Title: Northfleet

SPN Regional Development Plan

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

Document History

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2.0	26/02/2014	Major	Sam Martin	1	Updated proposed projects >£1m, updated cost profile, changed proposed projects
2.0	03/03/2014	Major	Sam Martin	2.2	Updated Distributed generation table
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2.0	12/03/2014	Major	Sam Martin	4.1	Updated asset replacement
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2.0	13/03/2014	Major	Sam Martin	Appendix B	Inserted new existing network diagram
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3.0	21/03/2014	Major	Sam Martin	2.3	Change text in scheme 5548
3.1	25/03/2014	Major	Sam Martin	7	Deleted repetition of the name Chris Winch
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3.1	25/03/2014	Major	Sam Martin	3.3	Updated analysis to reflect data in LI tables and P2/6 analysis tables
3.1	25/03/2014	Major	Sam Martin	Contents	Updated page numbers
3.2	26/3/2014	Major	PH	1.3	Update table to NAMP 19 Feb 14
3.2	26/3/2014	Major	PH	4.4	Update table to NAMP 19 Feb 14
3.2	26/3/2014	Major	PH	Cost & phasing	Update table to NAMP 19 Feb 14

Contents

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

1 Introduction

1.1 Executive Summary

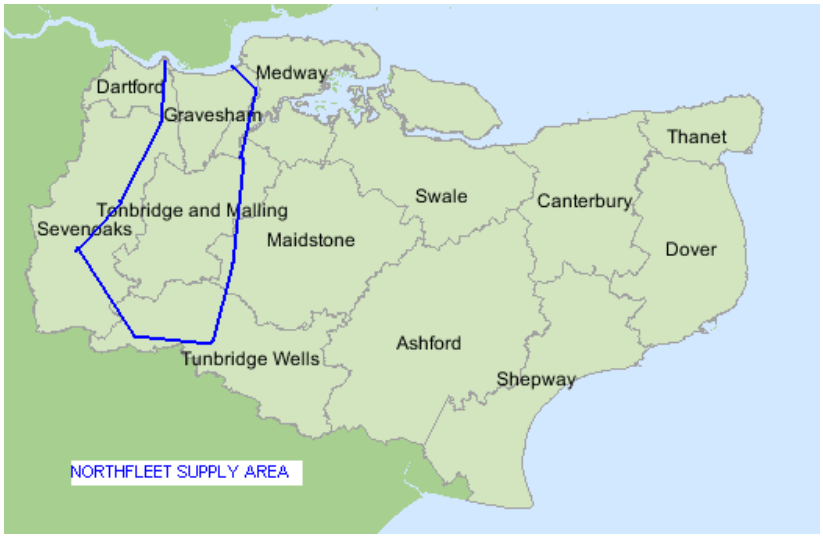
This Regional Development Plan (RDP) reviews the EHV network supplied from Northfleet Super Grid Supply Point (GSP).

The network is complex with 132kV interconnection to four adjacent GSP's at Littlebrook, Kingsnorth (via Burham & Medway) Bolney (via Dormansland) and Ninfield (via Pembury, Harley & Hastings) with 33kV interconnection to Hurst (via Orpington), Ninfield (via Paddock Wood) and Kingsnorth (via Burham). Group demand is 475MW which is forecast to decrease to 466MW by 2023 (Element Energy). The decrease is attributable to decommissioning of Sharnal Street Primary where 3MW of load has been transferred to Kingsnorth GSP and the decommissioning of APCM Cement Works block load of 7MW following the installation of a cement importation terminal and 'bagging plant' (7MW). The APCM 132/11kV substation was dismantled during the period under review after cement production ceased.

The area encompasses a diverse range of residential, mixed industrial and brown field areas ranging from prosperous areas like Tunbridge Wells in the south through to suburban Bromley and Orpington and the post-industrial Thames riverside towns of Northfleet and Gravesend.

High profile developments supplied from Northfleet East include the Blue Water Shopping centre and Ebbsfleet International train station. Future major developments are expected to be clustered along the Thames corridor and include the proposed Paramount Pictures theme park. Local development plans show that there is a significant increase in new homes for parts of Gravesham and Dartford Districts which lie within the Thames Gateway Development Zone.

Northfleet Supply Area



Reinforcement is proposed at 4 existing substations to ensure continued adherence to Engineering Recommendation P2/6 together with management of load index (LI) profile. In addition, developments in the Estuary area may trigger the requirement for a new main substation at Ebbsfleet. Proposed asset replacements are designed to ensure reliable and secure network performance. With the exception of Ebbsfleet, adopting this approach results in no major network reconfigurations with proposed works contained within the boundary of the existing network and substation sites.

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1.2 Proposed Projects >£1M

Reinforcement

- Gravesend Town 33/6.6kV Reinforcement £4.4M

Asset Replacement

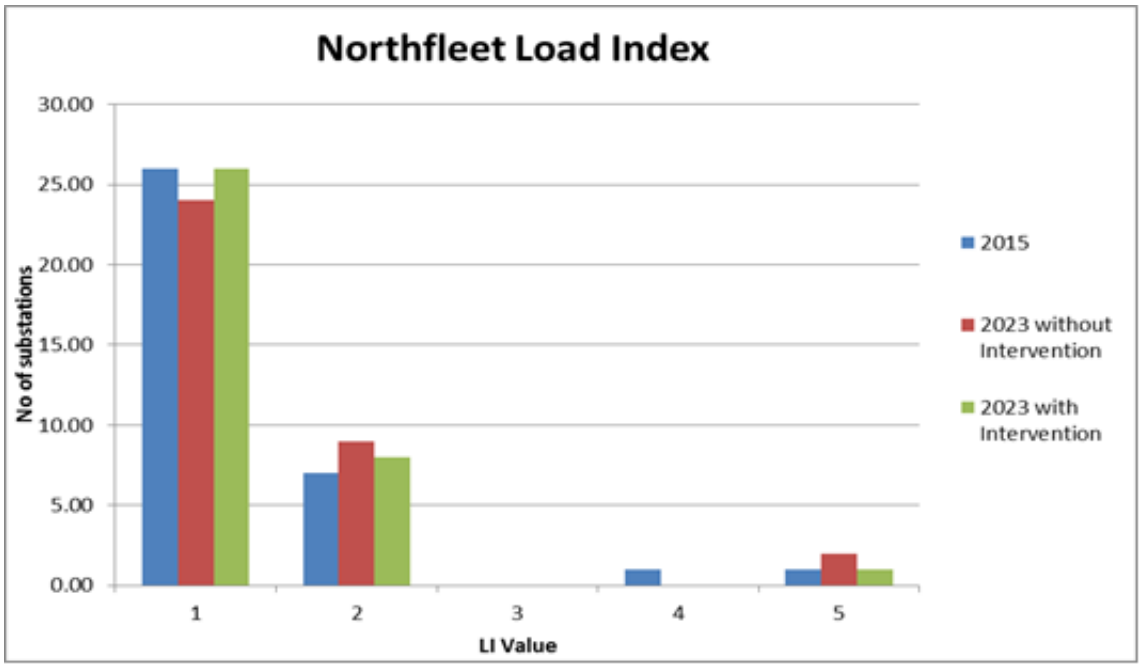
- Northfleet East – Hartley 132kV Conductor Replacement £3.5M
- Rosherville Transformer Replacement £1.2M
- Northfleet East Grid – Shornewood 33kV Conductor Replacement No. 2 £1.2M
- South Orpington 11kV Switchboard Replacement £1.1M
- Northfleet East Grid – Shornewood 33kV Conductor Replacement No. 1 £1.1M

1.3 Costs Profile

SR_Table J	S&R - Baseline_Final ED1 Re-submission_19th February 2014_15:15										
Category		2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022	2022/2023
A	TOTAL ASSET REPLACEMENT	0	264	1,448	2,189	1,222	1,860	1,644	554	1,676	1,559
R	TOTAL REINFORCEMENT	0	0	822	2,642	1,538	1,096	144	0	0	0

1.4 Output Measures Load Index

The forecast health indices for 2023, with and without intervention, for each plant category are detailed below.



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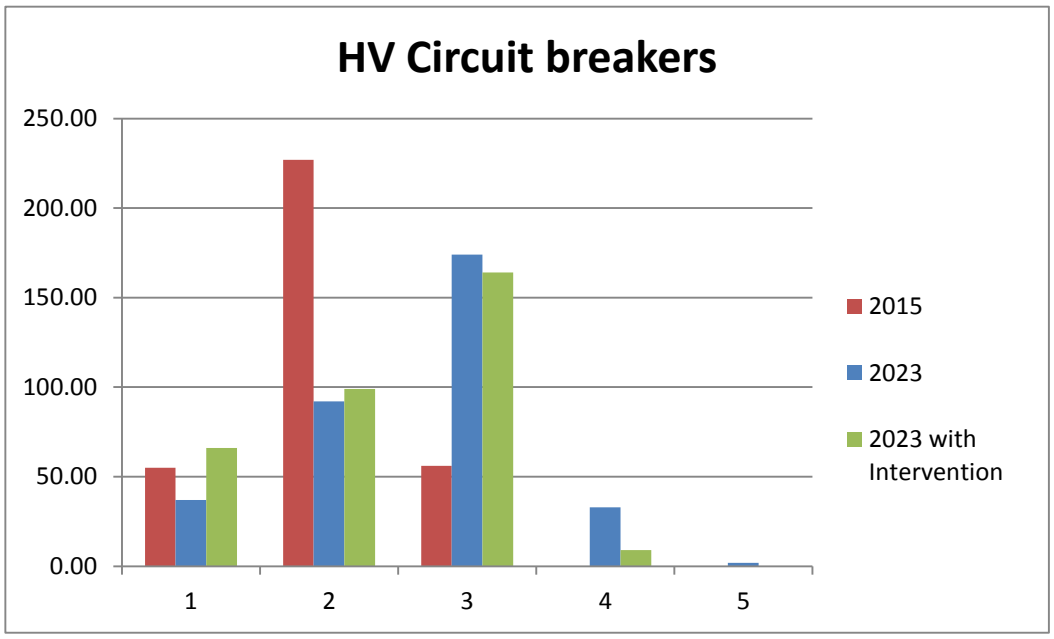
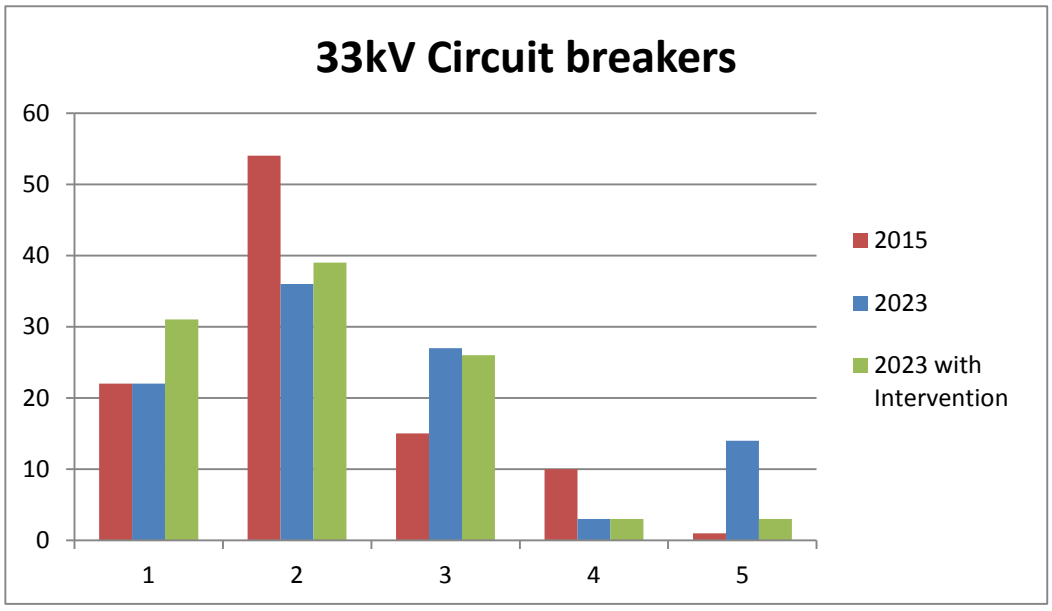
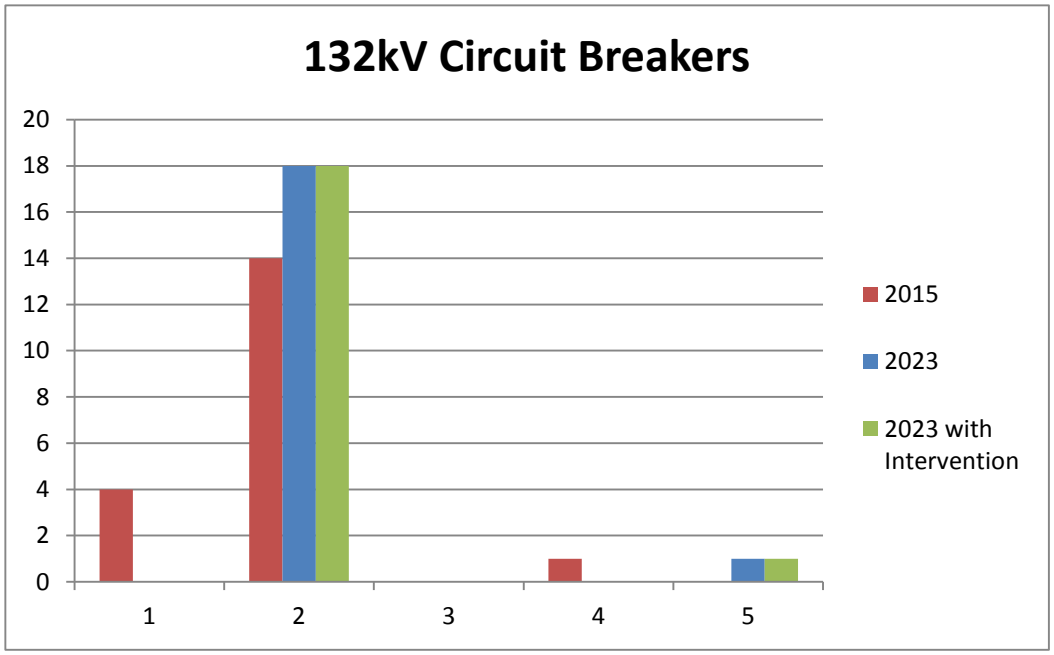
1.5 Output Measures Health Index

