

# Regional Development Plan



Dartford



**Title: Dartford**

**LPN Regional Development Plan**

Version: 2.4

Date: March 2014

Dartford

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

Document History

Version	Date	Revision Class	Originator	Section Update	Details
1	June 2013		Sharon Green		First Submission
2.0	20/02/14	Major	M. Jones	Executive summary	Updated costs according to 12 <sup>th</sup> Feb NAMP
		Major	M. Jones	2.3 Projects in Progress	Updated costs according to 12 <sup>th</sup> Feb NAMP
		Major	M. Jones	4.3 Summary of Proposed Interventions	Updated costs according to 12 <sup>th</sup> Feb NAMP
2.1	12/03/2014	Minor	Sharon Green	Contents	Updated table of contents
2.1	12/03/2014	Minor	Sharon Green	1 Executive Summary	Revised and edited the text/content/wording
2.1	12/03/2014	Major	Sharon Green	1 Executive Summary	Updated NAMP summary table
2.1	12/03/2014	Major	Sharon Green	2.3 Projects in Progress	Edited & updated list and description of ongoing schemes and NAMP costs summary table
2.1	12/03/2014	Minor	Sharon Green	3.3 Security of Supply Analysis	Updated P2/6 assessment and LI Table pre-intervention
2.1	12/03/2014	Major	Sharon Green	4.2 Reinforcement	Updated list and description of proposed schemes
2.1	12/03/2014	Major	Sharon Green	4.3 Costs and Phasing	Updated NAMP summary table
2.1	12/03/2014	Major	Sharon Green	4.4 HI / LI Improvement	Updated LI tables post-intervention
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2.4	27/03/2014	Minor	Regulation	All	Final publication

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**1 Executive Summary**

This development plan reviews the LPN EHV network supplied by Littlebrook 132kV Grid Supply Point (GSP). The aggregated group peak demand is 155MW and 108MW for winter and summer respectively, although this includes load on some SPN substations fed from the Littlebrook 132kV GSP (approximately 20MW).

The Dartford Grid network is expected to see little load growth during the ED1 period and as such no major reinforcement schemes are planned. The purchase of an existing 132/11kV substation known as Wellcome Foundation will enable load transfers from Dartford Grid B, which will provide some mitigation against a high impact low probability (HILP) event on the 132kV circuits crossing the Darenth River. The purchase and transfers to the substation are expected to complete in DPCR5.

All other projects planned in the area are asset condition driven.

**ED1 Proposed Projects >£1M**

Reinforcement Schemes

No reinforcement projects in excess of £1m are planned during ED1.

Asset Replacement Schemes

- Dartford Grid B – Replace Transformer GT1B £1.6m
- Dartford Grid A – Replace Transformers T1A, T2A, T3A & T4A £7.6m

**Costs profile**

NAMP Table J less Indirect 19<sup>th</sup> February 2014

Cat.	Reference	Description	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
A & H		Total Asset Replacement	1,107,676	93,308	0	78,060	3,191,419	3,136,274	3,043,788	115,952	0	0
R		Total Reinforcement	2,893,475	2,000,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000
		Grand Total	4,001,152	2,093,308	3,500,000	3,578,060	6,691,419	6,636,274	6,543,788	3,615,952	3,500,000	3,500,000

