Document 21
Asset Category – Batteries
SPN

Asset Stewardship Report 2014

Brian Matthews

Approved by Richard Wakelen / Barry Hatton

Document Date 03/03/2014

Document History

Version	Date	Details	Originator	Revision Class	Section Update
1.0	18/02/2014	Original issue	Brian Matthews		
1.1	18/02/2014	Reference to EFPI batteries removed. Costs and volumes updated. Ref to CV105 added Appendix 8 added	Brian Matthews	Major	1.1, 1.2, 1.3, 2.0, 7.0
1.2	20/02/2014	Blank appendices added	Brian Matthews	Minor	App 1, 2, 3, 4, 6, 7, 9
1.3	20/02/2014	Appendix 5 populated. Costs removed from Appendix 8	Brian Matthews	Major	App 5, App 8
1.4	24/02/2014	ASR Preface added and ref to unscaled in header removed	Brian Matthews	Minor	Preface
1.5	26/02/2014	Align with gold checklist v11	Brian Matthews	Minor	Throughout document
1.6	28/02/2014	App 10 expanded to include all rows, Explanation of cost to vol difference added to 7.0	Brian Matthews	Major	App 10, 7.0
2.0	03/03/2014	Final version	Brian Matthews	Minor	

Preface

UK Power Networks uses Asset Stewardship Reports ('ASR') to describe the optimum asset management strategy and proposals for different groups of assets. This optimised asset management strategy and plan details the levels of investment required and the targeted interventions and outputs needed. Separate ASRs define the most efficient maintenance and inspection regimes needed and all documents detail the new forms of innovation which are required to maximise value, service and safety for all customers and staff throughout the ED1 regulatory period. Outline proposals for the ED2 period are also included.

Each DNO has a suite of approximately 20 ASR's. Although asset policy and strategy is similar for the same assets in each DNO the detailed plans and investment proposals are different for each DNO. There are also local issues which must be taken into account. Accordingly each DNO has its own complete set of ASR documents.

A complete list of titles of the ASR's, a summary of capex and opex investment is included in '**Document 20: Asset Stewardship Report: Capex/Opex Overview'**. This document also defines how costs and outputs in the various ASR's build up UK Power Networks 'NAMP' (Network Asset Management Plan) and how the NAMP aligns with Ofgem's ED1 RIGs tables and row numbers.

Where 'HI' or asset 'Health Index' information is included please note predicted ED1 profiles are before any benefits from 'Load driven investment.'

This ASR has also been updated to reflect the feedback from Ofgem on our July 2013 ED1 business plan submission. Accordingly to aid the reader three additional appendices have been added. They are;

1. **Appendix 8 - Output NAMP/ED1 RIGS reconciliation:** This section explains the 'line of sight' between the UKPN Network Asset Management Plan (NAMP) and the replacement volumes contained in the Ofgem RIGS tables. The NAMP is the UKPN ten year rolling asset management investment plan. It is used as the overarching plan to drive both direct and indirect Capex and Opex interventions volumes and costs. The volume and cost data used in this ASR to explain our investment plan is taken from the UK Power Networks NAMP. Appendix 8 explains how the NAMP outputs are translated into the Ofgem RIGS tables. The translation of costs from the NAMP to the ED1 RIGS tables is more complex and it is not possible to explain this in a simple table. This is because the costs of a project in the 'NAMP' are allocated to a wide variety of tables and rows in the RIGS. For example the costs of a typical switchgear replacement project will be allocated to a range of different Ofgem ED1 RIGs tables and rows such as CV3 (Replacement), CV5 (Refurbishment) CV6 (Civil works) and CV105 (Operational IT Technology and Telecoms). However guidance notes of the destination RIGs tables for NAMP expenditure are included in the table in the Section 1.1 of the Executive Summary of each ASR.

2. **Appendix 9 – Efficiency benchmarking with other DNO's:** *(Not relevant in this document)* This helps to inform readers how UK Power Networks is positioned from a benchmarking position with other DNO's. It aims to show why we believe our investment plans in terms of both volume and money is the right answer when compared to the industry, and why we believe our asset replacement and refurbishment investment proposals are efficient and effective and in the best interest for our customers.