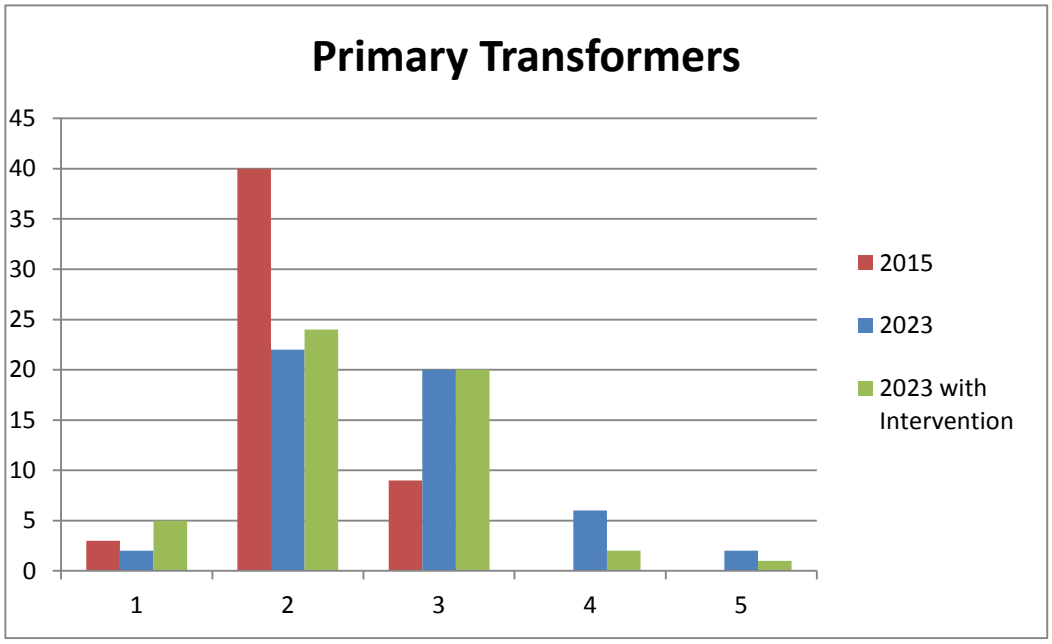
The forecast health indices for 2023, with and without intervention, for each plant category are detailed below.





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





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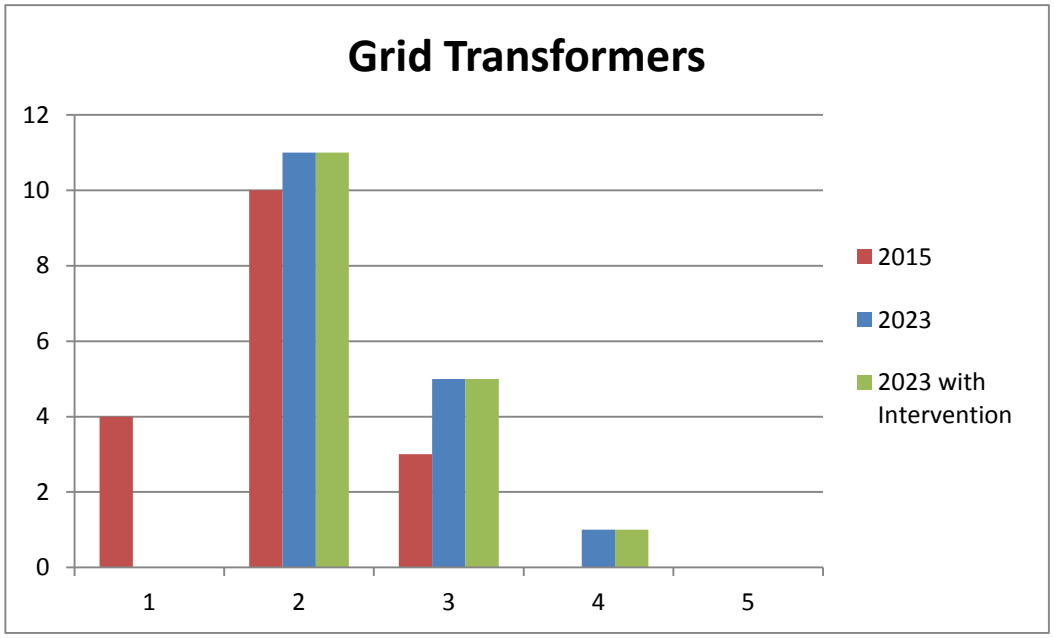

1.6 Principle Risks and Dependencies

The schemes covered in this RDP have been planned based on the planning load estimates 2013 with the 2011/12 maximum demand. The load forecasts are based on the element energy model. If the economic situation improves there is a risk that there will be shortfall of reinforcement schemes in the plan.

The load forecasts also include an assumed level of embedded generation being connected to the network. Should this generation not materialise, then a larger than forecast load growth could be realised.

Where Demand Site Response has been included at a substation, this is based on an assumption that customers will be willing to accept the scheme. In most cases these customers have not as yet been identified.

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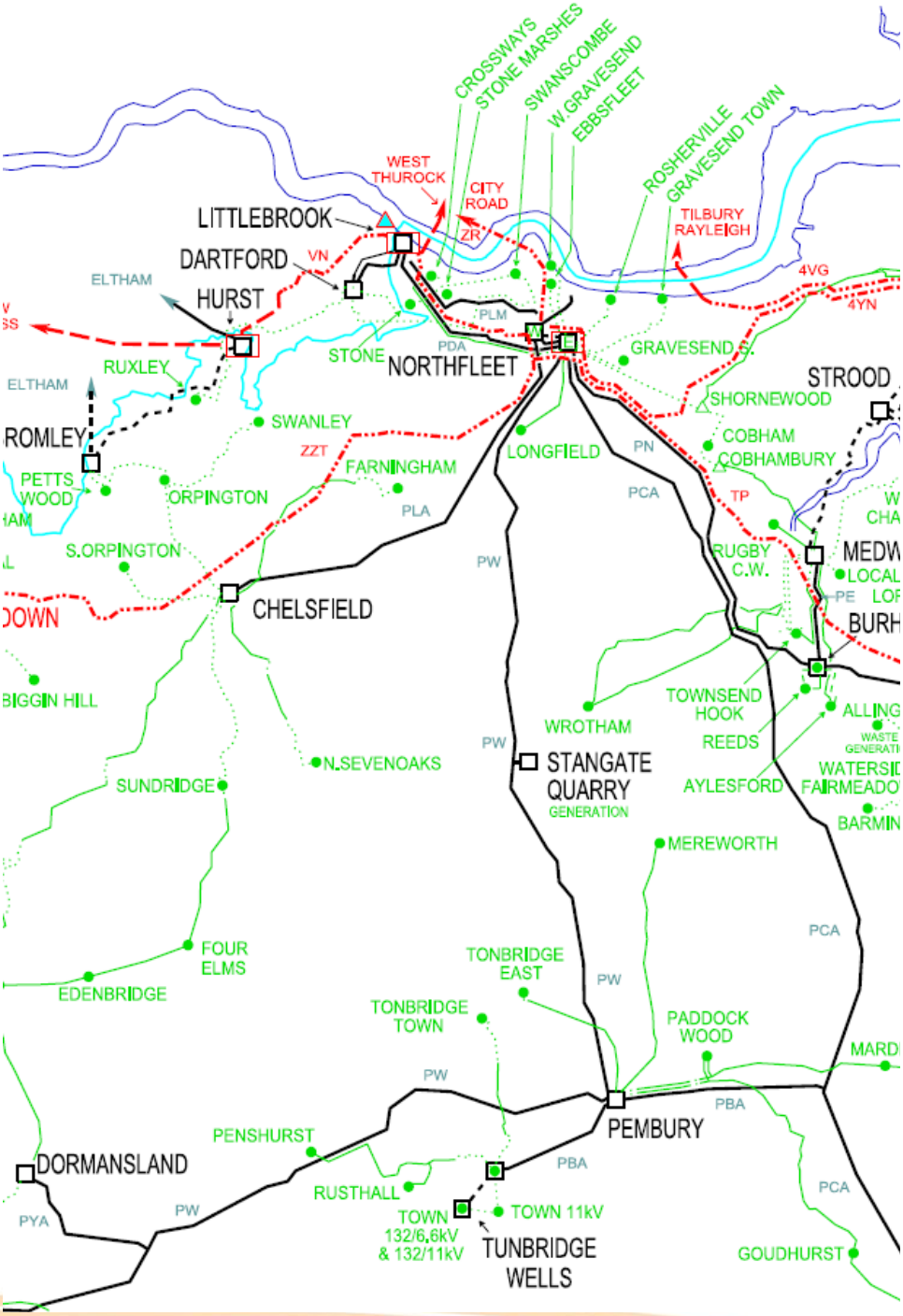
2 Network Configuration

2.1 Existing Network

The Northfleet network shown in Figure 1 is complex. It is supplied by 4x 240MVA 400/132kV SGT's at Northfleet East substation with 132kV interconnection to four adjacent grid substations at Littlebrook, Kingsnorth (via Burham & Medway) Bolney (via Dormansland) and Ninfield (via Pembury, Harley & Hastings). The aggregated group demand is 475MW which is forecast to decrease to 466MW by 2023 (EE). The network form Northfleet East supplies a large geographic area south of the Thames Estuary (see attached map showing Kent District Boundaries)

Figure 1: Northfleet Network Diagram



The substation hierarchy is detailed below

Table 1. Group Substations

Substation & Voltage	
Northfleet East 132kV	**Tunbridge Wells 132kV**
Northfleet East 132/33kV	**Tunbridge Wells Grid 132/33kV**
Crossways 33/11kV	Tonbridge Town 33/6.6kV
Stone Marshes 33/11kV	Penhurst 33/11kV
Longfield 33/11kV	Rusthall 33/11kV
Ebbsfleet 33/11kV	**Tunbridge Wells Grid 132/11kV**
Rosherville 33/6.6kV	Tunbridge Wells Grid 11kV
Gravesend South 33/11kV	Tunbridge Wells Town 11kV
Gravesend Town 33/6.6kV	Tunbridge Wells Town 6.6kV
Gravesend West 33/11kV	**Dormansland Grid 132/33kV**
Grain 33/11kV	Crowhurst 33/11kV
Sharnal Street 33/11kV	Four Elms 33/11kV
Burham 132/33kV	Edenbridge 33/11kV
Aylesford 33/6.6kV	East Grinstead 33/11kV
Chelsfield Grid 132/33kV	**Pembury Grid 132/33kV**
Farningham 33/11kV	Tonbridge East 33/6.6kV
South Orpington 33/11kV	Mereworth 33/11kV
Oxted 33/11kV	Paddock Wood 33/11kV
Sundridge 33/11kV	
North Sevenoaks 33/11kV	
Swanley 33/11kV	

Northfleet East 132kV substation is double busbar AIS with 132kV feeders supplying five 132/33kV grid substations and three 132/11kV substations with a further thirty one 11kV or 6.6kV primary substations.

Dormansland 132/33kV grid substation is supplied by 2x 90MVA transformers with one transformer supplied from Northfleet and the other from Bolney. There are 2x 33kV interconnecting circuits to Chelsfield Grid via Crowhurst and Four Elms.

