are a modern design.

NAMP lines and RiGs lines

Primary RTUs	1.57.02.8038
Primary SCADA Comms (links)	1.57.02.8295
Primary SCADA Comms (routers)	1.57.02.8307
EPN SCADA system maintenance	2.28.15.9731
EPN SCADA Satellite System Rental	2.28.15.6813
RTU Fault Rect	2.28.01.8291
CV105 6	

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Emergency Voice Comms	1.57.10.9110
Environment Monitoring	1.57.04.6089
CV105 7	
IT - Control Centre Hardware & Software	1.57.20.8613
CV105 8	
3rd Party Circuit Faults	2.28.05.9479
UKPN circuit faults	2.28.07.6243
SCS Comms/Plant Faults	2.28.16.9732
RTU Battery Faults	2.29.30.9485
RTU Battery Maintenance	2.28.23.9849
CV13 31	
Satellite Comms Faults	2.28.28.9478
CV13 47	
EPN SCADA System management	2.28.29.9486
CV13 75	

2.2 Existing Secondary RTUs/LCUs (Local Control Units)

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

There are 6,894 secondary RTUs/LCUs installed on the EPN network.

There are 7 types of RTU/LCU on the EPN secondary SCADA network, which are:

- Schneider Sprite II. This is a pole-mounted switchgear used in conjunction with Whip and Bourn, Brush, Soule and ABB Sectos LCUs.

- Schneider Talus T200E Series 2 (ground-mounted switchgear LCU).

- Schneider Talus T200E Series 3 (ground-mounted switchgear LCU).

- Lucy Gemini 2 (ground-mounted switchgear LCU).

- Lucy Gemini 2.5 (ground-mounted switchgear LCU).

- Nu-Lec (Schneider) CAPM (pole-mounted switchgear LCU).

- Schneider T200P (pole-mounted switchgear LCU).

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The communications are provided by the Vodafone PAKNET system, which dates from the mid-1990s. This is a low-bandwidth, packet-based commercial radio communications network. UK Power Networks is working with the ENA and Vodafone to monitor the performance of the network and the longevity of the commercial offering. However, this must be considered as a high risk in ED1 and hence mitigation is required.

NAMP lines and RiGs lines:

Secondary RTUs	1.57.01.8215
Secondary SCADA Comms	1.57.02.8292
Secondary SCADA Battery Monitoring	1.57.07.8330
CV105 6	
IT - Communications for Switching & Monitoring	1.57.20.8610
CV105 7	
SCS Comms/Plant Faults	2.28.16.6646
CV13 31	

2.3   Existing RTUs Asset Age

2.3.1   Asset age

The Schneider primary RTUs and Schneider Sprit II and Schneider Talus 200 secondary RTUs date from the mid-1990s and the Converteam Primary RTUs and Lucy Gemini, Nu-Lec, Schneider 200P and Schneider Talus T200E Secondary RTUs are of a modern design. Asset age and volumes are shown in Tables 3 and 4.

EPN primary RTUs	Approximate year	Volume
Schneider	1993	294
Ferranti	1993	293
Converteam	2000	84

Table 3 – RTU asset age

EPN secondary RTU/LCU				
Control unit	Switchgear	Separate RTU	Approximate year	Volume
ABB Sectos	PM Switch	Sprite II	1990	140
Soule August	PM Switch	Sprite II	1990	177
Brush	PM Recloser	Sprite II	1990	117
WBO	PM Recloser	Sprite II	1998	1,153

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EPN secondary RTU/LCU				
Control unit	Switchgear	Separate RTU	Approximate year	Volume
NUL PTCC	PM Recloser	No	2000	60
SCH T200P Series 3	PM Switch	No	2012	23
Lucy Gemini 2	GM	No	2006	213
Lucy Gemini 2.5	GM	No	2007	202
SCH T200E Series 2	GM	No	1998	4,794
SCH T200E Series 3	GM	No	2011	15

Table 4 – RTU volumes

The relevant point with respect to secondary RTUs regarding asset age is the age of the technology and the components within the RTU. The Schneider Sprit II (and associated LCUs) and Schneider Talus 200E series 2 RTUs date from the early 1990s and the Lucy Gemini, Nu-Lec, Schneider 200P and Schneider Talus T200E series 3 RTUs are a modern design.

The communications used for secondary RTUs (Vodafone PAKNET) dates from the mid-1990s and is supported by Vodafone. While UK Power Networks has not been notified as such, due to the age of the technology, it is conceivable that Vodafone may terminate the PAKNET system within the next few years. The current contract allows Vodafone to give UK Power Networks 24 months' notice of termination. Were this to happen, there is a very 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 6,894 secondary SCADA sites within this timeframe.