3. **Appendix 10 – Material changes since the July 2013 ED1 submission:** This section shows the differences between the ASR submitted in July 2013 and the ASR submitted for the re-submission in March 2014. It aims to inform the reader the changes made to volumes and costs as a result of reviewing the plans submitted in July 2013. Generally the number of changes made is very small, as we believe the original plan submitted in July 2013 meets the requirements of a well justified plan. However there are areas where we have identified further efficiencies and improvements or recent events have driven us to amend our plans to protect customer safety and service.

We have sought to avoid duplication in other ED1 documents, such as 'Scheme Justification Papers', by referring the reader to key issues of asset policy and asset engineering which are included in the appropriate ASR documents.

Contents

1.0 Executive Summary SPN Batteries 6
1.1 Scope 6
1.2 Investment Strategy 7
1.3 Innovation 7
1.4 Risks and Opportunities 7
2.0 Description of Battery Population 7
3.0 Investment Drivers 9
4.0 Asset Assessment 9
5.0 Intervention Policies 10
6.0 Innovation 10
7.0 ED1 Expenditure Requirements for Batteries 11
8.0 Deliverability 13
Appendix 1: Age profiles 14
Appendix 2: HI Profiles 15
Appendix 3: Fault data 16
Appendix 4: WLC and other Case studies 17
Appendix 5: NLRE Expenditure plan 18
Appendix 6: Sensitivity Analysis 20
Appendix 7: Named schemes 21
Appendix 8: Output NAMP/ED1 Business Plan Data Table Reconciliation 22
Appendix 9: Efficiency benchmarking with other DNO's 23
Appendix 10 – Material changes since the July 2013 ED1 submission 24

1.0 Executive Summary SPN Batteries

1.1 Scope

This document details UK Power Networks' non-load related expenditure (NLRE) replacement and refurbishment proposals for batteries during the RIIO-ED1 period.

There are 1,209 battery and charger installations in Grid, Primary and Secondary substations and a further 5,519 assets containing batteries principally Remote Terminal Units (RTUs).

Replacement costs for these assets are held in the following locations in Ofgem and UK Power Networks investment planning documents:

INVESTMENT TYPE	ED1 COSTS	NAMP LINE	RIGS REFERENCE
Batteries	£7.5m	1.01.xx	Additions CV3 Row 51 - HV - Batteries at GM HV Substations CV3 Row 85 - EHV - Batteries at 33kV Substations CV3 Row 102 - 132kV - Batteries at 132kV Substations Removals Row 179 - HV - Batteries at GM HV Substations Row 213 - EHV - Batteries at 33kV Substations Row 230 - 132kV - Batteries at 132kV Substations
Batteries	£1.0	1.01.xx	CV105 Row 6

Table 1 - Investment summary

Source: 19th February 2014 NAMP Table J Less Indirect

Note that Appendix 8 provides more details of the Output NAMP to ED1 Business Plan Data Table reconciliation and Appendix 10 identifies the material changes since the July 2013 submission.

1.2 Investment Strategy

The investment strategy for RIIO-ED1 is detailed in EDP 00-0012, *Asset Lifecycle Strategy - Major Substations*, and is based on achieving an optimal balance between maintenance and replacement by adopting industry best practice testing techniques to maximise battery life.

1.3 Innovation

Automatic battery discharge testing is now incorporated into the Grid and Primary battery charger specification, which will optimise the timing of battery replacement.

1.4 Risks and Opportunities

	Description of similarly likely opportunities or risks arising in ED1 period	**Level of (uncertainties)/ cost growth (£m)**
Opportunity	Life of VRSL cells improved 10% by the use of automatic discharge testing	(0.9)
Risk	Black Start installation delayed or not timed to coincide with existing replacement dates	5.0 max*
Risk	Life of VRSL cells reduced 10% by use of automatic discharge testing	0.9

Table 2: Risks and opportunities

* The worst case risk is that each installation occurs within a year of routine scheduled replacement.

2.0 Description of Battery Population

Substation batteries and their associated chargers play an essential role in maintaining DC supplies to circuit breakers, inter-tripping supplies, SCADA equipment, emergency lighting and numerical protection relays. There are 1,209 battery and charger installations with nominal output voltages ranging from 30V to 110V. In addition, there are 5,519 batteries contained in other items of plant, principally Remote Terminal Units (RTUs) at secondary substations).