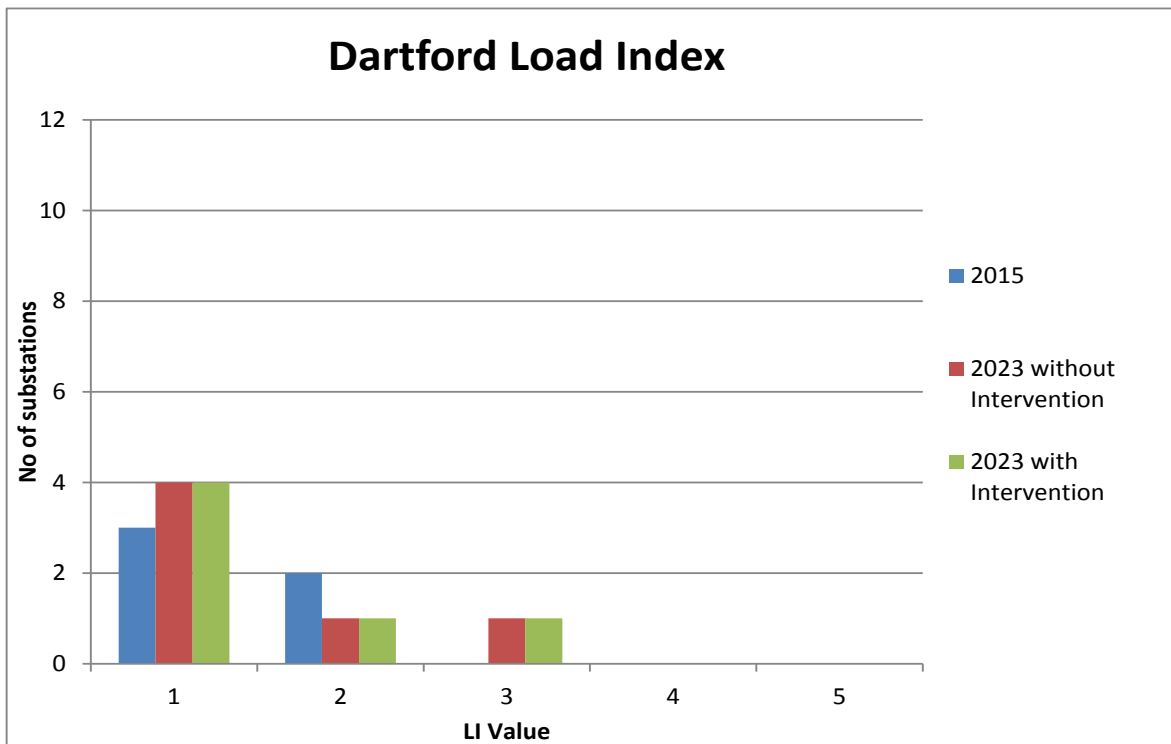
Table 1. Total Project Expenditure

**Dartford**

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**Output Measures**

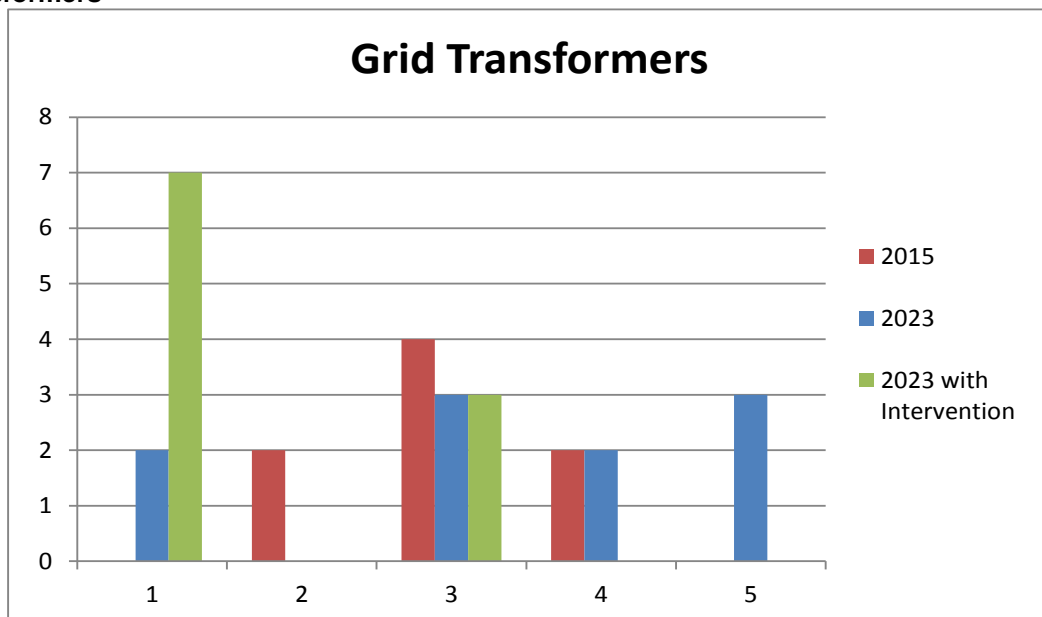
Load Index of substations within the Dartford Grid network.



Graph 1. Load Index With and Without Investment

Health of Assets within the Dartford Grid network.