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

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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

Significant investment has been made in primary SCADA communications during the DPCR5 period to adapt the application protocols (Wisp+ and DNP3) to operate using IP as the transport protocol. Efforts have also been made to install a private VSAT satellite communications network, and secure access to GPRS networks provided by mobile phone network operators. The satellite network enables primary SCADA to communicate using a network independent of any terrestrial service providers and will guarantee operation during any black-start scenario or widespread power failure.

Figure 1 shows the 7.6m hub antenna at UK Power Networks' Network Control Centre in Ipswich.

Figure 1 – Fore Hamlet antenna

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Figure 2 shows a typical VSAT antenna at a substation site.

Figure 2 – Substation VSAT

Secondary SCADA uses the Vodafone PAKNET system to provide communications. There are three issues with this system:

- There are 6,894 units installed on the network. PAKNET is an old technology and it is likely to be ceased during the ED1/ED2 period. Vodafone is required to give UK Power Networks 24 months' notice of termination and this is insufficient time to replace the system.

- The resilience of the PAKNET system is not sufficient for modern automation schemes due to the lack of battery back-up on the base station sites.

- Due to the age of the technology, PAKNET is not IP-compliant and is not compatible with modern communications networks and equipment.

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

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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.

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.

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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. This would then enable the GPRS connection to be removed, reducing opex costs and further improving the reliability of the SCADA network.

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
WBO	1990	1,153
SCH T200E Series 2	1998	4,794
Soule August	1990	177
Brush	1990	117
Schneider Primary RTU	1993	294
Ferranti Primary RTU	1993	293

Table 5 – Types and volumes of RTUs

These figures represent 90% of the total population of RTUs on the EPN 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

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the old generation of RTUs is insufficient to cope with new demands, and a case study demonstrating this is shown in Appendix 13.

Figures 3 and 4 show a typical Schneider primary RTU installed in a substation.
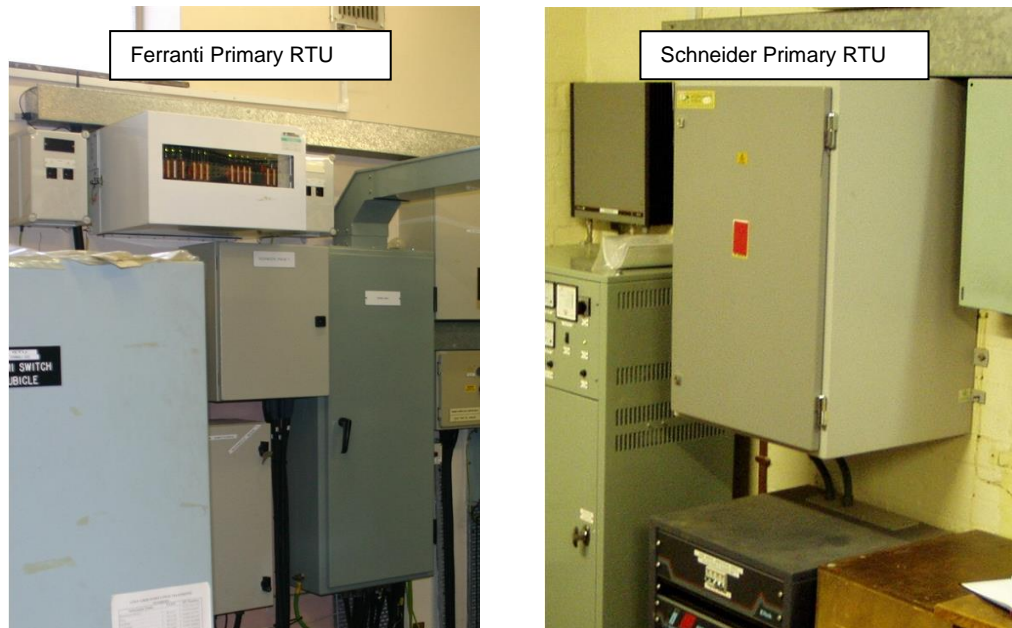
Figures 3 and 4 – RTU installation

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. The consequence of SCADA not operating was a quadrupling in CIs and a doubling in 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