Stangate Quarry 132/11kV is a single transformer 132/11kV 5MVA transformer tee connected to the Northfleet/Pembury circuit. It is a sole user customer site with a demand of circa 6MW with 5.5MW of local generation.

Chelsfield is supplied by a composite 132kV overhead line and underground cable double circuit connecting to a four switch mesh substation with three 60MVA grid transformers. The 33kV switchboard is a 3 section Reyrolle L42 double busbar.

Pembury is a two grid transformer substation supplied by the Northfleet/Stangate/Dormansland and Northfleet/Tunbridge Wells circuits. The two transformers are rated at 45MVA and 60MVAwith a Reyrolle L42 33kV switchboard.

Tunbridge Wells is a complex 4 substation configuration comprising 2x 132/33kV transformers, 2x 132/11kV transformers, 2x 132/6.6kV transformer with 11/6.6kV inter bus transformers interconnecting Tunbridge Wells Town and Tunbridge Wells Grid. The site is currently being reinforced, Section 2.3 refers.

Burham is supplied by a composite overhead line and underground cable 132kV double circuit. The 2x90MVA transformer secondary windings have double banked connections with one pair connected to a GEC single busbar ZX1.2 switchboard to supplying local demand and the remaining pair connected to the Burham Mill

power station associated with the Aylesford paper factory. A project is currently in the delivery phase to establish a switchable 132kV interconnection to the adjacent Kingsnorth GSP.

2.2 Embedded Generation (G59/2)

The group contains a significant contribution from embedded generation detailed in Table 2, below.

Table 2. Embedded Generating within the Northfleet Group

Site Name	Type	Mode of Operation	Installed DG (MW)	No. of Generators	Operating Voltage (kV)	Substation Name	Grid Group	GSP/BSP
STANGATE QUARRY LANDFILL SITE	Landfill gas	LONG TERM PARALLEL	6.000	1	132.000	Pembury Grid 33kV	Pembury Grid	Northfleet SGT
PALMERS WOOD OILFIELD	Gas	LONG TERM PARALLEL	0.600	1	11.000	Oxted 11kV	Chelsfield Grid	Northfleet SGT
GREATNESS QUARRY - EXPORT METER	Biogas	LONG TERM PARALLEL	1.150	1	11.000	North Sevenoaks 11kV	Chelsfield Grid	Northfleet SGT
COTTON LANE GENERATION S/S - PHS 1	Landfill gas	LONG TERM PARALLEL	1.000	1	11.000	Crossways 11KV	Northfleet East	Northfleet SGT
FORSTAL WATER TREATMENT WORKS	Diesel	LONG TERM PARALLEL	0.450	1	11.000	Aylesford 6.6kV	Burham Grid	Northfleet SGT
TESCO	CHP	LONG TERM PARALLEL	0.250	1	11.000	Aylesford 6.6kV	Burham Grid	Northfleet SGT
AYLESFORD SEWAGE WORKS	Diesel	LONG TERM PARALLEL	0.342	1	11.000	Aylesford 6.6kV	Burham Grid	Northfleet SGT
COTTON LANE GENERATION S/S - PHS 2	Biogas	LONG TERM PARALLEL	0.330	1	11.000	Crossways 11KV	Northfleet East	Northfleet SGT
NORTHFLEET WTW	Diesel	LONG TERM PARALLEL	1.250	1	11.000	Ebbsfleet 11KV	Northfleet East	Northfleet SGT
LONGREACH WTW	CHP	LONG TERM PARALLEL	2.000	2	11.000	Crossways 11KV	Northfleet East	Northfleet SGT

2.3 Project in Progress

There are 23 Northfleet group schemes either in progress or scheduled to commence during DPCR5, Table 3 refers.

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Table 3. NAMP Extract for DPCR5 Northfleet Projects

SR_Table J	S&R - Baseline_Final ED1 Re-submission_19th						
Cat.	**Namp Line**	**Project ID**	**DNO**	**Description**	**2013/2014**	**2014/2015**	**2015/2016**
A	1.48.01	3272	SPN	Pembury Grid 132kV Isolators	46,500	0	0
A	1.49.30	3281	SPN	Tunbridge Wells Town 6.6kV Reconfiguration and Auto-Close Scheme	63,097	0	0
A	1.02.03	4116	SPN	PW - Dormansland-Northfleet East - Conductor Replacement	37,811	219,066	316,895
A	1.26.10	5252	SPN	BT21CN Mitigation - Burham/Maidstone	354,612	0	0
A	1.26.10	5282	SPN	BT21CN Mitigation - Hartley/Pembury	19,000	0	0
A	1.26.10	5311	SPN	BT21CN Mitigation - Northfleet East/Chelsfield	570,396	16,029	144,264
A	1.26.10	5370	SPN	BT21CN Mitigation - Northfleet East/Stangate Quarry	24,809	351,711	1,155,846
R	1.33.01	3060	SPN	Tunbridge Wells Grid - 33/11kV Inter. Transformer	397,906	0	0
R	1.36.01	3061	SPN	Tunbridge Wells - 132kV Switchgear	999,493	767,319	0
R	1.37.06	3171	SPN	Burham - Maidstone 132kV Interconnector	640,416	370,056	0
R	1.35.01	3215	SPN	Tunbridge Wells Grid - 132/33kV Reinforcement	407,184	0	0
R	1.33.03	3228	SPN	Tunbridge Wells Town - 11kV Switchgear Uprating	804,546	0	0
R	1.35.01	3344	SPN	Chelsfield 132/33kV Grid Reinforcement-Replace 1 x 45 MVA Tx with 1 x 60 MVA & Install 4 x 132kV CBs	26,237	0	0
R	1.37.07	3346	SPN	Chelsfield 33kV Interconnection Reinforcement-Install 2 x 33kV UGC Circuits to the Bromley Group	120,314	360,941	0
R	1.34.02	3710	SPN	Gravesend Town - Increase 6.6kV Transfer Capability	21,849	131,093	196,640
R	1.37.06	3773	SPN	Tunbridge Wells Area Reinforcement - Pembury Tunbridge Wells 33kV Cable	480,839	703,666	0
R	1.16.02	5425	SPN	Decommission Sharnal Street 33/11kV Primary Substation	40,500	0	0
R	1.35.05	5548	SPN	Chelsfield Grid Reinforcement - Enabling Transfers	4,872	29,233	43,850

Schemes 5252, 5311, 5370 & 5282

These four on-going projects are part of the BT21CN Mitigation Strategy. As background, the ENA was advised by BT in 2004 that legacy BT services would be withdrawn following an upgrade of BT's telecoms network to an IP based system known as BT21CN.

Scheme 4116

Dormansland - Northfleet East. This route consists of 197 towers, and is 51.15 km long. It is a single circuit route with a non-uniform age profile. The date of installation of the phase conductor and earth wire varies from 1967 to 1996. It is proposed to refurbish this circuit.

Scheme 5425

Sharnal Street 33/11kV Primary Substation will become redundant and decommissioned following completion of the reinforcement of Kingsnorth 132/11kV substation with a 2nd 30MVA transformer (project 3319 refers).

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Chelsfield: Schemes 3344, 5548, & 3346

This main reinforcement of Chelsfield Grid is almost completed. It involves replacing a 45MVA transformer with a 60MVA unit and providing 4x 132kV CBs to establish a 3x 60MVA 132/11kV substation. Associated 11kV and 33kV reconfigurations are programmed for 2014.

Burham: Scheme 3171

This project proposes the establishment of a 132 kV circuit utilising part of a disused overhead line on the PN route between Burham and Maidstone Junction and a new 2.4 km 132kV cable between Maidstone Junction and Maidstone Grid. The new circuit between Maidstone Grid and Burham will provide an alternative 132 kV supply to Maidstone from Northfleet East.

Gravesend: Scheme 3710

The predicted load at Gravesend Town 6.6kV will exceed the existing firm capacity, including the transfer capacity. It is therefore proposed to enhance the 6.6kV interconnection with Rosherville to increase the transfer capacity towards this substation.

A total of five Gravesend Town circuits could be transferred to Rosherville with a total maximum demand of 5.95MVA. This project will replace the switchgear at the switching points with remotely controllable switchgear.

Tunbridge Wells: Schemes 3281, 3060, 3061, 3228, 3215 & 3773

These five projects will result in the reinforcement and rationalisation of the Tunbridge Wells 132/33/11/6.6kV networks.

Project 3773 provides for the establishment of 33kV interconnection between Tunbridge Wells and Pembury to provide 38MW of transfer capacity thereby maintaining (n-2) P2/6 compliance due to the total demand on route PCA/PBA exceeding 100MW.

Pembury Grid: Scheme 3272

The Pembury Grid 132kV feeder circuit isolators are in poor condition and it has been determined that they should be replaced.

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3 Network Development Considerations

3.1 District / Local Development Plans

The Northfleet supply area covers a wide range of residential, mixed industrial and brown field areas from Tunbridge Wells in the south to Bromley, Orpington and the post-industrial Thames riverside towns of Northfleet and Gravesend. High profile developments which are established in the area include Blue Water shopping centre and Ebbsfleet International station on the St Pancras cross channel rail link.

Gravesham and Dartford fall within the Thames Gateway Development Zone, a speculative public/private sector partnership formed in 2001 with the objectives to attract investment and deliver sustainable growth along the north and south Thames Estuary. The zone provides a framework for development with timescales influenced more by local economic factors rather than an overall master plan.

Both the Gateway Growth Plan and Gravesham Council Plans identify a number of key areas as early candidates for development:

Ebbsfleet Valley: There is a 260 hectare site between Ebbsfleet International and Bluewater shopping Centre with scope to develop up to 7,750 new homes and approximately 800,000 m^2 of mixed commercial and retail development with potential of up to 20,000 new jobs.

Dartford North Gateway: In early 2006 the then SEEDA (The South East England Development Agency) purchased a 2.6 hectare site on the edge of Dartford. They also purchased the neighboring Matrix Business. While both sites are probably in hands of the various civic authorities now, the original intention behind the purchase was to develop one of the sites into a mixture of retail and other businesses and housing. There is potential to develop up to 2,000 new homes in this area.

Dartford Town Centre: The town centre of Dartford Town has potential for an additional 1,000 new homes.

Northfleet Embankment: An industrial site of 0.74 km² with 1.9 km of river frontage, it is made up of two sites of the ex-cement works and the Northfleet power station with deep water river frontage for cruise liner facilitates and wind energy manufacture. The key sites were originally acquired by SEEDA to prepare for the re-development of the area.

In addition, Sevenoaks, Tonbridge and Tunbridge Wells's local authority plans forecast up to 7,100 new homes for the period to 2026.

Figure 3. Kent District Boundaries

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

The Northfleet supply area covers the districts of Gravesham, Tonbridge & Malling (part), Sevenoaks and Tunbridge Wells.

Paramount Pictures Theme Park Ebbsfleet

There are early development proposals for a Paramount Pictures theme park at the Swanscombe Peninsular near Dartford on a 900 acre brown field site close the Ebbsfleet Station which is 17 minutes from London and 2 hours from Paris. Planning applications are expected to be submitted within 18 months and offers of support have been given by Dartford and Gravesham Borough Councils (source BBC News 8/10/12). Plans are likely to include Europe's largest indoor water park. Consulting Engineers have made preliminary contact with UK Power Networks concerning the feasibility of a new 132/33kV substation supplied from Northfleet. Diversions of National Grid's overhead line may also be required.