**Grid Transformers**

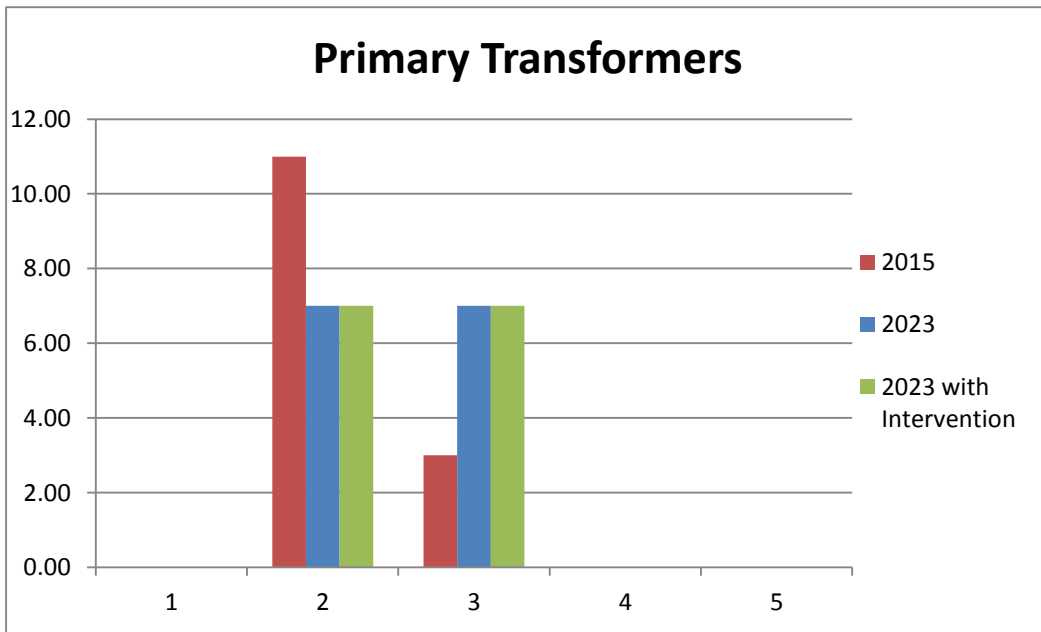


Graph 2. Grid Transformers With and Without Intervention

**Dartford**

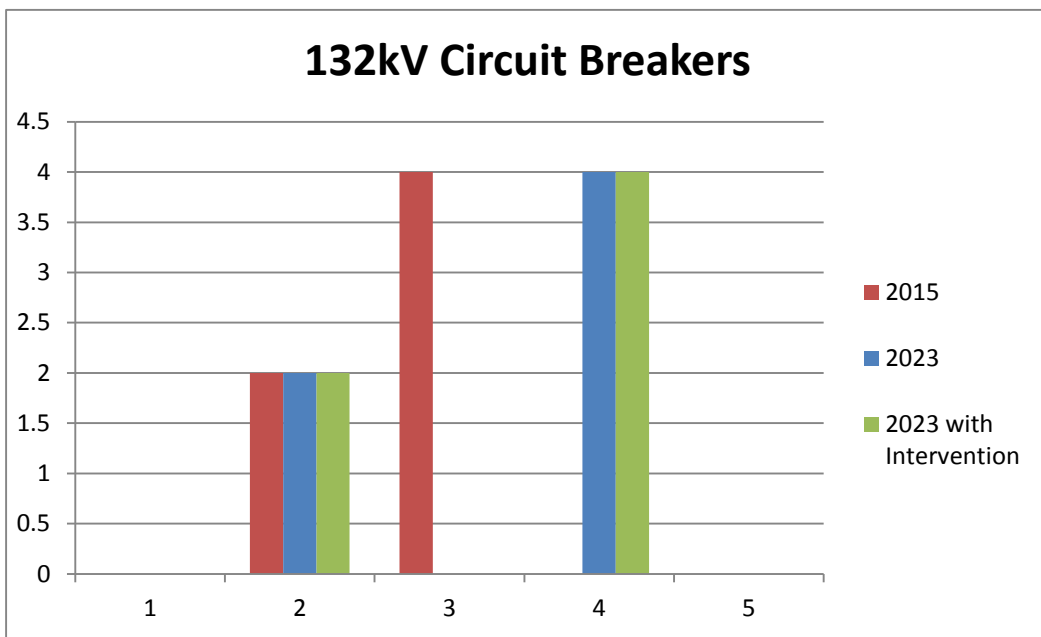
All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

**Primary Transformers**



Graph 3. Primary Transformers With and Without Intervention

**132&66kV Switchgear**

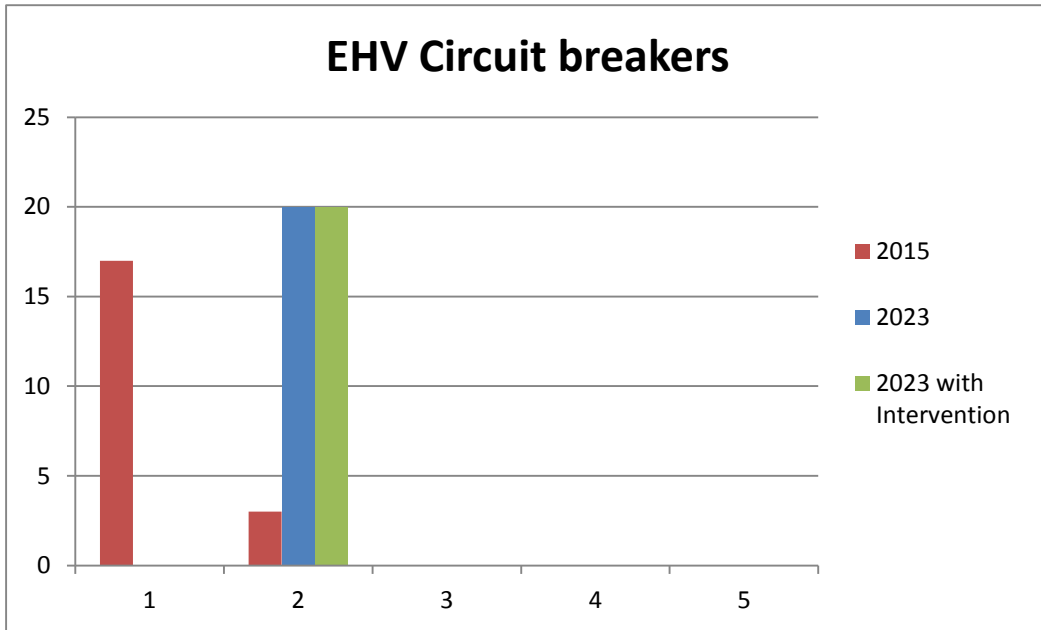


Graph 4. 132&66kV Switchgear With and Without Intervention

**Dartford**

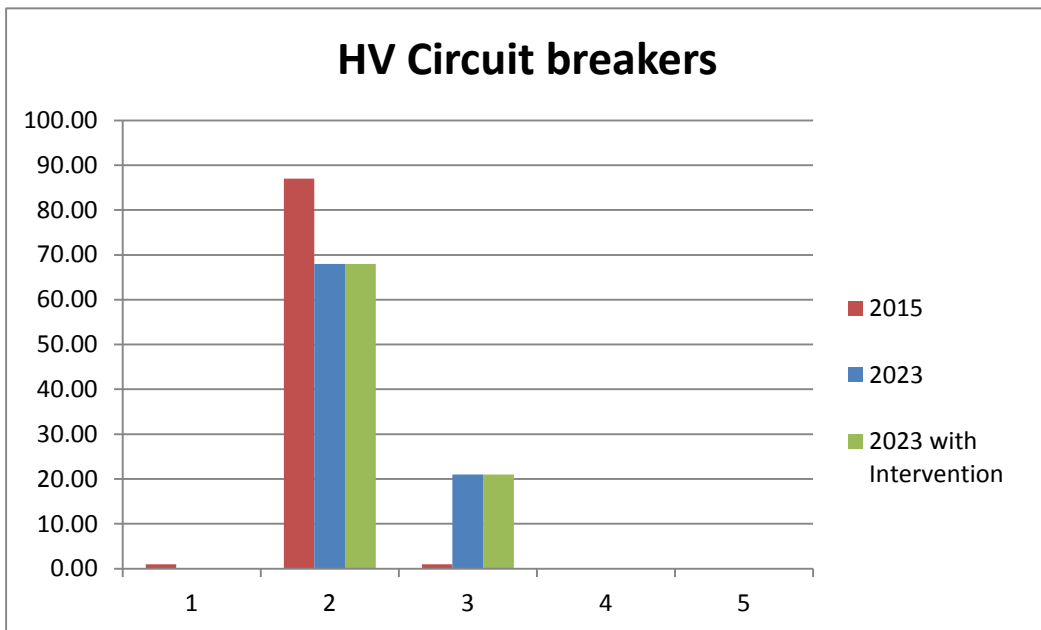
All of the cost numbers displayed in this document are before the application of on-going efficiencies and real price effects.