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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 5.
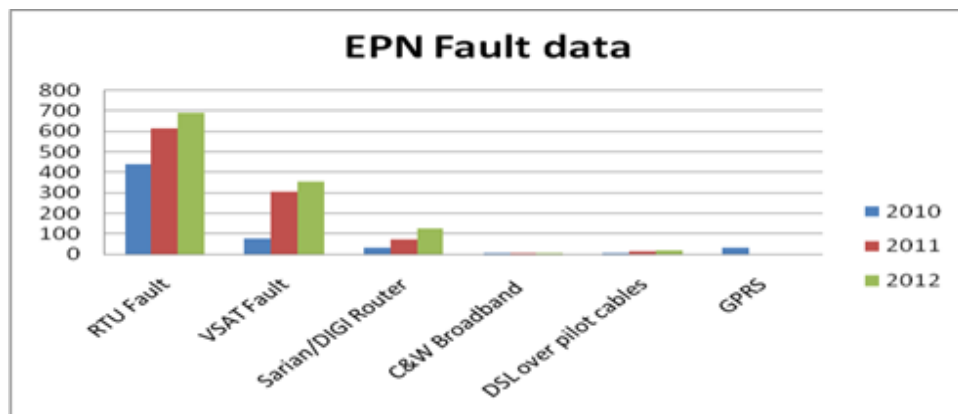
Figure 5 – EPN fault data

This shows a general increase in failure rates over the period, particularly RTU faults. Many of these faults are with RTU components, such as input/output cards, rather than total RTU failure.

The VSAT fault volumes are showing as increasing because the installed volumes are increasing over the period. Many of these faults are associated with installation errors and have been corrected.

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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 EPN primary and secondary networks 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.

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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 EPN primary SCADA have been upgraded to use IP as the transport protocol. As UK Power Networks' fibre/DSL network is installed for the BT21CN project to cater for operational intertripping and inter-site protection systems, and also when a separate fibre link is established into the Network Control Centre at Fore Hamlet primary and grid substation, RTUs should be moved onto the fibre network. This will reduce operating costs by reducing the size of the satellite network and therefore the amount of bandwidth that is required, and improve the speed of communications and bandwidth available to substations. Capacity on the satellite network is rented and the fibre network for the BT21CN project is owned by UK Power Networks, therefore any reduction in the bandwidth on the satellite network will reduce costs.

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.

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5.1.2   Secondary SCADA communications

The secondary SCADA network will be upgraded to operate using IP as the transport protocol. DNP3 IP will be introduced when the NMS is upgraded to V5 (this is planned for March 2015). This will enable the use of any modern communication networks and ensure that all SCADA communications can use a common platform.

During ED1 and ED2, 915 of the PAKNET sites 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.

5.1.3   Replace Sarian router interventions

All EPN Grid and Primary substations utilise a GPRS 'router' (Sarian routers) to manage the IP connection to the substation and the changeover between main and standby communications, and to facilitate a serial connection to the RTUs (required for old RTUs). These date back to 2007 when the Satellite system was deployed. The technology for this equipment (especially with regards to cyber security and communications network technology such as GPRS and 3G) is currently out of date (they have been superseded for new sites with a new version), and will not be able to be supported by the end of ED1.

 The existing routers used at grid and primary substations will be replaced with an appropriate modern equivalent, taking into account future SCADA and substation asset requirements, such as smart grids, asset management and monitoring, IEC61850, etc.

5.2   RTU Interventions

5.2.1   Replace some RTUs (recommended option)

The recommended option is to replace 198 of the combined fleet of Schneider and Ferranti Primary RTUs, and 1,680 of the combined fleet of Schneider Sprit II and Schneider Talus 200E Series 2 Secondary RTUs. This will provide sufficient spares for the remaining RTUs to remain in service for the ED1 period. These figures have been decided because:

- By the end of ED1 the technology employed in the old RTUs will be around 25-30 years old, and by the end of ED2 it will be around 33-38 years old. It will be impracticable to support the old RTUs by the end of ED2 (as described in section 3.4), so UK Power Networks is planning to remove them from the network by the end of ED2. Due to the large number of RTUs on the network, this work must start now to allow a

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planned and controlled replacement programme to take place. All of the primary RTUs and about half of the secondary RTUs will be replaced by the end of ED2.

- 198 of the primary RTUs and 1,680 of the secondary RTUs is considered to be the maximum number UK Power Networks can replace during ED1, given the resources available.

5.2.2   Replace all RTUs (rejected option)

This option has been rejected because:

- The increased technology level offered by the new generation of RTUs will not be required at all sites.

- The costs of replacing all the RTUs will be very high. It is not necessary to replace all the RTUs, and the spares released from those that will be replaced can be used to maintain the remaining RTUs, therefore reducing costs.