3.1 Asset Health

The forecast 'Health Index' assessment for the principal plant categories without intervention are detailed in the following Tables:

Table 4. HV Circuit Breakers

Substation	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
AYLESFORD 33/6.6KV	3	18					20	1		
BURHAM GRID 132 KV		1					1			
CROWHURST 33/11KV		7						7		
EAST GRINSTEAD 33KV	4	11				3	11	1		
EBBSFLEET 33/11KV	13						13			
FARNINGHAM 33KV		7	4					11		
FOUR ELMS 33/11KV		8						8		
GRAIN 33/11KV		11					1	10		
GRAVESEND SOUTH 33/11KV		10	1					11		
GRAVESEND TOWN 6.6/11KV		2						2		
GRAVESEND TOWN 6.6KV		15	2					17		
GRAVESEND WEST 11KV		14	2				1	14	1	
MEREWORTH 33/11KV	1	3	7				2	8	1	
NORTH SEVENOAKS 33/11KV	17					17				
OXTED 33KV		8						8		
PADDOCK WOOD 33KV		9					2	7		
PENSHURST 33KV		6						6		
ROSHERVILLE 33/6.6KV		16					16			
RUSTHALL 33KV		2	5					4	3	
SHARNAL STREET 33/11KV		1					1			
SOUTH ORPINGTON 33KV	1	3	7			1		3	7	
STONE 33/11 KV	4					4				
STONE MARSHES 33/11		13					5	8		
SUNDRIDGE 33/11KV		3	6						9	
SWANLEY 33/11KV		9						9		
TONBRIDGE EAST 33/6.6KV		9	6					13	2	
TONBRIDGE TOWN 33/6.6KV	2	14				2	3	11		
TUNBRIDGE WELLS GRID 132 KV	2					2				
TUNBRIDGE WELLS GRID 132/11KV	12	3	7			12		5	3	2
TUNBRIDGE WELLS TOWN 11KV		8	9					10	7	
TUNBRIDGE WELLS TOWN 132/6.6KV		16					16			

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

Table 5. 132kV Circuit Breakers

Substation	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
CHELSFIELD GRID 132 KV	4						4			
DORMANSLAND GRID 132 KV				1						1
NORTHFLEET EAST 132 KV		14					14			

Table 6. 33kV Circuit Breakers

Substation	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
BURHAM GRID 132 KV	2	1				2	1			
BURHAM GRID 33KV	5					5				
CHELSFIELD GRID		4	9					7	3	3
CHELSFIELD GRID 132 KV		1	2					3		
CHELSFIELD RMU	1					1				
DORMANSLAND GRID		7	1					8		
DORMANSLAND GRID 132 KV		2						2		
EASTBOURNE GRID		8					8			
NORTHFLEET EAST 132 KV		4					3	1		
NORTHFLEET EAST GRID		23					23			
PEMBURY GRID		2	3	2				5		2
PEMBURY GRID 132 KV		2					1	1		
STONEMARSHES SW STN	3					3				
TUNBRIDGE WELLS GRID	11					11				
TUNBRIDGE WELLS GRID 132 KV				2						2
TUNBRIDGE WELLS GRID 33KV				6	1					7

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

Table 7. Primary Transformers

	2015					2023				
Substation	**No. HI1**	**No. HI2**	**No. HI3**	**No. HI4**	**No. HI5**	**No. HI1**	**No. HI2**	**No. HI3**	**No. HI4**	**No. HI5**
APCM SWANSCOMBE 33/3KV		2.00						2.00		
AYLESFORD 33/6.6KV	2.00	1.00				2.00	1.00			
CROWHURST 33/11KV			2.00					2.00		
EAST GRINSTEAD 33KV		2.00	1.00					2.00		1.00
EBBSFLEET 33/11KV		2.00					1.00		1.00	
FARNINGHAM 33KV		2.00					1.00	1.00		
FOUR ELMS 33/11KV		2.00						2.00		
GRAIN 33/11KV		2.00						2.00		
GRAVESEND SOUTH 33/11KV		1.00	1.00					1.00	1.00	
	2015					2023				
Substation	**No. HI1**	**No. HI2**	**No. HI3**	**No. HI4**	**No. HI5**	**No. HI1**	**No. HI2**	**No. HI3**	**No. HI4**	**No. HI5**
GRAVESEND TOWN 6.6KV		2.00						2.00		
GRAVESEND WEST 11KV		1.00	1.00						1.00	1.00
MEREWORTH 33/11KV		2.00					2.00			
NORTH SEVENOAKS 33/11KV		3.00					3.00			
OXTED 33KV		2.00						2.00		
PADDOCK WOOD 33KV		2.00					1.00	1.00		
PENSHURST 33KV		2.00					2.00			
ROSHERVILLE 33/6.6KV			2.00						2.00	
RUSTHALL 33KV		2.00					2.00			
SHARNAL STREET 33/11KV			1.00						1.00	
SOUTH ORPINGTON 33KV		2.00					1.00	1.00		
STONE 33/11 KV		1.00						1.00		
STONE MARSHES 33/11		2.00					2.00			
SUNDRIDGE 33KV		1.00	1.00				1.00	1.00		
SWANLEY 33KV		2.00					2.00			
TONBRIDGE EAST 33/6.6KV		2.00					2.00			
TONBRIDGE TOWN 33/6.6KV	1.00	1.00					1.00	1.00		

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

Table 8. Grid Transformers

Substation	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
BURHAM GRID 132 KV		2					2			
CHELSFIELD GRID 132 KV	2	1					2		1	
DORMANSLAND GRID 132 KV		1	1				1	1		
NORTHFLEET EAST 132 KV		2					2			
PEMBURY GRID 132 KV	2						2			
TUNBRIDGE WELLS GRID 132 KV		2	2				1	3		
TUNBRIDGE WELLS TOWN 132 KV		2					1	1		

3.2 Security of Supply Analysis and LI Profile

A P2/6 analysis of the February 2013 planning load estimates (PLE's) base on the Element Energy growth forecast is detailed below, together with an associated load index (LI) profile.

Table 9. P 2/6 Analysis (Part 1)

Sub-station	P2/6	Secondary Voltage	Firm Capacity (MW)	Transfer (MW)	P. F.	Winter 12/13 Summer 2012 (MW)	Winter 13/14 Summer 2013 (MW)	Winter 14/15 Summer 2014 (MW)	Winter 15/16 Summer 2015 (MW)	Winter 16/17 Summer 2016 (MW)	Winter 17/18 Summer 2017 (MW)	Winter 18/19 Summer 2018 (MW)	Winter 19/20 Summer 2019 (MW)	Winter 20/21 Summer 2020 (MW)	Winter 21/22 Summer 2021 (MW)	Winter 22/23 Summer 2022 (MW)
Aylesford	YES	6.6kV	28.42	1.20	0.98	24.43	24.40	24.39	24.40	24.42	24.43	24.45	24.47	24.50	24.58	24.66
Aylesford	YES	6.6kV	28.42	0.00	0.98	18.04	18.02	18.01	18.01	18.03	18.04	18.05	18.07	18.08	18.14	18.20
Burham Grid	YES	33kV	89.10	0.00	0.99	38.47	38.44	38.43	38.45	38.48	38.50	38.54	38.57	38.62	38.75	38.89
Burham Grid	YES	33kV	89.10	0.00	0.99	54.99	54.96	54.95	54.96	55.01	55.04	55.08	55.13	55.18	55.35	55.52
Burham Mill	YES	33kV	79.20	0.00	0.99	59.19	59.19	59.19	59.19	59.19	59.19	59.19	59.19	59.19	59.19	59.19
Burham Mill	YES	33kV	79.20	0.00	0.99	65.47	65.47	65.47	65.47	65.47	65.47	65.47	65.47	65.47	65.47	65.47
Chelsfield Grid	YES	33kV	129.00	0.00	0.99	106.53	106.51	107.00	107.67	108.36	108.58	108.88	109.21	109.58	110.62	111.64
Chelsfield Grid	YES	33kV	118.80	0.00	0.99	69.66	69.62	69.93	70.36	70.80	70.95	71.14	71.35	71.59	72.25	72.90
Crossw ays	YES	11kV	23.52	0.00	0.98	7.06	7.09	7.18	7.28	7.37	7.38	7.39	7.40	7.42	7.46	7.51
Crossw ays	YES	11kV	17.64	0.00	0.98	9.23	9.27	9.39	9.52	9.63	9.64	9.65	9.67	9.69	9.74	9.80
Crow hurst	YES	11kV	12.90	0.00	0.99	6.60	6.66	6.87	7.09	7.28	7.30	7.33	7.37	7.41	7.52	7.63
Crow hurst	YES	11kV	9.70	0.00	0.97	4.13	4.17	4.29	4.43	4.54	4.56	4.57	4.59	4.62	4.68	4.75
Dormansland Grid	YES	33kV	115.83	0.00	0.99	60.43	60.44	60.68	60.98	61.27	61.37	61.50	61.64	61.79	62.18	62.56
Dormansland Grid	YES	33kV	89.10	0.00	0.99	44.57	44.56	44.70	44.89	45.08	45.15	45.23	45.32	45.43	45.69	45.95
Dormansland Grid RT	YES	33kV	8.64	0.00	0.96	7.72	7.72	7.72	7.72	7.72	7.72	7.72	7.72	7.72	7.72	7.72
Dormansland Grid RT	YES	33kV	8.64	0.00	0.96	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.68	7.68
East Grinstead	YES	11kV	44.14	0.00	0.99	34.10	34.05	34.04	34.08	34.14	34.21	34.29	34.37	34.47	34.71	34.94
East Grinstead	YES	11kV	37.60	0.00	0.94	24.43	24.38	24.37	24.40	24.44	24.49	24.54	24.60	24.67	24.83	24.99
Ebbsfleet	YES	11kV	32.26	0.00	0.95	11.91	11.90	11.91	11.93	11.96	11.97	11.98	11.99	12.00	12.07	12.13
Ebbsfleet	YES	11kV	28.80	0.00	0.96	8.93	8.91	8.92	8.94	8.96	8.97	8.97	8.98	8.99	9.04	9.08
Edenbridge	YES	11kV	8.20	9.24	0.96	6.08	6.08	6.13	6.19	6.24	6.26	6.29	6.31	6.34	6.41	6.48
Edenbridge	YES	11kV	6.80	7.72	0.96	4.61	4.61	4.64	4.68	4.73	4.74	4.76	4.78	4.80	4.85	4.91
Farningham	YES	11kV	22.90	0.00	1	16.60	16.59	16.66	16.76	16.87	16.91	16.96	17.01	17.07	17.22	17.38
Farningham	YES	11kV	17.25	0.00	1.00	11.15	11.15	11.19	11.26	11.33	11.35	11.38	11.42	11.46	11.56	11.66
Four Elms	YES	11kV	11.64	0.00	0.97	6.07	6.08	6.14	6.20	6.26	6.28	6.31	6.34	6.37	6.43	6.50
Four Elms	YES	11kV	10.58	0.00	0.94	3.68	3.69	3.72	3.76	3.80	3.81	3.82	3.84	3.86	3.90	3.94
Grain	YES	11kV	12.09	0.00	0.93	5.10	5.10	5.12	5.15	5.18	5.18	5.20	5.21	5.22	5.25	5.29
Grain	YES	11kV	9.30	0.00	0.93	4.70	4.70	4.71	4.74	4.76	4.77	4.78	4.79	4.80	4.83	4.86
Gravesend South	YES	11kV	22.60	10.90	0.99	17.19	17.19	17.31	17.48	17.66	17.70	17.75	17.81	17.88	18.11	18.33
Gravesend South	YES	11kV	19.20	8.01	0.96	14.56	14.55	14.66	14.80	14.95	14.99	15.03	15.08	15.14	15.33	15.52
Gravesend Tow n	YES	6.6kV	17.90	5.42	0.98	18.39	18.35	18.37	18.42	18.50	18.53	18.56	18.60	18.65	18.82	18.99
Gravesend Tow n	YES	6.6kV	16.80	3.39	0.92	10.21	10.17	10.18	10.21	10.25	10.27	10.29	10.31	10.33	10.43	10.52
Gravesend West	YES	11kV	18.24	0.00	0.96	15.60	15.62	15.67	15.73	15.78	15.78	15.79	15.80	15.81	15.83	15.86
Gravesend West	YES	11kV	16.60	0.00	0.92	14.56	14.58	14.62	14.67	14.72	14.72	14.73	14.73	14.74	14.77	14.79
Longfield	YES	11kV	23.00	0.00	1	11.91	11.88	11.88	11.91	11.95	11.98	12.02	12.07	12.11	12.24	12.37
Longfield	YES	11kV	17.08	0.00	0.99	9.75	9.72	9.72	9.74	9.77	9.80	9.83	9.86	9.90	10.00	10.10
Merew orth	YES	11kV	20.10	0.00	0.95	17.03	17.05	17.12	17.22	17.32	17.39	17.47	17.57	17.66	17.84	18.02
Merew orth	YES	11kV	17.10	0.00	0.95	13.37	13.39	13.44	13.51	13.59	13.64	13.71	13.78	13.85	13.98	14.12
North Sevenoaks	YES	11kV	44.90	1.68	0.98	20.98	21.00	21.15	21.33	21.51	21.58	21.67	21.76	21.87	22.12	22.36
North Sevenoaks	YES	11kV	37.60	3.73	0.94	16.55	16.57	16.68	16.82	16.96	17.01	17.08	17.15	17.23	17.42	17.61

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

P 2/6 Analysis (Part 2)