**E.H.V. Switchgear**



Graph 5. EHV Switchgear With and Without Intervention

**H.V. Switchgear**

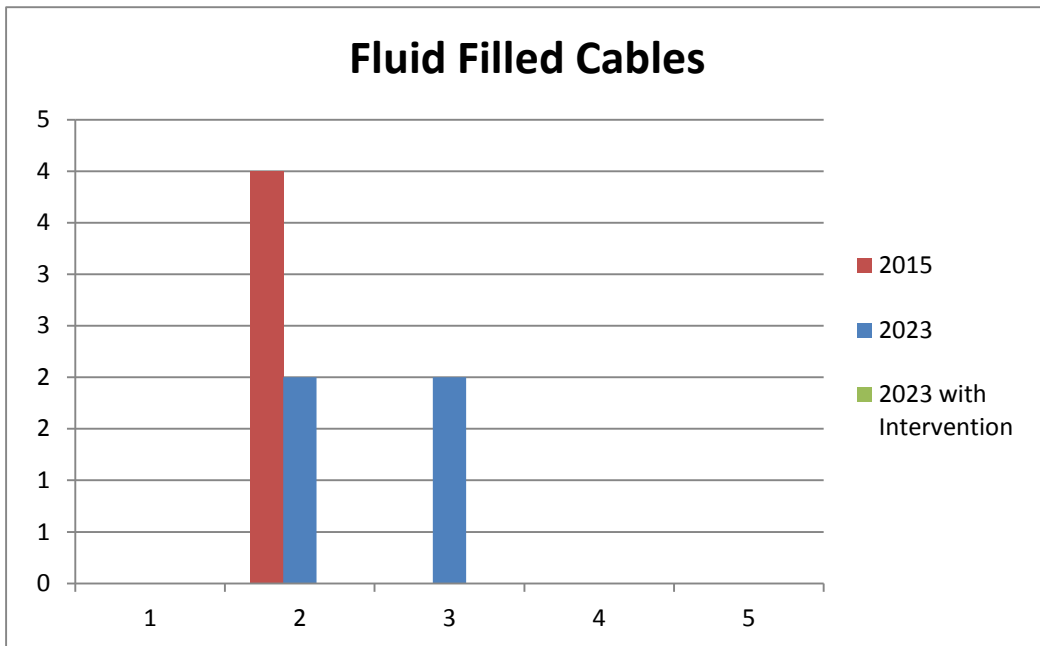


Graph 6. HV Switchgear With and Without Intervention

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Fluid Filled Cables



Graph 7. Fluid Filled Cables With and Without Intervention

**Scenario Considered**

The Scenario considered is based on the LPN Planning Load Estimates of February 2013 using Element Energy Load Growth assessment and the Asset Risk Prioritisation model of July 2013.

**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**

This development plan reviews the LPN EHV network supplied by Littlebrook 132kV grid supply point which comprises: 3 x 400/132kV 240MVA super grid transformers (SGT’s). The aggregated group peak demand is 155MW and 108MW for winter and summer respectively.

Dartford Grid 132kV is supplied from Littlebrook 132kV GIS. The 132kV circuits consist of underground cable and a section of overhead line. Dartford Grid 132kV consists of 4 tee points which feed 2 grid substations and 3 primary substations.

**Dartford Grid B 11kV**

Dartford Grid B 11kV is a 132/11kV 4x15MVA substation. The 11kV switchboard is a single busbar switchboard with 28 panels.

**Dartford Grid A 33kV**

Dartford Grid A 33kV is supplied by 4 x 45MVA 132/33kV transformers. It is located on the same site as Dartford Grid B 11kV.

**Broadway**

Broadway is a standard LPN 4 x 15MVA 33/11kV substation. Load growth on the local network is limited by small section cables on the first legs out of the MSS.

**Crayford**

Crayford is a 4 x 15MVA 33/11kV substation with a 26 panel 11kV switchboard.

**Erith**

Erith is supplied via 3 x 12MVA auto transformers from Dartford Grid A 33. The site consists of 3 x 15MVA 22/11kV transformers and an 11 panel single busbar switchboard.

See Appendix A for Geographical Map and Appendix B for Single Line Diagram.

**2.2 Embedded Generation**

In accordance with ER P2/6 distributed generation can be off set against substation capacity if the aggregated capacity (excluding Diesel and PV) exceeds 5% of the connected load. Table 3 details the generating plants used in the analysis for the Dartford Grid Network.

**Embedded Generation**

Generation Plants	Type	DNC (MVA)	F (%)	pf	DG Output = F*DNC		
					MVA	MW	MVA <sub>r</sub>
Erith Oil Works	CHP	18.5MVA	0	0.98	5.1	5.0	1.01

Table 2. Output of generating plants on this network

## Dartford

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## 2.3 Projects in progress

NAMP table J (less indirect costs) 19<sup>th</sup> February 2014.