- There is insufficient resource to carry out the replacements.

5.2.3   Do nothing (rejected option)

This has been rejected because:

- The technology level of the old generation of RTUs is insufficient to meet the requirements and demands of smart grids and smart networks.

- Some spares for the old generation of RTUs are now unavailable. As units fail they will not be able to be fixed, resulting in network control and monitoring being lost.

- Cost savings associated with the connection of alarms and analogues at new sites through the use of communications bus rather than hard wiring will not be realised.

5.2.4   Intervention strategy

- Intervention strategies for RTUs will be optimised by targeting the replacement of the RTU where possible at sites where other significant work is occurring (such as replacement of the switchboard). This will enable installation costs to be minimised.

- The intervention strategy optimises the expenditure plans by targeting RTU replacements at the sites where the benefits of the improved technology from new RTUs can be used. The spares released by these

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replacements will then maintain the remaining fleet of RTUs, therefore deferring the need to replace them.

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 8 substation sites.

5.4   Voice Communications Interventions

All primary and grid substations are equipped with a BT phone line. A fibre/DSL network is planned to be installed for the BT21CN 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, but a secondary benefit.

Substations that do not have UK Power Networks' fibre/DSL connections will keep their existing BT phone line.

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.

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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, 198 Schneider primary RTUs and 1,680 of the Schneider Sprit II and Schneider Talus 200 secondary RTUs will be replaced.

Also during this period, 915 of the communications to secondary RTUs will be replaced with IP-compliant communications.

The BT21CN project (Document 17) will provide mitigation for the BT proposals to change the infrastructure of its communications network and the consequent impact on protection systems. This proposal provides the opportunity to independently expand this network to support SCADA communications, asset management data and voice communications. This associated expenditure is dedicated to this activity and is not covered within the proposals for BT21CN mitigation.

Battery monitoring will be installed on all existing secondary SCADA sites. Where batteries are replaced as part of the battery replacement programme,

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this functionality will be included if not already available. Substation battery replacement is detailed in Document 21.

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

The inspection and maintenance expenditure for primary SCADA is split into 10 categories. No costs/volumes are included for the old SCADA network, which has been replaced with the new IP network:

- Third-party circuit faults.

  - Identification and rectification of faults with rented communications circuits. All third-party circuits were replaced by the IP/satellite network. A small number of new third-party circuits will be installed during ED1/ED2.

- UK Power Networks circuit faults.

  - Identification and rectification of faults with UK Power Networks-owned communications circuits.

- EPN SCADA system maintenance.

  - Maintenance of the primary SCADA system, which includes maintenance of RTUs and communications equipment. No maintenance was carried out on the EPN SCADA network until 2011 because there were insufficient resources due to SPN and EPN satellite installation work.

- EPN SCADA satellite system rental.

  - Rental of capacity on the communications satellite. The equipment was rented immediately after installation, hence the higher costs. System rental costs were reduced following purchase of the equipment.

- SCS communications/plant faults.

  - Identification and rectification of faults associated with secondary SCADA communications and RTUs. It is anticipated that the fault will reduce slightly as equipment and systems are replaced.

- Satellite communications faults.

  - Identification and rectification of faults with the satellite communications system. Although the number of satellite-connected sites will reduce slightly as RTUs are moved onto the fibre network,

the fault volumes are expected to remain the same due to age-related failures of the satellite equipment.

- EPN SCADA system management.

  - Management of the SCADA system as a whole.

- RTU battery maintenance.

  - Maintenance of the dedicated SCADA batteries.

- RTU battery faults.

  - Rectification of the dedicated SCADA battery and charger faults.

- RTU fault rectification.

  - Primary SCADA RTU faults. It is anticipated that the fault rate will reduce following replacement of some of the RTUs and communications during ED1/ED2.

  - 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.

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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 this process will be carried out during the remainder of DPCR5. The budget for this is based on simply replacing the communications device on-site (PAKNET pad) 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 198 of the combined fleet of Schneider and Ferranti Primary RTUs and 1,680 of the combined fleet of Schneider Sprit II and Schneider Talus 200 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 was upgraded to use UK Power Networks' new satellite system and IP communications. This is when the project to convert the whole primary SCADA communications system commenced and the method of recording data was changed. 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.