Table 3 shows a volume breakdown by battery type and location.

Location	Planté	VRSL	Dry	Other	Total
Grid and Primary substation	10	797	73	7	887
Secondary substation	4	118	196	4	322
Total battery/charger installations in substations	**14**	**915**	**269**	**11**	**1,209**
RTU installations (GM)	0	4,631	0	0	4,631
RTU installations (PM)	0	888	0	0	888
Pathfinder installations (PM)	0	0	1,534	0	1,534

Table 3: Analysis of batteries by type and location

Source: Ellipse BC extract 11 March 2013

All routine NLRE battery replacements proposed for ED1 are listed under NAMP lines 1.01. The volume of routine replacements is depressed in during part of ED1 due to the Black Start Resilience (BSR) project which has its own separate NAMP line 1.13. Details of the NAMP lines are given in Table 4 with RIGS mapping to the NAMP lines given in Table 5 and Appendix 8.

NAMP Line	Description
1.01.01	Replace Tripping Primary Batteries and Chargers
1.01.04	Replace Remote Control Batteries - GM Equipment
1.01.05	Replace Tripping Primary Chargers
1.01.06	Replace Tripping Batteries (Distribution)
1.01.07	Replace Tripping Grid Batteries and Chargers
1.01.13	Replace Remote Control Batteries - Pole Mounted Equipment
1.01.14	Replace Pole mounted pathfinder batteries
1.01.15	50/60V intertrip batteries
1.01.16	30V intertrip batteries

Table 4 Battery NAMP Lines

NAMP Line	Line (Additions)	Line (Removals)	Description
1.01.01	CV3 85	CV3 213	Batteries at 33kV Substations
1.01.04	CV105 6		Substation RTUs, marshalling kiosks, receivers

1.01.06	CV3 51	CV3 179	Batteries at GM HV Substations
1.01.07	CV3 102	CV3 230	Batteries at 132kV Substations
1.01.13	CV105 6		Substation RTUs, marshalling kiosks, receivers
1.01.14	CV3 51	CV3 179	Batteries at GM HV Substations
1.01.15	CV3 85	CV3 213	Batteries at 33kV Substations
1.01.16	CV3 85	CV3 213	Batteries at 33kV Substations

Table 5: RIGS/NAMP mapping

3.0 Investment Drivers

During the ED1 period 1067 battery and charger installations at Grid and Primary substations will be visited as part of the Black Start resilience project and some will be replaced. These have been excluded from the ED1 NLRE volumes and costs. Full details of this project are given in *Commentary Document 18*.

4.0 Asset Assessment

The condition of batteries and battery chargers is best determined by monitoring the amount of outstanding battery defects recorded against them.

At Grid and Primary substations the majority of battery chargers send alarms to the control centre via the SCADA system providing serious battery defect notifications at the time they occur. Otherwise battery defects are noted by the substation inspectors at routine inspection used the Ellipse hand held device.

The exact nature of the battery defect is noted on the free text attached to the record, with the majority being:

- A high impedance alert.
- Failed discharge test.
- A reminder that the battery is due for replacement.

Battery defects are classified as high priority P5 defects under the Defect Management Programme, and new defects should be rectified within three months. Figure 1 shows the number of defects recorded against the batteries at grid and primary substations. There are 46 defects more than six months old; these represent 5% of the installed population. UK Power Networks plans to clear the backlog by the end of 2013.