Cat.	Reference	Description	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
A	1.48.01.2601	Littlebrook 132kV Circuit Breaker Replacement LPN (NG*)	371,445	93,308	0	0	0	0	0	0	0	0
A	1.50.01.8202	Retrofit of 11kV Circuit Breakers at Broadway	726,231	0	0	0	0	0	0	0	0	0
A	1.26.01.3571	Littlebrook - Dartford Grid - 132kV Protection Replacement	10,000	0	0	0	0	0	0	0	0	0
R	1.34.01.5031	Various Locations: 11kV Reconfiguration/Reinforcement - LPN (Non-Named Schemes)	1,500,000	2,000,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000
R	1.35.07.7936	Wellcome Foundation: Purchase Existing Substation	1,393,475	0	0	0	0	0	0	0	0	0

Table 3. Extract from Network Asset Management Plan 19<sup>th</sup> February 2014

### 1.48.01.2601: Littlebrook 132kV Circuit Breaker Replacement (LPN)

This scheme provides for the asset replacement of the 4 LPN 132kV circuit breakers at Littlebrook. The work is to be carried out in conjunction with the asset replacement of the SPN and National Grid circuit breakers at this shared supergrid exit substation.

The project is expected to be completed in 2015.

### 1.50.01.8202 Retrofit of 11kV Circuit Breakers at Broadway

This scheme provides for the retrofit of 28 x AEI QF circuits breakers at Broadway MSS. The scheme is expected to be completed by 2015.

### 1.26.01.3571 Dartford 132kV Protection Replacement

This scheme provides for the installation of fibre optic pilots and replacement protection relays on the Littlebrook-Wellcome-Dartford teed circuits. The circuits are currently protected by slow unit protection with obsolete split pilot and CF11 relays which exceed the 120ms operating requirement for feeder circuits.

The work is to be coordinated with the asset replacement of the associated 132kV switchgear at Littlebrook and is expected to be completed in 2015.

### 1.35.07.7936 Wellcome Foundation – Purchase Existing Substation

The Wellcome Foundation substation is a customer owned and operated 132/11kV site in Dartford. As the site is being demolished and the substation no longer required, GSK have approached UKPN for a possible purchase of the land, building and equipment. The acquisition will provide some mitigation in the event should a High Impact Low Probability (HILP) event occur on the EHV cable bridge as it will allow the permanent transfer of load to the new site, reducing the CI and CML impact of such an event (see scheme below).

The scheme includes costs for the civil works required to bring the substation up to acceptable standards.

Negotiations are on-going and are expected to be completed successfully by 2014.

### 1.34.01.5031 Various Schemes: 11kV Reconfiguration – Non named schemes

Following the acquisition and upgrade to required standards of the new Wellcome Foundation primary substation, a permanent load transfer from Dartford Grid B 11kV to Wellcome Foundation can be completed. This load transfer will be achieved through the 11kV network. 11kV feeders from the North East group of Dartford Grid B can be jointed onto the new feeders. In addition, the DH feeders (supplying Dartford Hospital) can be transferred to the Wellcome Foundation substation.

This load transfer will reduce the load at Dartford Grid B 11kV. Over the ED1 period, the load index for the site would rise to LI3 if this load transfer were not carried out.

As well as relieving the high loading of Dartford Grid B 11kV, the permanent load transfer will also help to reduce the impact of a fault on the Littlebrook 132kV to Dartford Grid 132kV circuits.

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### 3 Network Development Considerations

#### 3.1 Development areas

##### Northern Gateway, Dartford

The Northern Gateway project is a mixed residential and commercial development located just north of Dartford Grid substation.