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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.
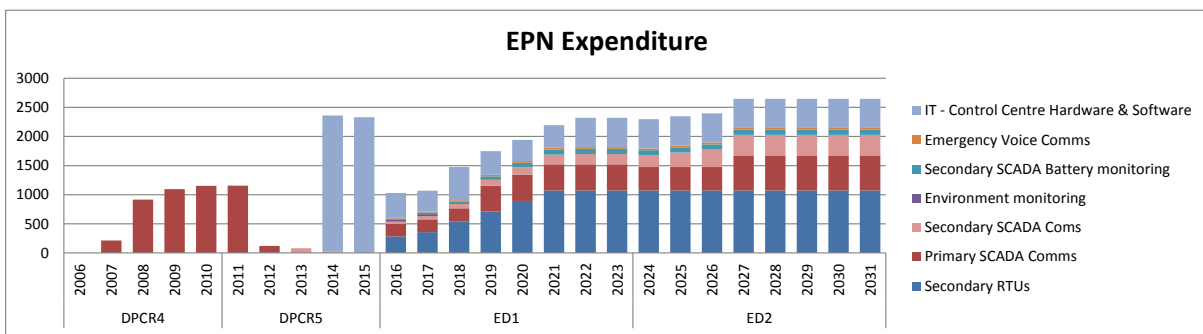
Figure 6 – SCADA expenditure (£k)
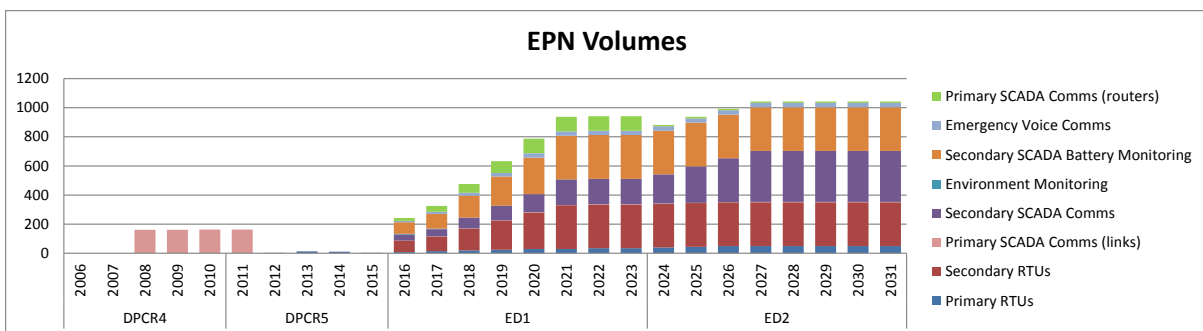
Figure 7 – SCADA replacement volumes and interventions

7.4.2 SCADA inspection and maintenance.

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EPN Volumes

Legend:
- RTU Battery Faults
- RTU Battery Maintenance
- EPN SCADA System management
- Satellite Comms Faults
- SCS Comms/Plant Faults
- EPN SCADA system maintenance
- UKPN circuit faults
- 3rd Party Circuit Faults

Figure 8 – Inspection and maintenance volumes

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 in this document.

The inspection 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.

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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 the ED1 work to identify any additional resources required and ensure the programmes can be delivered.

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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 contains components that are no longer available.

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Appendices

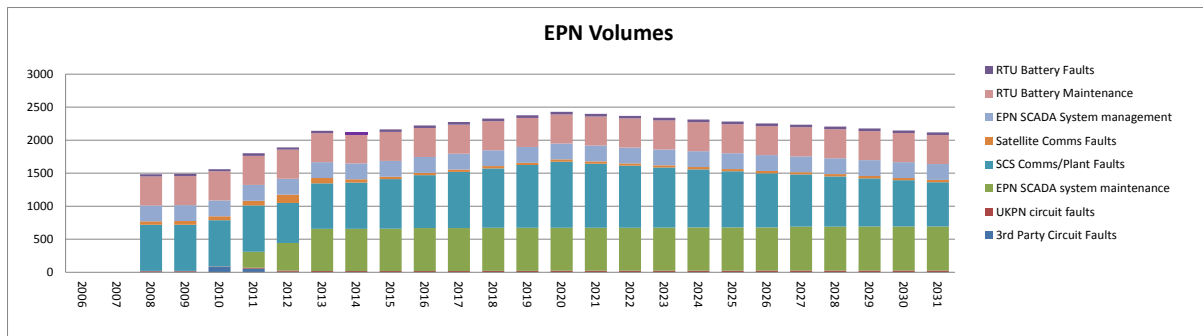## Appendix 1 Age Profiles

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 Schneider and Ferranti RTUs date to the early 1990s and the Converteam RTUs are a modern design.