Sub-station	P2/6	Secondary Voltage	Firm Capacity (MW)	Transfer (MW)	P. F.	Winter 12/13 Summer 2012 (MW)	Winter 13/14 Summer 2013 (MW)	Winter 14/15 Summer 2014 (MW)	Winter 15/16 Summer 2015 (MW)	Winter 16/17 Summer 2016 (MW)	Winter 17/18 Summer 2017 (MW)	Winter 18/19 Summer 2018 (MW)	Winter 19/20 Summer 2019 (MW)	Winter 20/21 Summer 2020 (MW)	Winter 21/22 Summer 2021 (MW)	Winter 22/23 Summer 2022 (MW)
Northfleet East	YES	33kV	217.20	0.00	0.95	120.67	120.62	121.02	121.57	122.13	122.28	122.48	122.69	122.93	123.75	124.54
Northfleet East	YES	33kV	171.00	0.00	0.95	94.41	94.37	94.70	95.14	95.58	95.68	95.82	95.97	96.15	96.72	97.28
Northfleet East RT	YES	33kV	35.52	0.00	0.96	11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21	11.21
Northfleet East RT	YES	33kV	35.52	0.00	0.96	11.24	11.24	11.24	11.24	11.24	11.24	11.24	11.24	11.24	11.24	11.24
Northfleet SGT	YES	400kV	829.40	0.00	0.96	446.71	446.71	448.76	451.42	454.13	454.89	455.93	457.08	458.37	462.20	465.93
Northfleet SGT	YES	400kV	732.70	0.00	0.96	339.29	339.18	340.56	342.36	344.20	344.72	345.44	346.23	347.12	349.75	352.31
Northfleet West	YES	11kV	74.88	0.00	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northfleet West	YES	11kV	57.60	0.00	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oxted	YES	11kV	17.64	0.00	0.98	11.91	11.94	12.08	12.23	12.38	12.41	12.46	12.51	12.56	12.70	12.84
Oxted	YES	11kV	16.74	0.00	0.93	7.82	7.84	7.93	8.03	8.12	8.14	8.17	8.21	8.24	8.33	8.42
Paddock Wood	YES	11kV	22.30	0.00	0.97	15.48	15.54	15.75	15.99	16.20	16.25	16.31	16.38	16.45	16.63	16.81
Paddock Wood	YES	11kV	16.74	0.00	0.93	10.92	10.96	11.10	11.26	11.41	11.44	11.48	11.53	11.58	11.70	11.83
Pembury Grid	YES	33kV	65.55	0.00	0.95	48.14	48.19	48.50	48.90	49.29	49.43	49.61	49.80	50.02	50.52	51.02
Pembury Grid	YES	33kV	61.75	0.00	0.95	34.31	34.34	34.55	34.82	35.09	35.18	35.31	35.45	35.60	35.94	36.28
Penshurst	YES	11kV	14.20	0.76	0.95	4.56	4.60	4.73	4.87	4.99	5.01	5.04	5.07	5.11	5.20	5.28
Penshurst	YES	11kV	10.60	1.27	0.92	2.93	2.95	3.03	3.12	3.19	3.21	3.22	3.24	3.26	3.32	3.37
Rosherville	YES	6.6kV	18.90	0.00	0.97	12.41	12.40	12.45	12.52	12.60	12.62	12.65	12.68	12.71	12.83	12.95
Rosherville	YES	6.6kV	13.65	0.00	0.91	9.52	9.50	9.54	9.59	9.65	9.66	9.68	9.70	9.73	9.82	9.90
Rusthall	YES	11kV	12.70	0.00	0.98	5.43	5.47	5.60	5.74	5.88	5.90	5.93	5.96	6.00	6.11	6.21
Rusthall	YES	11kV	9.20	0.00	0.92	3.47	3.49	3.57	3.66	3.74	3.76	3.77	3.80	3.82	3.88	3.95
Rusthall Penshurst circuits	YES	kV	21.10	0.00	0.96	9.70	9.77	10.03	10.30	10.55	10.59	10.65	10.71	10.79	10.97	11.16
Rusthall Penshurst circuits	YES	kV	18.90	0.00	0.96	6.26	6.31	6.46	6.64	6.79	6.81	6.85	6.89	6.93	7.05	7.16
Sharnal Street	YES	11kV	2.50	2.50	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sharnal Street	YES	11kV	2.00	2.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
South Orpington	YES	11kV	22.60	0.00	0.99	19.13	19.10	19.12	19.18	19.25	19.28	19.32	19.36	19.41	19.57	19.73
South Orpington	YES	11kV	19.80	0.00	0.99	12.81	12.78	12.80	12.83	12.88	12.90	12.92	12.95	12.98	13.08	13.19
Stone Marshes	YES	11kV	22.08	5.07	0.96	14.56	14.56	14.60	14.63	14.67	14.67	14.68	14.68	14.69	14.72	14.75
Stone Marshes	YES	11kV	20.70	4.10	0.92	16.83	16.84	16.88	16.92	16.96	16.96	16.97	16.98	16.98	17.02	17.05
Sundridge	YES	11kV	19.30	2.00	0.99	20.21	20.22	20.32	20.45	20.58	20.63	20.70	20.77	20.86	21.06	21.26
Sundridge	YES	11kV	14.10	1.33	0.94	13.53	13.54	13.60	13.68	13.77	13.80	13.85	13.89	13.95	14.08	14.20
Swanley 911	YES	11kV	22.63	0.00	0.99	17.79	17.74	17.75	17.80	17.85	17.86	17.87	17.89	17.90	18.04	18.16
Swanley 911	YES	11kV	17.08	0.00	0.99	12.07	12.02	12.03	12.06	12.09	12.10	12.11	12.11	12.13	12.21	12.30
Tonbridge East	YES	6.6kV	22.18	0.00	0.97	16.42	16.39	16.42	16.49	16.56	16.59	16.62	16.66	16.70	16.86	17.01
Tonbridge East	YES	6.6kV	15.70	0.00	0.91	10.89	10.86	10.88	10.92	10.97	10.98	11.01	11.03	11.06	11.15	11.25
Tonbridge Town	YES	6.6kV	21.95	2.93	0.96	16.75	16.75	16.84	16.95	17.06	17.10	17.14	17.19	17.24	17.39	17.55
Tonbridge Town	YES	6.6kV	17.28	3.20	0.96	11.72	11.72	11.78	11.86	11.94	11.96	11.99	12.02	12.05	12.16	12.26
Tunbridge Wells 132/11	YES	11kV	37.05	3.20	0.95	29.02	29.03	29.26	29.52	29.78	29.80	29.85	29.91	29.98	30.25	30.51
Tunbridge Wells 132/11	YES	11kV	28.50	2.17	0.95	21.41	21.42	21.57	21.75	21.93	21.94	21.98	22.02	22.06	22.25	22.43
Tunbridge Wells 132/11 Feeders	YES	kV	16.00	0.00	0.96	12.12	12.12	12.12	12.12	12.12	12.12	12.12	12.12	12.12	12.12	12.12
Tunbridge Wells 132/11 Feeders	YES	kV	12.00	0.00	0.96	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90	9.90
Tunbridge Wells 132/33	NO	33kV	37.44	0.00	0.96	38.47	38.55	38.89	39.28	39.63	39.71	39.81	39.92	40.04	40.38	40.71
Tunbridge Wells 132/33	NO	33kV	27.60	0.00	0.92	28.22	28.27	28.47	28.70	28.92	28.96	29.02	29.09	29.17	29.37	29.57
Tunbridge Wells 132/33 RT	YES	33kV	17.28	0.00	0.96	11.95	11.95	11.95	11.95	11.95	11.95	11.95	11.95	11.95	11.95	11.95
Tunbridge Wells 132/33 RT	YES	33kV	17.28	0.00	0.96	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Tunbridge Wells 132/6.6	YES	6.6kV	35.49	0.00	0.91	23.39	23.33	23.35	23.41	23.50	23.53	23.58	23.64	23.71	23.95	24.16
Tunbridge Wells 132/6.6	YES	6.6kV	27.30	0.00	0.91	17.91	17.86	17.87	17.92	17.99	18.01	18.06	18.10	18.16	18.34	18.51
Tunbridge Wells 6.6 Feeders	YES	kV	26.00	0.00	0.96	18.27	18.27	18.27	18.27	18.27	18.27	18.27	18.27	18.27	18.27	18.27
Tunbridge Wells 6.6 Feeders	YES	kV	20.00	0.00	0.96	11.85	11.85	11.85	11.85	11.85	11.85	11.85	11.85	11.85	11.85	11.85
Tunbridge Wells Total	YES	132kV	103.68	0.00	0.96	90.06	90.11	90.85	91.75	92.64	92.81	93.08	93.38	93.73	94.90	96.01
Tunbridge Wells Total	YES	132kV	77.76	0.00	0.96	67.19	67.20	67.68	68.28	68.87	68.98	69.16	69.37	69.61	70.41	71.17
Tunbridge Wells Town via 132/11	YES	11kV	21.10	2.66	0.97	18.18	18.17	18.24	18.34	18.44	18.46	18.48	18.51	18.55	18.69	18.82
Tunbridge Wells Town via 132/11	YES	11kV	16.50	1.81	0.97	13.01	13.00	13.05	13.12	13.19	13.20	13.22	13.24	13.26	13.36	13.45
Tunbridge Wells Town via 132/6.6	YES	6.6kV	9.46	2.96	0.97	7.31	7.31	7.34	7.39	7.44	7.45	7.46	7.48	7.50	7.57	7.63
Tunbridge Wells Town via 132/6.6	YES	6.6kV	7.28	3.24	0.97	6.19	6.18	6.21	6.25	6.29	6.30	6.31	6.32	6.34	6.39	6.45

Key

Compliant with P2/6

Approaching limit of P2/6 compliance

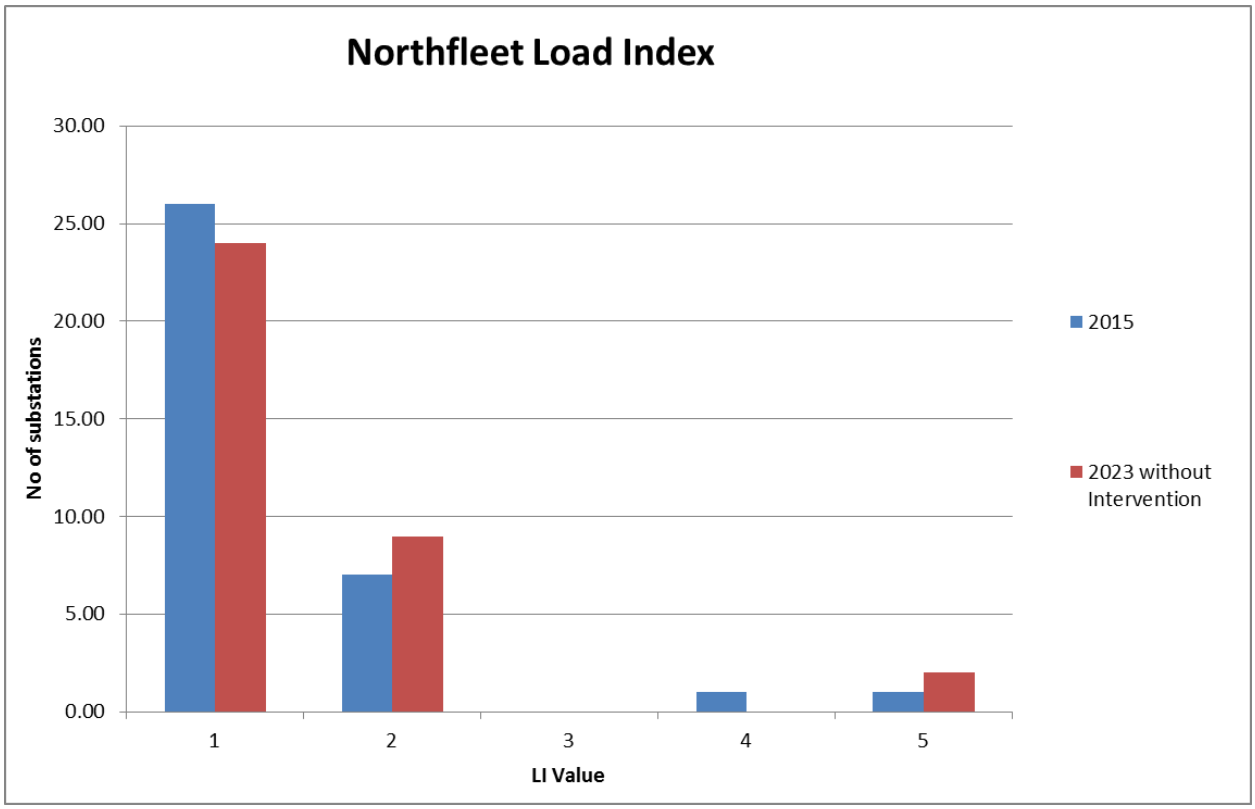
All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

LI Profile (Assumes LRR only)

LI Profile (Without Intervention)

Substation	Voltage kV	Load Index 2015	Load Index 2023
Northfleet East 132/33kV	33	1	1
Crossways 33/11kV	11	1	1
Stone Marshes 33/11kV	11	2	2
Longfield 33/11kV	11	1	1
Ebbsfleet 33/11kV	11	1	1
Rosherville 33/6.6kV	6.6	1	1
Gravesend South 33/11kV	11	1	2
Gravesend Town 33/6.6kV	6.6	4	5
Gravesend West 33/11kV	11	2	2
Grain 33/11kV	11	1	1
Sharnal Street 33/11kV	11		
Burham 132/33kV	33	1	1
Aylesford 33/6.6kV	6.6	2	2
Chelsfield Grid 132/33kV	33	2	2
Farningham 33/11kV	11	1	1
South Orpington 33/11kV	11	2	2
Oxted 33/11kV	11	1	1
Sundridge 33/11kV	11	5	5
North Sevenoaks 33/11kV	11	1	1
Swanley 33/11kV	11	1	2
Tunbridge Wells Grid 132/33kV	33	1	1
Tonbridge Town 33/6.6kV	6.6	1	1
Penhurst 33/11kV	11	1	1
Rusthall 33/11kV	11	1	1
Tunbridge Wells Grid 132/11kV			
Tunbridge Wells Grid 11kV	11	2	2
Tunbridge Wells Town 11kV	11	1	1
Tunbridge Wells Town 6.6kV	6.6	1	1
Dormansland Grid 132/33kV	33	1	1
Crowhurst 33/11kV	11	1	1
Four Elms 33/11kV	11	1	1
Edenbridge 33/11kV	11	1	1
East Grinstead 33/11kV	11	1	1
Pembury Grid 132/33kV	33	1	1
Tonbridge East 33/6.6kV	6.6	1	1
Mereworth 33/11kV	11	2	2
Paddock Wood 33/11kV	11	1	1

Forecast Load index Profile – Without Intervention



The P2/6 analysis identifies 1 site that is forecast to exceed its firm capacity during ED1: Tunbridge Wells 132/11kV.