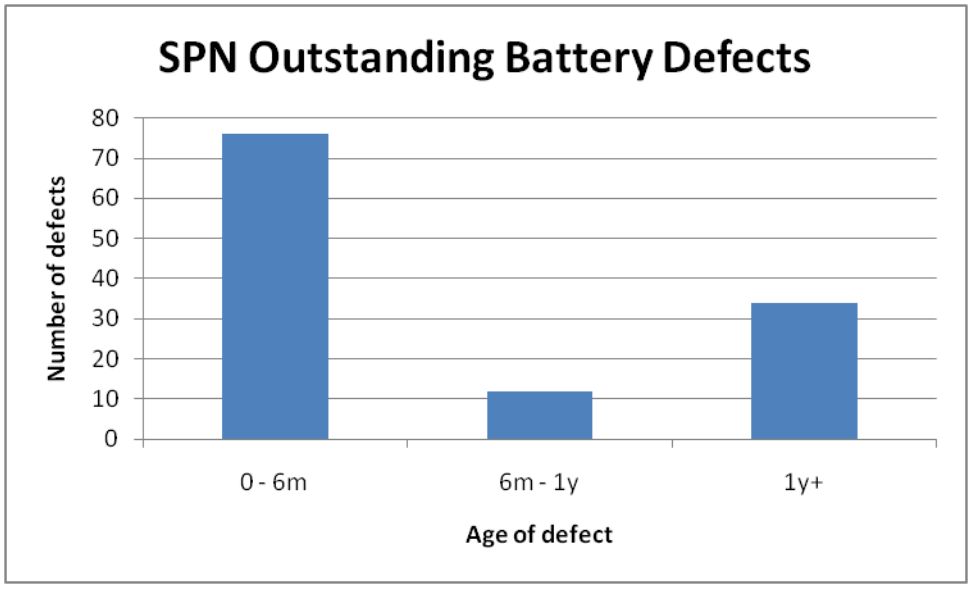

Figure 1: Outstanding battery defects

5.0 Intervention Policies

Healthy batteries are essential for maintaining the correct operation of protection and switchgear. Document EMS 10-0005, *Inspection and Maintenance of Batteries and Chargers*, outlines the testing required on substation batteries and determines the criteria for replacement.

Valve regulated sealed lead acid or gel type cells are usually replaced at between five- and ten-year intervals, as detailed in EMS 10-0002, *Inspection and Maintenance Frequency Schedule*, but may be replaced earlier if they fail a test.

Free breathing Planté cells are replaced only when their impedance starts to rise above set parameters or if they fail a load discharge test. The policy is now to replace existing Planté cells with VRLA cells.

The replacement frequencies are based on industry best practice detailed in EA Technology *STP Report 6190 Substation Battery Maintenance.*

6.0 Innovation

Automatic battery discharge testing is now incorporated into the Grid and Primary battery charger specification, which will optimise the timing of battery replacement. It is anticipated that battery life will be extended by one or two years by the use of this feature.

7.0 ED1 Expenditure Requirements for Batteries

With the exception of Planté cells, the programme of battery changes in ED1 has been constructed using the Maintenance Scheduled Task (MST) feature of the Ellipse asset register. The Planté cell replacement has been based on historic trends.

The estimated replacement volumes during ED1 are shown in figure 2 with the corresponding investment plan shown in figure 3. Note that the maximum life for to dominant VRSL cell type is eight years so the majority will be changed in ED1.