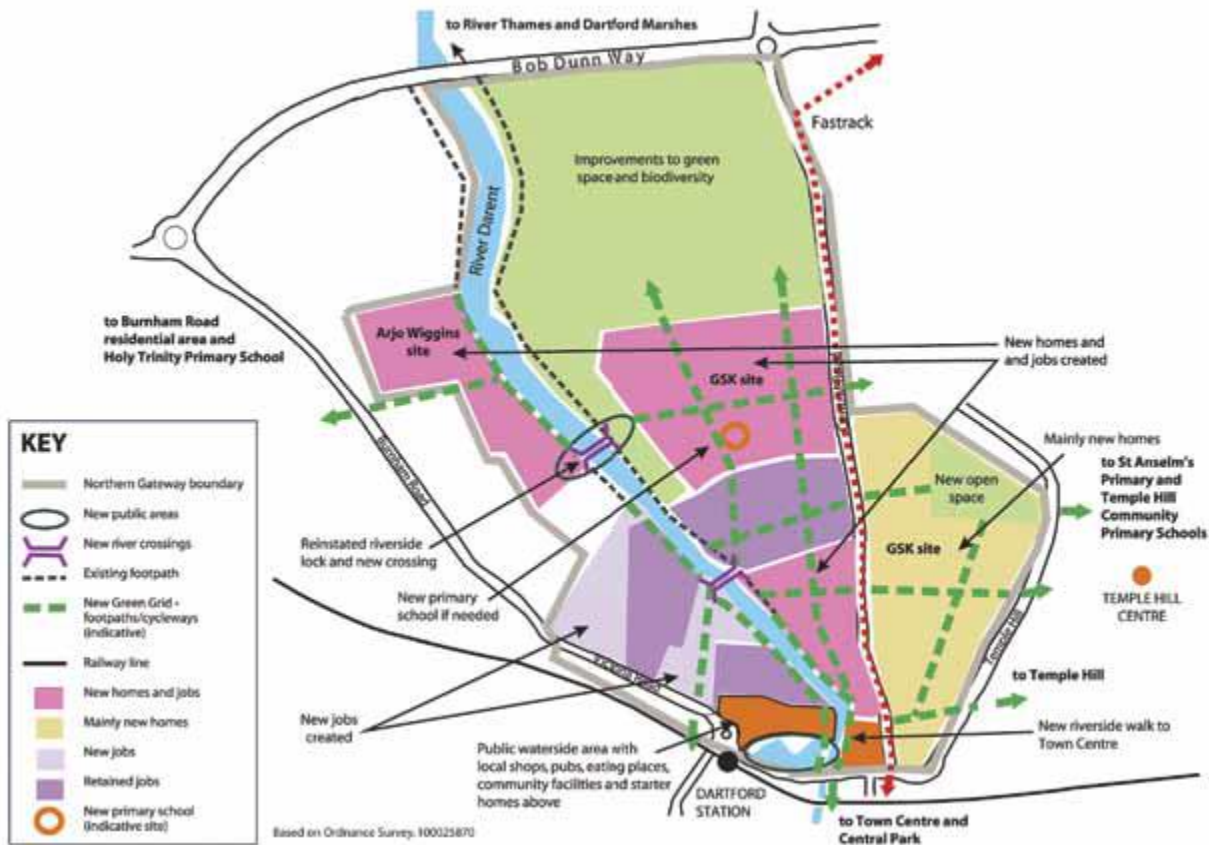


Figure 1. Northern Gateway Development

Negotiations are currently on-going to purchase the existing 132/11kV substation, known as Wellcome Foundation, located on the ex Glaxo Smith Kline site. This substation would meet the new load demand forecast in this area.

Dartford

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3.2 Asset Health

The Asset Replacement programme has been developed using outputs from the Asset Risk Prioritisation (A.R.P.) model, version July 2013. The forecast HI figures for all asset groups **without investment** are shown in the following tables for years 2015 and 2023.

It should be noted that HIs presented in the RDP will not align with the RIGS. The HI's presented in the RDP are the outcome of our ARP models on an asset by asset basis. Different rules are applied for RIGs reporting, as agreed with Ofgem, where assets may be grouped and all assets in the group take the same HI.

The 2015 HI figures include any projects that are currently in progress (see section 2.3 for details) and are due to be completed by the end of DPCR5.

HV Circuit Breakers

SUBSTATION NAME	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
BROADWAY		28					28			
CRAYFORD		23	1				3	21		
DARTFORD GRID B 11KV		26					26			
ERITH 11KV	1	10					11			

Table 4. Health Indices of HV Circuit Breakers

EHV Circuit Breakers

SUBSTATION NAME	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
DARTFORD GRID A 33KV	17	3					20			

Table 5. Health Indices of EHV Circuit Breakers

66 and 132kV Circuit Breakers

SUBSTATION NAME	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
LITTLEBROOK 132KV			4						4	
WELLCOME FOUNDATION 132KV		2					2			

Table 6. Health Indices of 132 and 66kV Circuit Breakers

Primary Transformers

SUBSTATION NAME	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
BROADWAY		4					2	2		
ERITH 11KV		3					1	2		
CRAYFORD		4					4			
DARTFORD GRID A 33KV			3					3		

Table 7. Health Indices of Primary Transformers

**Dartford**

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**Grid Transformers**

SUBSTATION NAME	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
DARTFORD GRID B 11KV		2	1	1				3		1
DARTFORD GRID A 33KV			3	1					2	2

Table 8. Health Indices of Grid Transformers

**Fluid Filled Circuit Sections**

SUBSTATION NAME	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
LITTLEBROOK 132KV-DARTFORD GD 33KV			4				2	2		

Table 9. Health Indices of Fluid Filled Circuit Sections

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3.3 Security of supply and Load Index analysis

Table 10 shows the forecast load growth on the LPN Littlebrook Substations. Highlighted in orange are any loads that exceed the substation firm capacity plus any post fault transfer capability.

Sub-station	P2/6	Type of substation	Secondary Voltage	Firm Capacity (MW)	Transfer (MW)	P. F.	Winter 12/13 Summer 2012 (M W)	Winter 13/14 Summer 2013 (M W)	Winter 14/15 Summer 2014 (M W)	Winter 15/16 Summer 2015 (M W)	Winter 16/17 Summer 2016 (M W)	Winter 17/18 Summer 2017 (M W)	Winter 18/19 Summer 2018 (M W)	Winter 19/20 Summer 2019 (M W)	Winter 20/21 Summer 2020 (M W)	Winter 21/22 Summer 2021 (M W)	Winter 22/23 Summer 2022 (M W)
Broadway	YES		11kV	57.33	1.29	0.98	48.91	49.24	49.80	50.41	50.92	51.50	52.09	52.70	53.33	54.15	54.99
Broadway	YES		11kV	42.30	1.29	0.94	32.62	32.83	33.19	33.58	33.91	34.29	34.67	35.06	35.47	36.00	36.54
Crayford	YES		11kV	56.75		0.97	3126	3151	3193	3239	3277	3321	3365	3410	3456	3517	3579
Crayford	YES		11kV	42.75		0.95	2188	2205	2233	2264	2290	2319	2349	2379	2410	2451	2493
Dartford B	YES		11kV	56.16		0.96	4114	4162	4242	4327	4397	4476	4558	4640	4724	4834	4946
Dartford B	YES		11kV	42.30		0.94	3187	3223	3283	3346	3399	3459	3519	3581	3644	3727	3811
Dartford Grid 33kV	YES		33kV	166.73		0.95	13.95	14.67	16.02	17.48	18.71	19.90	21.13	22.39	23.69	25.48	27.31
Dartford Grid 33kV	YES		33kV	130.95		0.97	85.24	85.76	86.73	87.78	88.67	89.50	90.37	91.26	92.17	93.43	94.73
Erith	YES		11kV	26.44	5.28	0.98	18.09	18.20	18.38	18.56	18.71	18.87	19.05	19.22	19.40	19.61	19.83
Erith	YES		11kV	23.03	4.60	0.93	18.18	18.30	18.47	18.65	18.79	18.96	19.13	19.30	19.47	19.68	19.89
LittleBrook 132kV	YES		132kV	553.00		0.96	63.96	65.12	67.20	69.45	71.33	73.26	75.24	77.26	79.33	82.14	85.01
LittleBrook 132kV	YES		132kV	488.40		0.96	10.30	11.12	12.60	14.18	15.52	16.86	18.25	19.66	21.12	23.08	25.09
Wellcome Foundation	YES	Customer		37.44		0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wellcome Foundation	YES	Customer		27.60		0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 10. P2/6 Assessment Table Dartford Grid