Two sites are forecast to reach LI5 by 2023: Gravesend Town 33/6.6kV and Sundridge 33/11kV. The two sites currently maintain P2/6 compliance by relying on load transfers of 5.2MW and 2MW respectively.

3.3 Operational and technical restrictions

None identified.

3.4 National Grid

There are no National Grid scheduled works at Northfleet 400kV substation.

3.5 Network Constraints

No network constraints have been identified.

4 Recommended strategy

The network strategy is formulated to ensure:

- Continued adherence to the security of supply criteria defined in Engineering Recommendation P2/6
- A stable load index (LI) profile over the ED1 period over the ED1 period subject to Element Energy growth assumptions and Imperial College Model core 3 assumptions
- Maintaining reliable network operation by selective asset replacement, or refurbishment, of poorly performing equipment identified through asset condition monitoring (HI) techniques

Adopting this approach results in modest network reconfigurations with proposed works contained mainly within the boundary of the existing network and substation sites.

The proposals are summarised below:

4.1 Asset Replacement

4.1.1 Switchgear

Based on the health index (HI) analysis replacement or retrofit is proposed at the following sites:

4165 Farningham 33/11kV – Farningham Primary is equipped with 11 x Reyrolle C-gear all manufactured in 1961. It is proposed to replace the 11kV switchgear (4x panels forecast to become HI4).

7842 Rusthall 33/11kV – The condition assessment of the 1968 South Wales Switchgear C4X Oil Switchgear installed at Rusthall 33kV has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements; therefore this project recommends its Refurbishment. Completion of the project will see 7 circuit breakers replaced with 7 new circuit breakers.

7844 South Orpington 33/11kV – The condition assessment of the 1963 Reyrolle C gear Oil Switchgear installed at South Orpington 33kV has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements; therefore this project recommends its replacement. The replaced switchboard is to have an additional 4 panels (1 incomer and 3 feeder panels) required for load reinforcement under project 3736. Completion of the project will see 12 circuit breakers replaced with 12 new circuit breakers.

7928 Tonbridge East 33/6.6kV – The condition assessment of the 1967 Reyrolle LMT oil switchgear installed at Tonbridge East 33/6.6KV has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements; therefore this project recommends its Refurbishment. Completion of the project will see 14 circuit breakers replaced with 14 new circuit breakers.

7808 Pembury Grid – The condition assessment of the 1956 - 67 Reyrolle L42T Oil Switchgear installed at Pembury Grid has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements; therefore this project recommends its Refurbishment. Completion of the project will see 3 circuit breakers replaced with 3 new circuit breakers.

1.50.01.7819 Sundridge 33/11kV - The condition assessment of the 1984 GEC VMX Vacuum Switchgear installed at Sundridge 11kV has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements; therefore this project recommends its Replacement. Completion of the project will see 9 x 11kV indoor circuit breakers replaced with 9 x 11kV indoor circuit breakers. This project is optimised with Load N-1 reinforcement (**1.33.01.8134**).

1.50.01.7925 Gravesend West 33/11kV - The condition assessment of the 1963 - 64 Reyrolle C gear Oil Switchgear installed at Gravesend West has shown that the probability of failure due to degradation will become

unacceptable. It is not possible to keep these assets in use without compromising operational requirements; therefore this project recommends its Refurbishment. Completion of the project will see 3 circuit breakers replaced with 3 new circuit breakers.

1.50.01.7934 Orpington 33/11kV - The condition assessment of the 1974 Brush VSI oil switchgear installed at ORPINGTON 33/11kV has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements; therefore this project recommends its Refurbishment. Completion of the project will see 13 circuit breakers replaced with 13 new circuit breakers.

4.1.2 Transformers

Based on the health index (HI) analysis replacement or refurbishment is proposed at the following sites:

3833 Rosherville – T1/T2 are 15 MVA transformers equipped with old tap-changers. The oil quality is poor due to acid content. The transformer has been condition assessed and cannot remain in service. Therefore, it is to be replaced with 12/24 MVA units. - To be harmonised with reinforcement

7885 Gravesend West – The condition assessment of the 1983 Hawker Siddeley Primary Transformers with ATL AT tap changers installed at Gravesend West has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements; therefore this project recommends its refurbishment. Completion of the project will see 1 Grid Transformer refurbished.

4.1.3 Circuits

Based on the health index (HI) analysis replacement or refurbishment is proposed at the following circuits:

EHV Cables

1.29.01.7966 Northfleet East-Gravesend Town No1– Asset replacement of poorly performing 33kV FF cable sections

132kV Overhead Lines

1.02.03.4124 Northfleet East- Maidstone (part Route PN) – Route PN is 14.7km long. It is proposed to replace fixtures and fittings between towers 1-3 and 45-92. Based on the CORMON test results from 2012 for the PN route in SPN, the worst conductor spans tested between towers 50 and 81 had a CR rating of 3. A condition rating of 4 is the trigger for replacement. The overhead line will need to have a CORMON retest in 5 years to determine if replacement will go ahead.

1.26.10.5352 Dormansland/PW Tee BT have advised the ENA that existing leased telecommunications service shall be withdrawn from 2014, following an upgrade of BT's network to an IP based system. Due to the non-deterministic nature of the proposed IP network, the performance of EDF Energy's protection schemes which utilise these leased services will be at risk and may not operate to required specification. The least cost option for the Three Bridges/ Dormansland 132kV transformer feeder circuit is renting a dark fibre from a third party.

33kV Overhead Lines

It is proposed to undertake selective refurbishment and replacement of the following connections

1.09.01.8167 Chelsfield Grid – Four Elms – Pole replacement

The condition assessment of the CHELSFIELD GRID-4 ELMS 33KV wood poles has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising CI and CML performance, therefore this project recommends the replacement. Completion of the project will see 19 km of 33KV POLE replaced.

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

1.09.01.8176 Northfleet East – Shornewood No1 – Pole replacement

The condition assessment of the NORTHFLEET EAST GRID-SHORNEWOOD NO 1 33KV wood poles has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising CI and CML performance, therefore this project recommends the replacement. Completion of the project will see 31 km of 33KV POLE replaced.

1.09.01.8177 Northfleet East – Shornewood No2 – Pole replacement

The condition assessment of the NORTHFLEET EAST GRID-SHORNEWOOD NO 2 33KV wood poles has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising CI and CML performance, therefore this project recommends the replacement. Completion of the project will see 33 km of 33KV POLE replaced.

1.26.10.7984 Chelsfield Grid – Sundridge 33/11kV cct1 - This scheme is part of the BT21CN Mitigation Strategy. As background, the ENA was advised by BT in 2004 that legacy BT services would be withdrawn following an upgrade of BT's telecoms network to an IP based system known as BT21CN.

1.26.10.7994 Chelsfield Grid – Sundridge 33/11kV cct2 This scheme is part of the BT21CN Mitigation Strategy. As background, the ENA was advised by BT in 2004 that legacy BT services would be withdrawn following an upgrade of BT's telecoms network to an IP based system known as BT21CN.

1.26.10.7986 Grain 33/11kV – Shakespeare Farm This scheme is part of the BT21CN Mitigation Strategy. As background, the ENA was advised by BT in 2004 that legacy BT services would be withdrawn following an upgrade of BT's telecoms network to an IP based system known as BT21CN.

4.2 Reinforcement

The following sites are identified in this RDP as reinforcement projects to improve network reliability and resilience:

Gravesend Town: 1.33.01.8129 - The maximum demand at Gravesend Town 33/6.6kV substation currently exceeds the existing firm capacity of 18.3MVA and regulatory compliance is maintained through transfers. It is proposed to install a third primary transformer (T3), install a new 24MVA 33kV XLPE solid cable circuit from Northfleet East to supply this transformer, and to replace both HV switchboards with new switchgear. The site firm capacity will increase to 41.8MVA (winter) / 37.4MVA (summer) which will be limited by rating of the existing FFC circuits.

Sundridge: 1.33.01.8134 - The load at Sundridge 33/11kV substation currently exceeds the existing firm capacity and regulatory compliance is only maintained by transfers to North Sevenoaks. It is therefore proposed to increase the firm capacity by replacing T2 with a 33/11kV 12/24MVA unit.

132kV Northfleet–Marden Junction (part of Route PCA) 1.37.09.4376 The Northfleet–Pembury–Tunbridge Wells 132kV connection is a composite cable and overhead line route. It is proposed to up rate selective spans of route PCA OHL to match the cyclic rating of the cable sections thereby increasing the firm circuit capacity to Tunbridge Wells to 126/148MVA summer/winter respectively. Furthermore, the fittings along the PCA route are in poor condition and require replacing.

Stone Marshes 33kV Reinforcement: 1.37.05.8133 - The 33kV circuit 1 which supplies Stone Marshes and Crossways is on the limit of operational requirements due to the increased load, with the firm capacity at Stone Marshes being exceeded now. This project proposes to increase circuit rating by restringing approximately 5 km of conductors between Stone Marshes and Northfleet East Grid, with conductor rated at 30MVA summer and 40MVA winter, to meet the predicted capacity requirements of the ED1 period.

Dormansland: 1.35.05.4375 - According to load flow studies carried out based on existing maximum load, the loss of this circuit results in a 33kV voltage drop of 13% (at maximum tap) which is outside acceptable operational limits. It is therefore proposed to install a capacitor bank on either side of the 33kV bus-section in order to sustain voltage within acceptable limits (+/-6).

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

4.3 Summary of Proposed Interventions

Table 10. Intervention Summary (Winter firm capacities quoted)

Substation	Driver	Commissioning Year	Scope of Works	Existing Firm Capacity	New Firm Capacity
Gravesend Town	Load Related Reinforcement	2016	Add new transformer and replace 6.6kV switchboard	23MVA	
Sundridge	Load Related Reinforcement	2023	Increase Transformer Capacity	19MVA	
Dormansland	Reinforcement	2019	Reactive Compensation	-	-
Chelsfield Grid	Reinforcement	2016	Enabling transfers	130MVA	130MVA
Stone Marshes	Reinforcement	2020	33kV OHL Replacement	23MVA	
Route PCA 132kV Northfleet-Marden Junction (part)	Asset Replacement	2020	Fittings Replacement and Conductor Uprating	-	-
South Orpington 33/11kV	Asset Replacement	2023	Replace 11kV Switchgear	-	-
Northfleet East Grid	Asset Replacement	2017	33kV Pole Replacement	-	-
Rosherville	Asset Replacement	2023	Replace Transformers	-	-
Pembury Grid	Reinforcement	2015	33kV Cable???	-	-
Northfleet East	Asset Replacement	2020	Install optical fibre on 132kV OH tower line and UG fibre ducts	-	-

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

4.4 Costs and phasing

Table 11. Costs and Phasing Part 1: Asset Replacement (NAMP Extract)