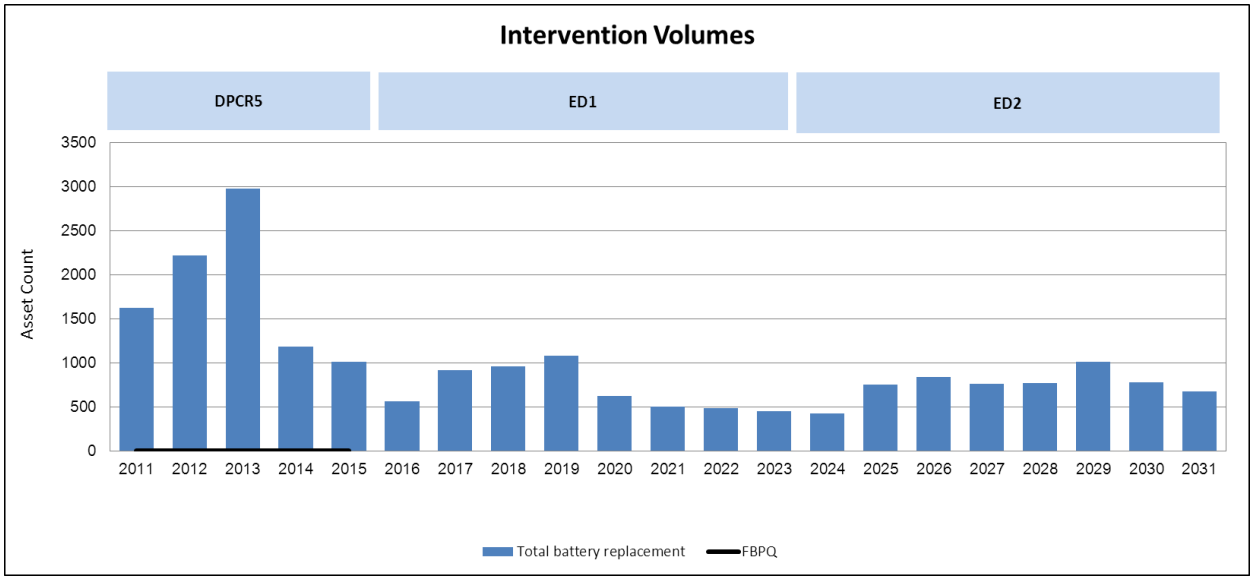

Figure 2: SPN battery replacement volumes

Sources:

- DPCR5 volumes: First three years – RIGs CV3 table
- DPCR5 volumes: Last two years – 14 June 2013 NAMP (Table O)
- DPCR5 FBPQ volumes: SPN FBPQ Mapping NAMP data
- ED1 volumes: 19 February 2014 NAMP (Table O)
- ED2 volumes: Estimates from Ellipse

Volumes	DPCR5 (Actual and Forecast from RIgs)				
Year end	2011	2012	2013	2014	2015
FBPQ	0	0	0	0	0
Replacement	1624	2221	2948	1182	1010

Volumes	ED1 Plan							
Year end	2016	2017	2018	2019	2020	2021	2022	2023
FBPQ								
Replacement	561	915	958	1085	620	499	483	449

Volumes	ED2 Plan							
Year end	2024	2025	2026	2027	2028	2029	2030	2031
FBPQ								
Replacement	422	752	837	761	772	1014	780	674

Estimates for battery replacement were not provided for FBPQ. The volumes previously reported via RIGS did not include RTU batteries at HV substations and so are substantially below the DPCR5 figures given above which have been derived from closed battery change work orders and so give a more accurate indication of replacements. In future, RIGS reports will include RTU battery replacements.

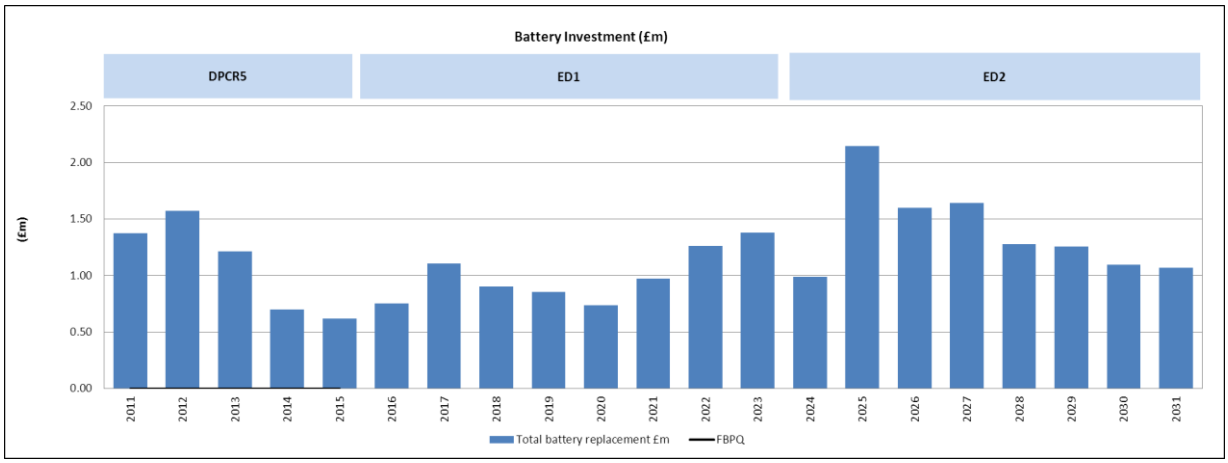

Figure 3: SPN battery replacement investment

Sources:

- DPCR5 costs: First three years – RIGS CV3 table
- DPCR5 costs: Last two years – 14 June 2013 NAMP (Table JLI)
- DPCR5 FBPQ costs: SPN FBPQ Mapping NAMP data
- ED1 costs: 19 February 2014 NAMP (Table J Less Indirect)
- ED2 costs: Estimated volumes from Ellipse * UCI of £2345

Investment (£'m)	DPCR5 (Actual and Forecast from RIGS)				
	2011	2012	2013	2014	2015
FBPQ	0.00	0.00	0.00	0.00	0.00
Replacement	1.38	1.57	1.22	0.70	0.62

Investment (£'m)	ED1 Plan							
	2016	2017	2018	2019	2020	2021	2022	2023
FBPQ								
Replacement	0.73	1.11	0.97	0.97	0.72	0.93	1.22	1.32

Investment (£'m)	ED2 Plan

	2024	2025	2026	2027	2028	2029	2030	2031
FBPQ								
Replacement	0.99	2.14	1.60	1.64	1.28	1.26	1.10	1.07

Due to the impact of the Black Start project, replacement volumes beyond ED1 are estimated only and will be refined during ED1.

Because of way volumes have been derived and because of the large variations in unit cost (UCI) between battery types, the expenditure per year is not always proportional to the volume.

8.0 Deliverability

Battery replacement is a routine task which has been carried out for many years and so no problems are anticipated in meeting the proposed volumes. For deliverability of the Black Start project please refer to Commentary Document 18.

Appendix 1: Age profiles

Not relevant: intentionally left blank

Appendix 2: HI Profiles

Not relevant: intentionally left blank

Appendix 3: Fault data

Not relevant: intentionally left blank

Appendix 4: WLC and other Case studies

Not relevant: intentionally left blank

Appendix 5: NLRE Expenditure plan

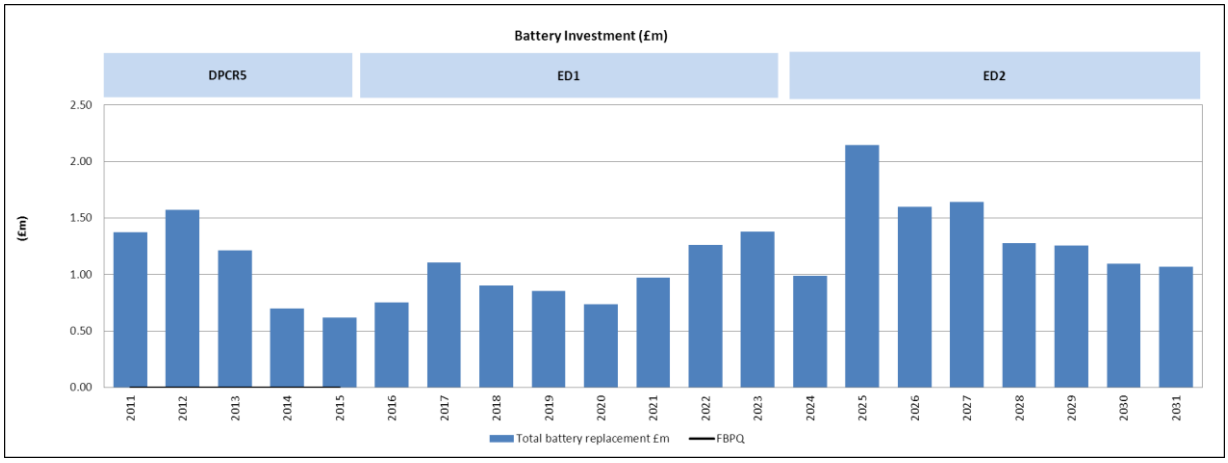

Figure 4: SPN Battery Replacement Investment

Sources:

- DPCR5 costs: First three years – RIGS CV3 table
- DPCR5 costs: Last two years – 14 June 2013 NAMP (Table JLI)
- DPCR5 FBPQ costs: SPN FBPQ Mapping NAMP data
- ED1 costs: 19 February 2014 NAMP (Table J Less Indirect)
- ED2 costs: Estimated volumes from Ellipse * UCI of £2345