Secondary RTUs: The Schneider Sprit II and Schneider Talus 200 RTUs date to the early 1990s and the Lucy Gemini, Nu-Lec, Schneider 200P and Schneider Talus T200E RTUs are a modern design.

Secondary SCADA comms: The communications used for secondary SCADA is the Vodafone PAKNET system that dates back to the mid-1990s.

Primary SCADA communications: The primary SCADA communications have been upgraded to use IP as the transport protocol. Satellite provides main communications and GPRS is used for back-up communications. Both the satellite and GPRS date from the early 2000s.

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.).

The costs for accelerating the secondary SCADA communications replacement programme are based on the following assumption:

- The project costs will increase by approximately 20% due to the fact that more contract engineers working overtime will be required to meet the timescales.

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Appendix 5 Fault Data

	Primary RTU fault	SCADA Comms	C&W Broadband	DSL over pilot cables	Totals
Jan-10	36	2	0	0	38
Feb-10	36	2	0	0	38
Mar-10	36	2	0	0	38
Apr-10	36	2	0	0	38
May-10	44	8	0	0	52
Jun-10	33	15	1	0	49
Jul-10	33	15	1	0	49
Aug-10	31	8	0	0	39
Sep-10	27	8	0	0	35
Oct-10	34	14	0	0	48
Nov-10	21	22	0	0	43
Dec-10	31	26	0	0	57
	398	124	2	0	
Jan-11	36	20	0	0	56
Feb-11	31	26	0	0	57
Mar-11	21	7	0	0	28
Apr-11	21	7	0	0	28
May-11	16	6	0	0	22
Jun-11	26	21	0	0	47
Jul-11	26	9	0	0	35
Aug-11	26	6	0	0	32
Sep-11	28	7	0	0	35
Oct-11	25	7	1	0	33
Nov-11	22	2	2	0	26
Dec-11	26	3	0	0	29
	304	121	3	0	
Jan-12	29	7	0	0	36
Feb-12	25	7	0	0	32
Mar-12	26	13	0	2	41
Apr-12	26	13	2	0	41
May-12	12	1	2	0	15
Jun-12	15	26	0	0	41
Jul-12	31	5	0	0	36
Aug-12	40	12	2	0	54
Sep-12	38	9	0	0	47
Oct-12	57	20	0	0	77
Nov-12	32	4	0	0	36
Dec-12	24	11	0	0	35
	355	128	6	2	

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Table 6 – SCADA fault data

Appendix 6 Maintenance history

Primary SCADA

Maintenance is carried out once a year on primary SCADA sites. This includes:

- Checking equipment settings.

- Checking equipment levels.

- Checking connection leads.

- Checking earth integrity.

- Checking fixing bolts.

- Testing of batteries.

- Operation of the 'dummy' circuit breaker on RTUs.

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.

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Appendix 9 SCADA expenditure by activity

ED1 expenditure

Primary RTUs								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	8	15	20	25	30	30	35	35

Secondary RTUs								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	80	100	150	200	250	300	300	300

Primary SCADA Comms								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes (links)	1	1	1	2	2	2	2	2
Forecast Volumes (routers)	20	40	60	80	100	100	100	100

Secondary SCADA Comms								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	40	50	75	100	125	175	175	175

Environment Monitoring								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	4	4	0	0	0	0	0	0

Secondary SCADA Battery Monitoring								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	80	100	150	200	250	300	300	300

Emergency Voice Comms								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	10	15	20	25	30	30	30	30

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	426	357	570	406	362	387	502	502

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3rd Party Circuit Faults								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	0	0	1	1	1	1	1	1

UKPN circuit faults								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	18	18	20	20	21	21	21	22

EPN SCADA system maintenance								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	642	652	652	653	653	653	654	654

EPN SCADA Satellite System Rental								
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	660	651	610	560	510	460	419	419

SCS Comms/Plant Faults								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	800	850	900	950	1000	970	940	910

Satellite Comms Faults								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	35	35	35	35	35	35	35	35

EPN SCADA System management								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	240	240	240	240	240	240	240	240

RTU Battery Maintenance								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	440	440	440	440	440	440	440	440

RTU Battery Faults								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	39	40	40	40	40	40	40	40

RTU Fault Rect								
ED1 Replacement	2016	2017	2018	2019	2020	2021	2022	2023
Forecast Volumes	582	582	582	577	572	567	562	557

IT - Communications for Switching & Monitoring								
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	813	682	1087	775	692	738	957	957