SR_Tabl	S&R - Baseline_Final ED1 Re-submission_19th February 2014_15:15												
Cat.	GWP	Ref.	Project ID	Description	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
A	1.51	1.51.03	3833	Rosherville Primary - Replace T1 & T2	0	0	0	0	0	0	0	108	670	402
A	1.02	1.02.03	4124	PN - Northfleet East - Maidstone - Conductor Replacement	0	0	0	0	0	0	0	0	213	542
A	1.50	1.50.01	4165	Farningham Primary - Retrofit 11kV Switchgear	0	0	0	0	0	0	0	0	66	54
A	1.02	1.02.03	4376	PCA Reinforcment - Northfleet East - Hartley - on wrong line	0	0	0	0	437	1,747	1,310	0	0	0
A	1.09	1.09.01	8167	100911107 - 33KV Chelsfield Grid/Four Elms (Sundridge Zone) - OHLReplacement	0	0	0	0	0	0	0	0	113	193
A	1.09	1.09.01	8176	100913717 - 33kV Northfleet East Grid/Shorne Wood No1 - OHLReplacement	0	0	301	755	0	0	0	0	0	0
A	1.09	1.09.01	8177	100913713 - 33kV Northfleet East Grid/Shornewood No2 OHLReplacement	0	0	318	806	0	0	0	0	0	0
A	1.26	1.26.10	5352	BT21CN Mitigation - Dormansland/PW Tee	0	0	0	83	744	0	0	0	0	0
A	1.26	1.26.10	7984	BT21CN Mitigation - 33kV Chelsfield 33kV cct1 To Sundridge 33kV/11kV	0	60	179	0	0	0	0	0	0	0
A	1.26	1.26.10	7986	BT21CN Mitigation - 33kV Grain 33/11kV To Shakespeare Farm	0	60	179	0	0	0	0	0	0	0
A	1.26	1.26.10	7994	BT21CN Mitigation - 33kV Sundridge To Chelsfield Grid	0	0	60	179	0	0	0	0	0	0
A	1.48	1.48.02	7808	Pembury Grid - Refurb 33kV Switchgear	0	0	0	0	0	0	0	45	134	0
A	1.50	1.50.01	7819	Sundridge 33kV - Replace 11kV Switchgear	0	144	412	304	0	0	0	0	0	0
A	1.50	1.50.01	7842	Rusthall 33kV - Retrofit 11kV Switchgear	0	0	0	61	42	0	0	0	0	0
A	1.50	1.50.01	7844	South Orpington 33kV - Replace 11kV Switchgear	0	0	0	0	0	0	147	391	391	80
A	1.50	1.50.01	7925	Gravesend West - Retrofit 11kV Switchgear	0	0	0	0	0	0	0	10	30	0
A	1.50	1.50.01	7928	Tonbridge East 33/6.6KV - Retrofit 11kV Switchgear	0	0	0	0	0	0	0	0	60	179
A	1.50	1.50.01	7934	Orpington 33/11kV - Retrofit 11kV Switchgear	0	0	0	0	0	0	0	0	0	109
A	1.51	1.51.11	7885	Gravesend West 11kV - Refurbish Primary Transformer (T1, T2)	0	0	0	0	0	114	188	0	0	0
	TOTAL ASSET REPLACEMENT				0	264	1,448	2,189	1,222	1,860	1,644	554	1,676	1,559

SR_Tabl	S&R - Baseline_Final ED1 Re-submission_19th February 2014_15:15												
Cat.	GWP	Ref.	Project ID	Description	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
R	1.33	1.33.01	8129	Gravesend Town 33kV/6.6kV Reinforcement - Add T3 and Replace 6.6kV Switchboard	0	0	822	2,542	1,017	0	0	0	0	0
R	1.33	1.33.01	8134	Sundridge 33kV/11kV Reinforcement- Replace 1x15MVA with 12/24MVA & Add 3rd Tx	0	0	0	99	225	158	0	0	0	0
R	1.35	1.35.05	4375	Dormansland 33 kV Substation-Reactive Compensation	0	0	0	0	249	746	0	0	0	0
R	1.37	1.37.05	8133	Stone Marshes 33kV Reinforcement - Replace 5km of 33kV Conductor	0	0	0	0	48	192	144	0	0	0
	TOTAL REINFORCEMENT				0	0	822	2,642	1,538	1,096	144	0	0	0

Table 12. Costs and Phasing Part 2: Reinforcement (NAMP Extract)

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

4.5 HI / LI Profile Post Intervention

Table 13. HV Circuit Breakers

	2015					2023				
Substation	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
AYLESFORD 33/6.6KV	3	18					20	1		
BURHAM GRID 132 KV		1					1			
CROWHURST 33/11KV		7						7		
EAST GRINSTEAD 33KV	4	11				3	11	1		
EBBSFLEET 33/11KV	13						13			
FARNINGHAM 33KV		7	4					11		
FOUR ELMS 33/11KV		8						8		
GRAIN 33/11KV		11					1	10		
GRAVESEND SOUTH 33/11KV		10	1					11		
GRAVESEND TOWN 6.6/11KV		2						2		
GRAVESEND TOWN 6.6KV		15	2					17		
GRAVESEND WEST 11KV		14	2				1	14	1	
MEREWORTH 33/11KV	1	3	7				2	8	1	
NORTH SEVENOAKS 33/11KV	17					17				
OXTED 33KV		8						8		
PADDOCK WOOD 33KV		9					2	7		
PENSHURST 33KV		6						6		
ROSHERVILLE 33/6.6KV		16					16			
RUSTHALL 33KV		2	5					4	3	
SHARNAL STREET 33/11KV		1					1			
SOUTH ORPINGTON 33KV	1	3	7			1		3	7	
STONE MARSHES 33/11		13					5	8		
SUNDRIDGE 33/11KV		3	6						9	
SWANLEY 33/11KV		9						9		
TONBRIDGE EAST 33/6.6KV		9	6					13	2	
TONBRIDGE TOWN 33/6.6KV	2	14				2	3	11		
TUNBRIDGE WELLS GRID 132 KV	2					2				
TUNBRIDGE WELLS GRID 132/11KV	12	3	7			12		5	3	2
TUNBRIDGE WELLS TOWN 11KV		8	9					10	7	
TUNBRIDGE WELLS TOWN 132/6.6KV		16					16			

*Note: Tunbridge Wells 3229 completed in 2012

Table 14. 132kV Circuit Breakers

	2015					2023				
Substation	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
CHELSFIELD GRID 132 KV	4						4			
DORMANSLAND GRID 132 KV				1						1
NORTHFLEET EAST 132 KV		14					14			

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

Table 15. 33kV Circuit Breakers

	2015					2023				
Substation	**No. HI1**	**No. HI2**	**No. HI3**	**No. HI4**	**No. HI5**	**No. HI1**	**No. HI2**	**No. HI3**	**No. HI4**	**No. HI5**
BURHAM GRID 132 KV	2	1				2	1			
BURHAM GRID 33KV	5					5				
CHELSFIELD GRID		4	9					7	3	3
CHELSFIELD GRID 132 KV		1	2					3		
CHELSFIELD RMU	1					1				
DORMANSLAND GRID		7	1					8		
DORMANSLAND GRID 132 KV		2						2		
EASTBOURNE GRID		8					8			
NORTHFLEET EAST 132 KV		4					3	1		
NORTHFLEET EAST GRID		23					23			
PEMBURY GRID		2	3	2				5		2
PEMBURY GRID 132 KV		2					1	1		
STONEMARSHES SW STN	3					3				
TUNBRIDGE WELLS GRID	11					11				
TUNBRIDGE WELLS GRID 132 KV				2						2
TUNBRIDGE WELLS GRID 33KV				6	1					7

Table 16. Primary Transformers

	2015					2023				
Substation	**No. HI1**	**No. HI2**	**No. HI3**	**No. HI4**	**No. HI5**	**No. HI1**	**No. HI2**	**No. HI3**	**No. HI4**	**No. HI5**
APCM SWANSCOMBE 33/3KV		2.00						2.00		
AYLESFORD 33/6.6KV	2.00	1.00				2.00	1.00			
CROWHURST 33/11KV			2.00					2.00		
EAST GRINSTEAD 33KV		2.00	1.00					2.00		1.00
EBBSFLEET 33/11KV		2.00					1.00		1.00	
FARNINGHAM 33KV		2.00					1.00	1.00		
FOUR ELMS 33/11KV		2.00						2.00		
GRAIN 33/11KV		2.00						2.00		
GRAVESEND SOUTH 33/11KV		1.00	1.00					1.00	1.00	
GRAVESEND TOWN 6.6KV		2.00						2.00		
GRAVESEND WEST 11KV		1.00	1.00						1.00	1.00
MEREWORTH 33/11KV		2.00					2.00			
NORTH SEVENOAKS 33/11KV		3.00					3.00			
OXTED 33KV		2.00						2.00		
PADDOCK WOOD 33KV		2.00					1.00	1.00		
PENSHURST 33KV		2.00					2.00			
ROSHERVILLE 33/6.6KV			2.00						2.00	
RUSTHALL 33KV		2.00					2.00			
SHARNAL STREET 33/11KV			1.00						1.00	
SOUTH ORPINGTON 33KV		2.00					1.00	1.00		
STONE MARSHES 33/11		2.00					2.00			
SUNDRIDGE 33KV		1.00	1.00				1.00	1.00		
SWANLEY 33KV		2.00					2.00			
TONBRIDGE EAST 33/6.6KV		2.00					2.00			
TONBRIDGE TOWN 33/6.6KV	1.00	1.00					1.00	1.00		

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

Table 17. Grid Transformers

Substation	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
BURHAM GRID 132 KV		2					2			
CHELSFIELD GRID 132 KV	2	1					2		1	
DORMANSLAND GRID 132 KV		1	1				1	1		
NORTHFLEET EAST 132 KV		2					2			
PEMBURY GRID 132 KV	2						2			
TUNBRIDGE WELLS GRID 132 KV		2	2				1	3		
TUNBRIDGE WELLS TOWN 132 KV		2					1	1		

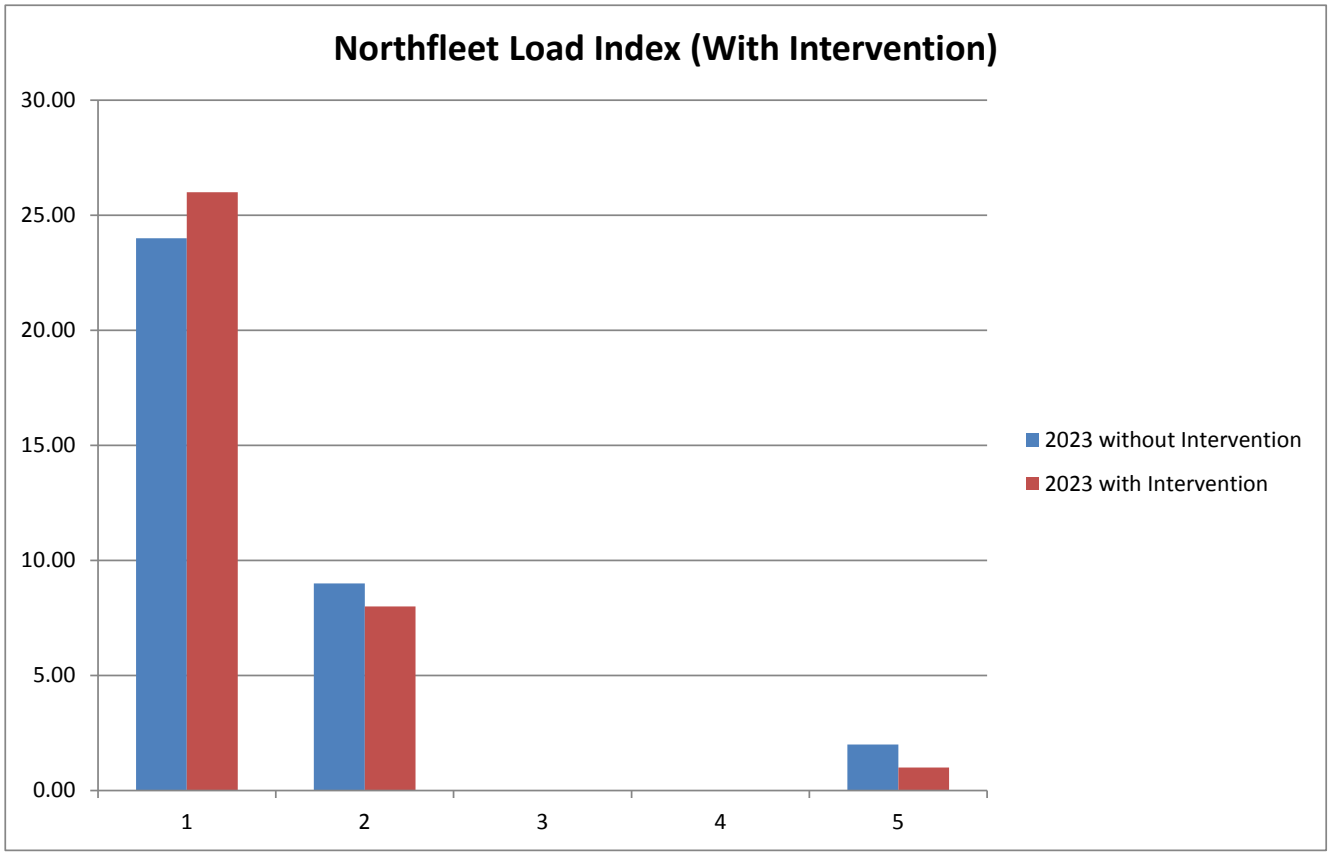
Table 18. Load Indices Post Intervention (Assumes LRR only)