Investment (£'m)	DPCR5 (Actual and Forecast from RIGS)				
	2011	2012	2013	2014	2015
FBPQ	0.00	0.00	0.00	0.00	0.00
Replacement	1.38	1.57	1.22	0.70	0.62

Investment (£'m)	ED1 Plan							
	2016	2017	2018	2019	2020	2021	2022	2023
FBPQ								
Replacement	0.73	1.11	0.97	0.97	0.72	0.93	1.22	1.32

Investment (£'m)	ED2 Plan							
	2024	2025	2026	2027	2028	2029	2030	2031
FBPQ								
Replacement	0.99	2.14	1.60	1.64	1.28	1.26	1.10	1.07

Because of way volumes have been derived and because of the large variations in unit cost (UCI) between battery types, the expenditure per year is not always proportional to the volume.

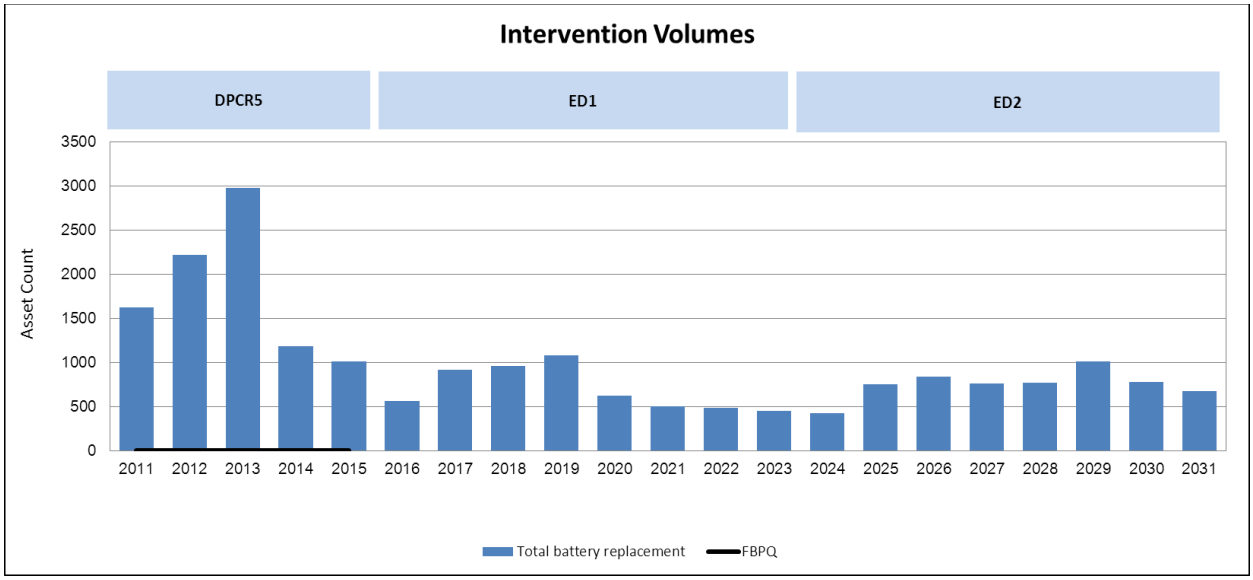

Figure 5: SPN Battery Replacement Volumes

Sources:

- DPCR5 volumes: First three years – RIGs CV3 table
- DPCR5 volumes: Last two years – 14 June 2013 NAMP (Table O)
- DPCR5 FBPQ volumes: SPN FBPQ Mapping NAMP data
- ED1 volumes: 19 February 2014 NAMP (Table O)
- ED2 volumes: Estimates from Ellipse

Volumes	DPCR5 (Actual and Forecast from RIGS)				
Year end	2011	2012	2013	2014	2015
FBPQ	0	0	0	0	0
Replacement	1624	2221	2948	1182	1010

Volumes	ED1 Plan							
Year end	2016	2017	2018	2019	2020	2021	2022	2023
FBPQ								
Replacement	561	915	958	1085	620	499	483	449

Volumes	ED2 Plan							
Year end	2024	2025	2026	2027	2028	2029	2030	2031
FBPQ								
Replacement	422	752	837	761	772	1014	780	674