Dartford Grid 132kV and its downstream network remains compliant with Engineering Recommendation P2/6 throughout the ED1 period, based on load growth rates forecast in the Planning Load Estimates February 2013.

Substation	Voltage kV	Load Index	
		2015	2023
<b>LittleBrook 132kV</b>			
Broadway	33/11	2.00	3.00
Crayford	33/11	1.00	1.00
Dartford B	132/11	1.00	1.00
Dartford Grid 33kV	132/33	1.00	1.00
Erith	22/11	2.00	2.00
Wellcome Foundation	132/11	#N/A	1.00

Table 11. Load Indices without Investment

The Load Indices have been calculated taking into account planned load transfers. These are not viewed as reinforcement.

## **Dartford**

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### **3.4 Operational and technical restrictions**

#### **22kV Auto-transformers**

Three auto-transformers at Dartford Grid are used to supply Erith at 22kV. The auto-transformers are rated at 12MVA and limit the firm capacity of Erith 11kV.

#### **Dartford Grid – Erith 22kV circuits**

The cables are solid paper insulated cables installed in 1925. These circuit ratings are matched to the auto-transformers at Dartford Grid and therefore also limit the Erith firm capacity. The cyclic rating of the circuits are 13MVA in winter and 12MVA in summer.

#### **Littlebrook 132kV – Dartford 132kV Pinch Point**

The four circuits from Littlebrook 132 to Dartford 132 tee point all cross the River Darent on cable bridge 0060.

Locations where an incident can cause complete or partial loss of a substation (such as cable bridges, cable tunnels or railway crossings) have been identified.

The following is a list of such cable bridges on the Dartford network:

#### **Dartford - Broadway**

Cable Bridge 0047  
Thames Road over River Cray  
TQ5274875302  
Voltage 33kV

#### **Dartford - Crayford**

Cable Bridge 0059  
Thames Road over River Cray  
TQ5274875302  
Voltage 33kV

#### **Littlebrook - Dartford**

Cable Bridge 0060  
Priory Road over River Darent  
TQ5407274915  
Voltage 132kV

### **3.5 National Grid**

#### **Littlebrook 132kV**

Four 132kV Circuit breakers are to be replaced at the end of DPCR5. The driver for the replacement is asset condition. There are no works planned in ED1 that require coordination with National Grid.

### **3.6 Demand Side Response**

No site has been identified for Demand Side Response.

**Dartford**

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## 4 Recommended strategy

### 4.1 Asset Replacement

#### 4.1.1 Transformers

##### **Dartford Grid B GT1B**

The condition assessment of the 1965 Yorkshire Electric Grid Transformer with Fuller HS tap changer installed at Dartford Grid B 132/11kV Substation 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 1 Grid Transformer replaced with 1 new Grid Transformer.

##### **Dartford Grid A T1A, T2A, T3A & T4A**

Transformers T1A, T2A, T3A & T4A have been identified for asset replacement due to obsolete slow speed tap changers and continued oil leaks. An overall condition score has been derived from dissolved gas analysis (DGA) and furfuraldehyde analysis (FFA) analysis, tapchanger type, oil leaks and consequence of failure.

The transformers will be replaced on a like for like basis.

#### 4.1.2 Overhead Lines

##### **Littlebrook / Dartford 3&4**

The condition assessment of the LITTLEBROOK/DARTFORD 3&4 132kV Tower Line (PJA) 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 the lines are recommended for replacement.

Completion of the project will see 3 km of 132kV Tower Line replaced.

##### **Littlebrook / Dartford 1&2**

The condition assessment of the LITTLEBROOK/DARTFORD 1&2 132kV Tower Line (PWD) 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 the lines are recommended for replacement.

Completion of the project will see 5 km of 132kV Tower Line replaced.

### 4.2 Reinforcement

No reinforcement schemes are planned for the Dartford Grid area in the ED1 period.

### 4.3 Summary of proposed interventions

The following table shows the planned expenditure and phasing for the asset replacement and reinforcement schemes in ED1.