LI Profile (With Intervention)

Substation	Voltage kV	Load Index 2015	Load Index 2023
Northfleet East 132/33kV	33	1	1
Crossways 33/11kV	11	1	1
Stone Marshes 33/11kV	11	2	1
Longfield 33/11kV	11	1	1
Ebbsfleet 33/11kV	11	1	1
Rosherville 33/6.6kV	6.6	1	1
Gravesend South 33/11kV	11	1	2
Gravesend Town 33/6.6kV	6.6	4	1
Gravesend West 33/11kV	11	2	2
Grain 33/11kV	11	1	1
Sharnal Street 33/11kV	11		
Burham 132/33kV	33	1	1
Aylesford 33/6.6kV	6.6	2	2
Chelsfield Grid 132/33kV	33	2	2
Farningham 33/11kV	11	1	1
South Orpington 33/11kV	11	2	2
Oxted 33/11kV	11	1	1
Sundridge 33/11kV	11	5	5
North Sevenoaks 33/11kV	11	1	1
Swanley 33/11kV	11	1	2
Tunbridge Wells Grid 132/33kV	33	1	1
Tonbridge Town 33/6.6kV	6.6	1	1
Penhurst 33/11kV	11	1	1
Rusthall 33/11kV	11	1	1
Tunbridge Wells Grid 132/11kV			
Tunbridge Wells Grid 11kV	11	2	2
Tunbridge Wells Town 11kV	11	1	1
Tunbridge Wells Town 6.6kV	6.6	1	1
Dormansland Grid 132/33kV	33	1	1
Crowhurst 33/11kV	11	1	1
Four Elms 33/11kV	11	1	1
Edenbridge 33/11kV	11	1	1
East Grinstead 33/11kV	11	1	1
Pembury Grid 132/33kV	33	1	1
Tonbridge East 33/6.6kV	6.6	1	1
Mereworth 33/11kV	11	2	2
Paddock Wood 33/11kV	11	1	1

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

Forecast Load Indices Post Intervention



5 Alternatives considered

5.1 Ebbsfleet: New Primary Substation

Initial discussions have been held with Consulting Engineers working on behalf of the Paramount Pictures Theme Park and although there has been considerable local publicity the magnitude of the new demand and timescales are unknown. This area is also within the Thames Gateway development zone which is driven by local economic factors rather than a centralised master plan.

Due to the combined uncertainties of magnitude of demand, timescales and location no NAMP provision has been made to construct a new primary substation. If a substation is required it is expected that it would be substantially customer funded in accordance with the connection charging policy. Should an application be made, UK Power Networks are likely to be required to fund a proportion of the total costs based on the percentage of unused capacity which could be offset by the reduced need to reinforce other substations within the area.

6 References

References	Description
Reference 1	Planning Load Estimates SPN 2011 – 2023 (issued 20 August 2012) Oxera
Reference 2	SPN 132kV System Diagram East
Reference 3	SPN LTDS Network Schematics
Reference 4	Baseline NAMP: 6th January 2013
Reference 5	Asset Strategy & Performance: Asset Replacement Report December 2012
Reference 6	Gravesham Local Plan Core Strategy December 2012
Reference 7	Tonbridge & Malling Local development Framework
Reference 8	Thames Gateway Regional Planning Framework
Reference 9	Tunbridge Wells Borough Council LDF & Core strategy

6.1 Appendices

Appendix	Description
Appendix A	Northfleet GSP: Aerial Photograph
Appendix B	Long Term Development Statement Single Line Diagram – Existing Network
Appendix C	132kV Single Line Diagram – Northfleet to Burham
Appendix D	132kV Single Line Diagram – Northfleet to Tunbridge Wells

6.2 Document History

Version	Date of Issue	Author	Details
1.0	December 2012	URS	First Draft
1.1-1.3	Jan-April 2013	Chris Winch	Updated and issued for review
1.4	31st May 2013	Chris Winch	Final
1.5	23rd June 2013	Zivanayi Musanhi & Tendai Matiringe	Updated with latest frozen NAMP of 5th June 2013
2.0	13th March 2014	Sam Martin	Updated with latest frozen NAMP 12th February
3.0	21st March 2014	Sam Martin	Changed text in Section 2.4 and Section 4.2
3.1	25/03/2014	Sam Martin	Updated and issued for review

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

7 Document sign off

Recommended by:

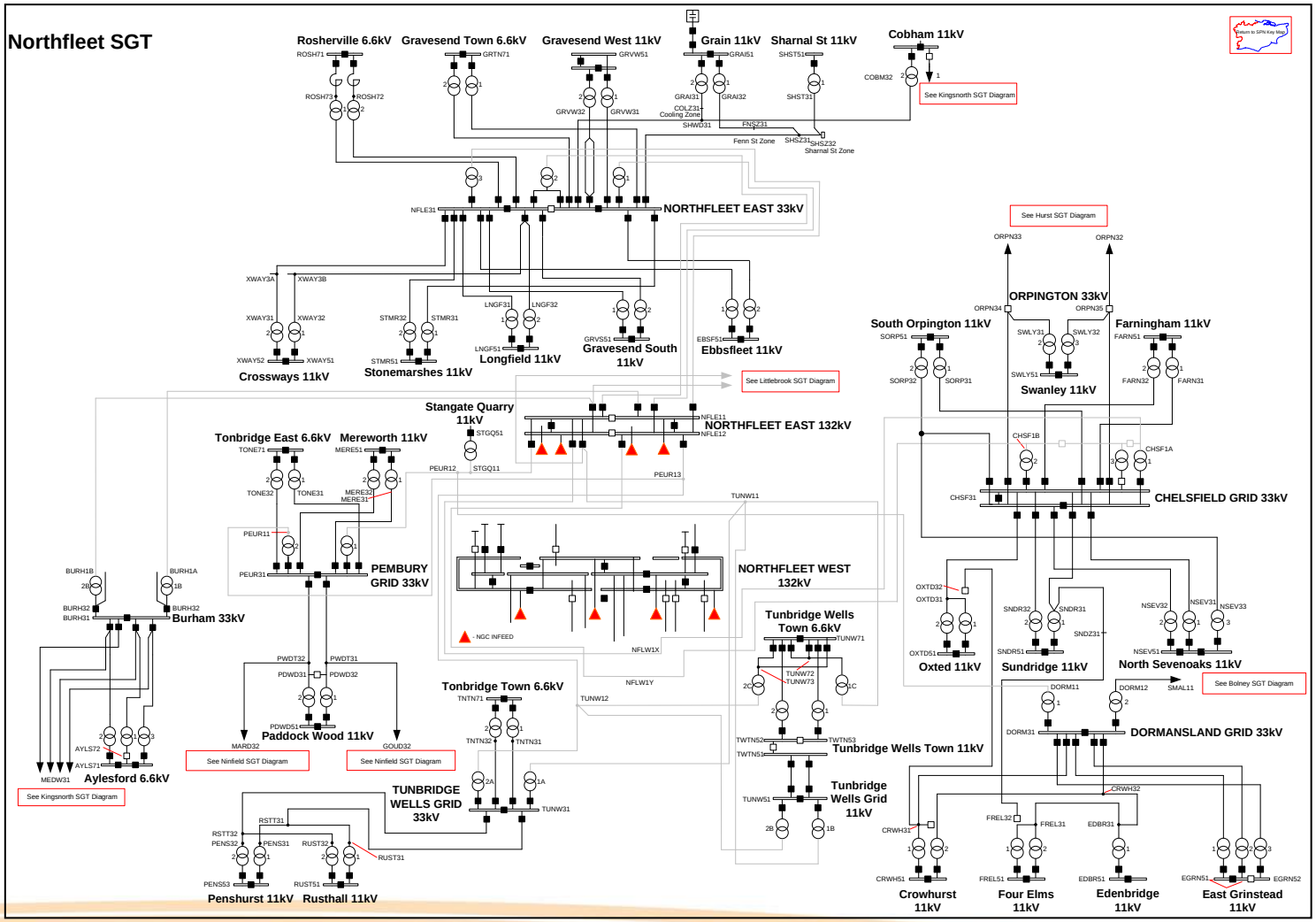
Name	Role	Signature	Date
Chris Winch	Infrastructure Planning Manager – SPN/LPN		
Tendai Matiringe	IDP Coordinator SPN		

Approval by:

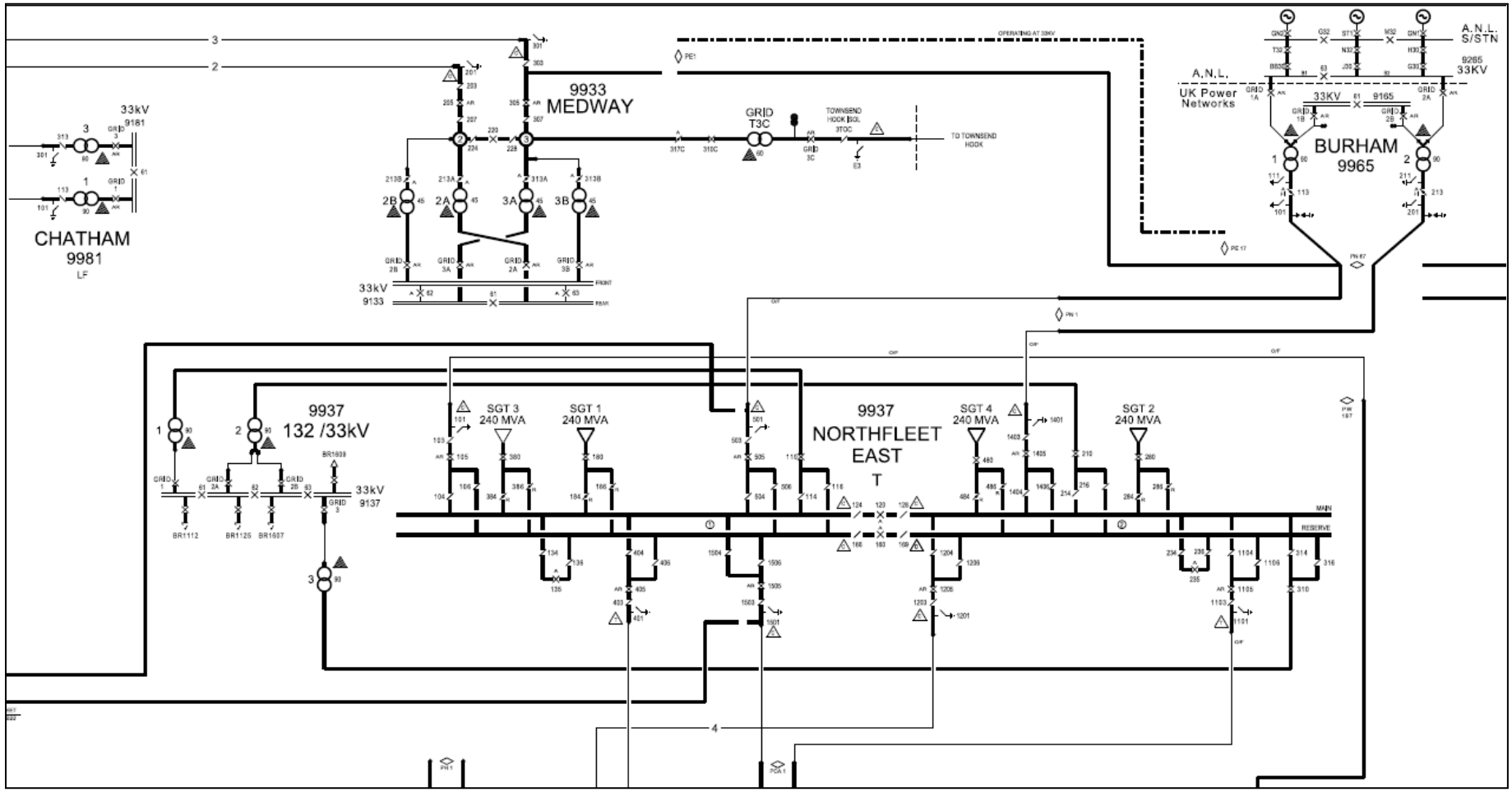
Name	Role	Signature	Date
Robert Kemp	Head of System Development	Robert Kemp	
Barry Hatton	Director of Asset Management	Barry Hatton	

APPENDIX A: NORTHFLEET GRID SUPPLY POINT AERIAL

APPENDIX B: SINGLE LINE DIAGRAM (SLD) – EXISTING NETWORK



APPENDIX C: SLD – EXISTING 132KV NETWORK NORTHFLEET - BURHAM



APPENDIX D: SLD - EXISTING 132KV NETWORK NORTHFLEET – TUNBRIDGE WELLS