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ED2 expenditure

Primary RTUs								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	40	45	50	50	50	50	50	50

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

Primary SCADA Comms								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes (links)	2	2	2	3	3	3	3	3
Forecast Volumes (routers)	10	10	10	10	10	10	10	10

Secondary SCADA Comms								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	200	250	300	350	350	350	350	350

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	300	300	300	300	300	300	300

Emergency Voice Comms								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	30	30	30	30	30	30	30	30

IT - Control Centre Hardware & Software								
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
Forecast Expenditure £k	502	502	502	502	502	502	502	502

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3rd Party Circuit Faults								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	1	1	1	2	2	2	2	2

UKPN circuit faults								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	22	22	23	23	23	24	24	24

EPN SCADA system maintenance								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	655	655	655	666	666	666	667	667

EPN SCADA Satellite System Rental								
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
Forecast Expenditure £k	410	410	410	410	410	410	410	410

SCS Comms/Plant Faults								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	880	850	820	790	760	730	700	670

Satellite Comms Faults								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	35	35	35	35	35	35	35	35

EPN SCADA System management								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	240	240	240	240	240	240	240	240

RTU Battery Maintenance								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	440	440	440	440	440	440	440	440

RTU Battery Faults								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	40	40	40	40	40	40	40	40

RTU Fault Rect								
ED2 Replacement	2024	2025	2026	2027	2028	2029	2030	2031
Forecast Volumes	552	547	542	537	532	527	522	517

IT - Communications for Switching & Monitoring								
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
Forecast Expenditure £k	957	957	957	957	957	957	957	957

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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 22 September 2012 a fault (FREP-575069-H) occurred on the Notley Green Roundabout/The Avenue feeder out of West Braintree Primary. 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, and 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 135 CIs and 2,644 CMLs (total cost: £1,300).

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On 3 August 2011 a fault (FREP-14400-D) occurred on the Notley Green Roundabout/The Avenue feeder out of West Braintree Primary. 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 527 CIs and 5,487 CMLs (total cost: £4,000).

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.

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Appendix 15 Asset Stewardship Report – RIGs Table (Volumes)

Document Name	SCADA		
Document Author	J Ford		CV105 data is taken from CV105 - 12 02 2014
DNO	EPN		CV13 data is taken from Master Tables_EPN_07022014_Unscaled_RV

Outputs		Asset Stewardship reports									RIG Table									
Investment destription	NAMP Line	2015/6	2016/7	2017/8	2018/9	2019/20	2020/21	2021/22	2022/23	Total	RIG Table	RIG Row	2015/6	2016/7	2017/8	2018/9	2019/20	2020/21	2021/22	2022/23	Total
Primary RTUs	1.57.02.8038	8	15	20	25	30	30	35	35	198	CV105	6	1,453	1,540	1,690	1,837	1,982	2,127	2,128	2,123	**14,880**
Secondary RTUs	1.57.01.8215	80	100	150	200	250	300	300	300	1,680	CV105	7	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**0**
Primary SCADA Comms (links)	1.57.02.8295	1	1	1	2	2	2	2	2	13	CV105	8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**0**
Primary SCADA Comms (routers)	1.57.02.8307	20	40	60	80	100	100	100	100	600	CV13	31	1,959	2,010	2,062	2,114	2,149	2,135	2,105	2,075	**16,609**
Secondary SCADA Comms	1.57.02.8292	40	50	75	100	125	175	175	175	915	CV13	47	409	409	409	409	409	409	409	409	**3,272**
Secondary SCADA Battery Monitoring	1.57.07.8330	80	100	150	200	250	300	300	300	1,680	CV13	75	600	600	600	597	588	572	545	530	**4,632**
EPN SCADA system maintenance	2.28.15.9731	642	652	652	653	653	653	654	654	5,213											
EPN SCADA Satellite System Rental	2.28.15.6813	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0											
RTU Fault Rect	2.28.01.8291	582	582	582	577	572	567	562	557	4,581											
CV105 6		**1,453**	**1,540**	**1,690**	**1,837**	**1,982**	**2,127**	**2,128**	**2,123**	**14,880**											
Emergency Voice Comms	1.57.10.9110	10	15	20	25	30	30	30	30	190											
Environment Monitoring	1.57.04.6089	4	4	0	0	0	0	0	0	8											
IT - Communications for Switching & Monitoring	1.57.20.8610	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0											
CV105 7		**14**	**19**	**20**	**25**	**30**	**30**	**30**	**30**	**198**											
IT - Control Centre Hardware & Software	1.57.20.8613	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**											
3rd Party Circuit Faults	2.28.05.9479	0	0	1	1	1	1	1	1	6											
UKPN circuit faults	2.28.07.6243	18	18	20	20	21	21	21	22	161											
SCS Comms/Plant Faults	2.28.16.9732	800	850	900	950	1,000	970	940	910	7,320											
RTU Battery Faults	2.29.30.9485	39	40	40	40	40	40	40	40	319											
RTU Battery Maintenance	2.28.23.9849	440	440	440	440	440	440	440	440	3,520											
CV13 31		**1,297**	**1,348**	**1,401**	**1,451**	**1,502**	**1,472**	**1,442**	**1,413**	**11,326**											
Satellite Comms Faults	2.28.28.9478	35	35	35	35	35	35	35	35	280											
CV31 47		**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**280**											
EPN SCADA System management	2.28.29.9486	240	240	240	240	240	240	240	240	1,920											
CV13 75		**240**	**240**	**240**	**240**	**240**	**240**	**240**	**240**	**1,920**											
Total		3,039	3,182	3,386	3,588	3,789	3,904	3,875	3,841	28,604			4,421	4,559	4,761	4,957	5,128	5,243	5,187	5,137	39,393