Appendix 6: Sensitivity Analysis

Not relevant: intentionally left blank

Appendix 7: Named schemes

Not relevant: intentionally left blank

Appendix 8: Output NAMP/ED1 Business Plan Data Table Reconciliation

Outputs	Asset Stewardship Report										Business Plan Data Table									
Investment description	NAMP Line	2015 /16	2016 /17	2017 /18	2018 /19	2019 /20	2020 /21	2021 /22	2022 /23	**Total**	RIG Table	RIG Row	2015 /16	2016 /17	2017 /18	2018 /19	2019 /20	2020 /21	2021 /22	2022 /23	**Total**
Batteries at GM HV Substations	1.01.06	51	58	54	70	39	60	49	57	**438**											
Batteries at GM HV Substations	1.01.14	169	169	169	169	169	169	169	169	**1,352**	CV3	179	220	229	225	241	214	229	218	226	**1,802**
Batteries at 33kV Substations	1.01.01	4	4	4	4	4	14	48	50	**132**											
Batteries at 33kV Substations	1.01.05	9	22	19	16	11	13	9	7	**106**											
Batteries at 33kV Substations	1.01.15	20	20	20	20	20	20	20	20	**160**	CV3	213	37	68	57	54	45	59	89	85	**494**
Batteries at 132kV Substations	1.01.07	10	28	9	3	10	18	24	26	**128**	CV3	230	10	28	9	5	10	20	24	26	**132**
Substation RTUs, marshalling kiosks, receivers	1.01.04	203	437	567	690	334	119	5	80	**2,435**											
Substation RTUs, marshalling kiosks, receivers	1.01.13	95	177	116	113	33	86	159	40	**819**	CV105	6	294	590	667	785	351	191	152	112	**3,142**
Total		**561**	**915**	**958**	**1,085**	**620**	**499**	**483**	**449**	**5,570**			**561**	**915**	**958**	**1,085**	**620**	**499**	**483**	**449**	**5,570**

Table 6: Output NAMP/ED1 Business Plan Data Table Reconciliation

Notes:

Table CV105 row 6 includes assets other than batteries. Volumes listed here are for batteries only

Source: 19th February 2014 NAMP Table O
21st February 2014 ED1 Business Plan Data Tables

Appendix 9: Efficiency benchmarking with other DNO's

Not relevant: intentionally left blank

Appendix 10 – Material changes since the July 2013 ED1 submission

Changes between the July 2013 submission and the March 2014 re-submission are summarised and discussed below.

Asset type	Action	Change type	2013	2014	Difference (Reduction)	Comment
Batteries at GM HV substations CV3 179	Replace	Volume (additions)	8955	1,816	(7,139)	EFPI batteries removed
		Volume (removals)	8941	1,802	(7,139)	EFPI batteries removed
		Investment (£m)	3.7	3.7	0	
		UCI (£k)	0.4	2.0	1.6	
Batteries at 33kV substations CV3 213	Replace	Volume (additions)	491	491	0	
		Volume (removals)	490	490	0	
		Investment (£m)	2.5	2.5	0	
		UCI (£k)	5.1	5.1	0	
Batteries at 132kV substations CV3 230	Replace	Volume (additions)	128	128	0	
		Volume (removals)	132	132	0	
		Investment (£m)	1.3	1.3	0	
		UCI (£k)	10.3	10.3	0	
Substation RTUs, marshalling kiosks, receivers CV105 6	Replace	Volume (additions)	3,142	3,142	0	
		Volume (removals)	3,142	3,142	0	
		Investment (£m)	0.45	0.45	0	
		UCI (£k)	0.14	0.14	0	

Table 7: Material changes to July 2013 ED1 Submission

Source: ED1 Business Plan Data Tables following the OFGEM Question and Answer Process 21st February 2014 ED1 Business Plan Data Tables

Batteries at GM HV substations

Following Ofgem query 147 which questioned the large volume of battery replacements in this category, EFPI battery replacement volumes were removed, but the investment was left unchanged resulting in a change to the UCI.

Note that Table CV105 row 6 includes assets other than batteries. The costs and volumes shown are only those associated with replacement of telecontrol batteries in SCADA equipment.