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.

All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

Appendix 16 Asset Stewardship Report – RIGs Table (Costs)

Document Name	SCADA										
Document Author	J Ford			CV105 data is taken from CV105 - 12 02 2014							
DNO	EPN			CV13 data is taken from Master Tables_EPN_07022014_Unscaled_RV							

Asset Type	Asset Name	RIGs Table	RIGs Row	Total investment by Asset Type	Cost in £m								
					2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	Total
Primary RTUs		CV105	6		0.32	0.60	0.80	1.00	1.20	1.20	1.40	1.40	7.92
Secondary RTUs		CV105	6		0.29	0.36	0.54	0.71	0.89	1.07	1.07	1.07	6.00
Primary SCADA Comms (links)		CV105	6		0.200	0.200	0.200	0.400	0.400	0.400	0.400	0.400	2.600
Primary SCADA Comms (routers)		CV105	6		0.010	0.020	0.030	0.040	0.050	0.050	0.050	0.050	0.301
Secondary SCADA Comms		CV105	6		0.041	0.054	0.075	0.100	0.130	0.165	0.175	0.175	0.916
Secondary SCADA Battery Monitoring		CV105	6		0.024	0.030	0.045	0.060	0.075	0.090	0.090	0.090	0.506
EPN SCADA system maintenance		CV105	6		0.101	0.102	0.102	0.103	0.103	0.103	0.103	0.103	0.819
EPN SCADA Satellite System Rental		CV105	6		0.660	0.651	0.610	0.560	0.510	0.460	0.419	0.419	4.289
RTU Fault Rect		CV105	6		0.243	0.243	0.242	0.241	0.239	0.236	0.235	0.235	1.913
Total		**CV105**	**6**	**38.68**									**25.263**
Emergency Voice Comms		CV105	7		0.010	0.015	0.020	0.026	0.030	0.030	0.030	0.030	0.192
Environment Monitoring		CV105	7		0.034	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.068
IT - Communications for Switching & Monitoring		CV105	7		0.813	0.682	1.087	0.775	0.692	0.738	0.957	0.957	6.703
Total		**CV105**	**7**	**6.95**									**6.963**
IT - Control Centre Hardware & Software		CV105	8		0.426	0.357	0.570	0.406	0.362	0.387	0.502	0.502	3.511
Total		**CV105**	**8**	**3.57**									**3.511**
3rd Party Circuit Faults		CV13	31		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
UKPN circuit faults		CV13	31		0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.041
SCS Comms/Plant Faults		CV13	31		0.137	0.145	0.154	0.162	0.168	0.166	0.161	0.161	1.254
RTU Battery Faults		CV13	31		0.013	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.110
RTU Battery Maintenance		CV13	31		0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.348
Total		**CV13**	**31**	**2.89**									**1.755**
Satellite Comms Faults		CV13	47		0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.073
Total		**CV13**	**47**	**0.85**									**0.073**
EPN SCADA System management		CV13	75		0.159	0.159	0.159	0.159	0.159	0.159	0.159	0.159	1.275
Total		**CV13**	**75**	**3.12**									**1.275**
													0.000
Total				**56.07**	**3.53**	**3.72**	**4.70**	**4.82**	**5.08**	**5.33**	**5.83**	**5.83**	**38.84**

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