Dartford

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Cat.	Reference	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
A	1.02.03.8198 PJA - Littlebrook - Dartford 3&4 - Conductor Replacement	0	0	0	0	0	0	46,081	77,018	0	0
A	1.02.03.8199 PWD - Littlebrook - Dartford 1&2 - Conductor Replacement	0	0	0	0	66,597	138,567	0	0	0	0
A	1.51.01.4065 Dartford Grid 33kV - Replace Transformers T1A, T2A, T3A and T4A	0	0	0	0	1,600,127	2,997,707	2,997,707	38,934	0	0
A	1.51.01.7859 Dartford Grid B 11kV - Replace Grid Transformer (GT1B)	0	0	0	78,060	1,524,695	0	0	0	0	0

Table 12. Summary of Proposed Interventions

Substation	Driver	Commissioning Year	Scope of works	New Firm capacity
Dartford Grid B	Asset Health	2018	Replace transformer GT1B	No change
Dartford Grid A	Asset Health	2020	Replace transformers T1A, T2A, T3A & T4A	No change
Littlebrook / Dartford 3&4	Asset Health	2020	Replace OHL	No change
Littlebrook / Dartford 1&2	Asset Health	2018	Replace OHL	No change

Table 13. Planned Reinforcement / Replacement Projects

4.4 HI / LI Improvement

A summary of the forecast HI and LI profiles post intervention are detailed below:

HV Circuit Breakers

SUBSTATION NAME	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
BROADWAY		28					28			
CRAYFORD		23	1				3	21		
DARTFORD GRID B 11KV		26					26			
ERITH 11KV	1	10					11			
WELLCOME FOUNDATION 11KV							10			

Table 14. Health Indices of HV Circuit Breakers with Investment

EHV Circuit Breakers

SUBSTATION NAME	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
DARTFORD GRID A 33KV	17	3					20			

Table 15. Health Indices of EHV Circuit Breakers with Investment

132 and 66kV Circuit Breakers

SUBSTATION NAME	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
LITTLEBROOK 132KV			4						4	
WELLCOME FOUNDATION 132KV		2					2			

Table 16. Health Indices of 132 and 66kV Circuit Breakers with Investment

Dartford

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

Primary Transformers

SUBSTATION NAME	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
BROADWAY		4					2	2		
CRAYFORD		4					4			
DARTFORD GRID A 33KV			3					3		
ERITH 11KV		3					1	2		

Table 17. Health Indices of Primary Transformers with Investment

Grid Transformers

SUBSTATION NAME	2015					2023				
	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
DARTFORD GRID A 33KV			3	1		4				
DARTFORD GRID B 11KV		2	1	1		1		3		
WELLCOME FOUNDATION 11KV						2				

Table 18. Health Indices of Grid Transformers with Investment

Substation	Voltage kV	2023 Load Index	
		Without Investment	With Investment
<b>LittleBrook 132kV</b>			
Broadway	33/11	3.00	3.00
Crayford	33/11	1.00	1.00
Dartford B	132/11	1.00	1.00
Dartford Grid 33kV	132/33	1.00	1.00
Erith	22/11	2.00	2.00
Wellcome Foundation	132/11	1.00	1.00

Table 19. Load Indices With and Without Investment

**Dartford**

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

## **5 Alternative Strategies**

### **5.1 Rejected Strategy 1 – Remove Pinch Point of 132kV Littlebrook to Dartford Circuits**

A number of options have been considered at the Darenth River crossing pinch point on the Littlebrook / Dartford 132kV circuits. Some of these are briefly outlined below:

- **Construct Micro Tunnel or utilise SEEDA pedestrian bridge**  
Costs: £2.2m  
This option would require the construction of a micro tunnel across Darenth River, or it may be possible to install circuits on a proposed pedestrian bridge. This would allow UKPN to separate the EHV circuits so that the CI's during a HILP event would be greatly reduced. It would leave in service the FFC and OHL.
- **Construct Micro Tunnels and Remove OHL's & FFC**  
Costs: £18m  
Two micro tunnels would be constructed across Darenth River and in addition, the OHL sections between Littlebrook and Dartford would be undergrounded. FFC sections would be replaced.

Options of retaining some of the OHL sections and some FFC sections were also considered.

These options have been rejected due to the very high cost.

Dartford

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

## 6 References

References	Description
Reference 1	Planning Load Estimates LPN Area 2011 – 2023 (27 February 2013)
Reference 2	Primary Distribution Systems Standard Running Arrangements 2012 Overview Diagrams
Reference 3	NAMP LPN Table J Less Ind 19 <sup>th</sup> February 2014
Reference 4	A.R.P. Model July 2013
Reference 5	Engineering Recommendation P2/6

### 6.1 Appendices

Appendix	Description
Appendix A	Geographical diagram
Appendix B	Single Line Diagram – Existing Network
Appendix C	Single Line Diagram – Recommended Strategy

### 6.2 Document History

Version	Date of Issue	Author	Details
1.0	23 <sup>rd</sup> June 2013	Sharon Green	Draft for review
1.1	23 <sup>rd</sup> June 2013	Sharon Green	Document updated
1.2	25 <sup>th</sup> June 2013	Sharon Green	Comments incorporated
2.0	20 <sup>th</sup> Feb 2014	Martin Jones	Updated costs according to 12th Feb NAMP
2.1	13 <sup>th</sup> March 2014	Sharon Green	Updated costs and projects according to 19 <sup>th</sup> Feb NAMP
2.2	20 <sup>th</sup> March 2014	Sophie Motte	Font and format changed

**Dartford**

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**

Sign-off of this Mandate certifies that the Sponsor has ratified the above and approval is sought to proceed to the development of the necessary PG&C Gate B documentation.

**Recommended by:**

Name	Role	Signature	Date
Sharon Green	Infrastructure Planner		
Sophie Motte	IDP Coordinator (LPN)		
Chris Winch	Planning Manager (South)		

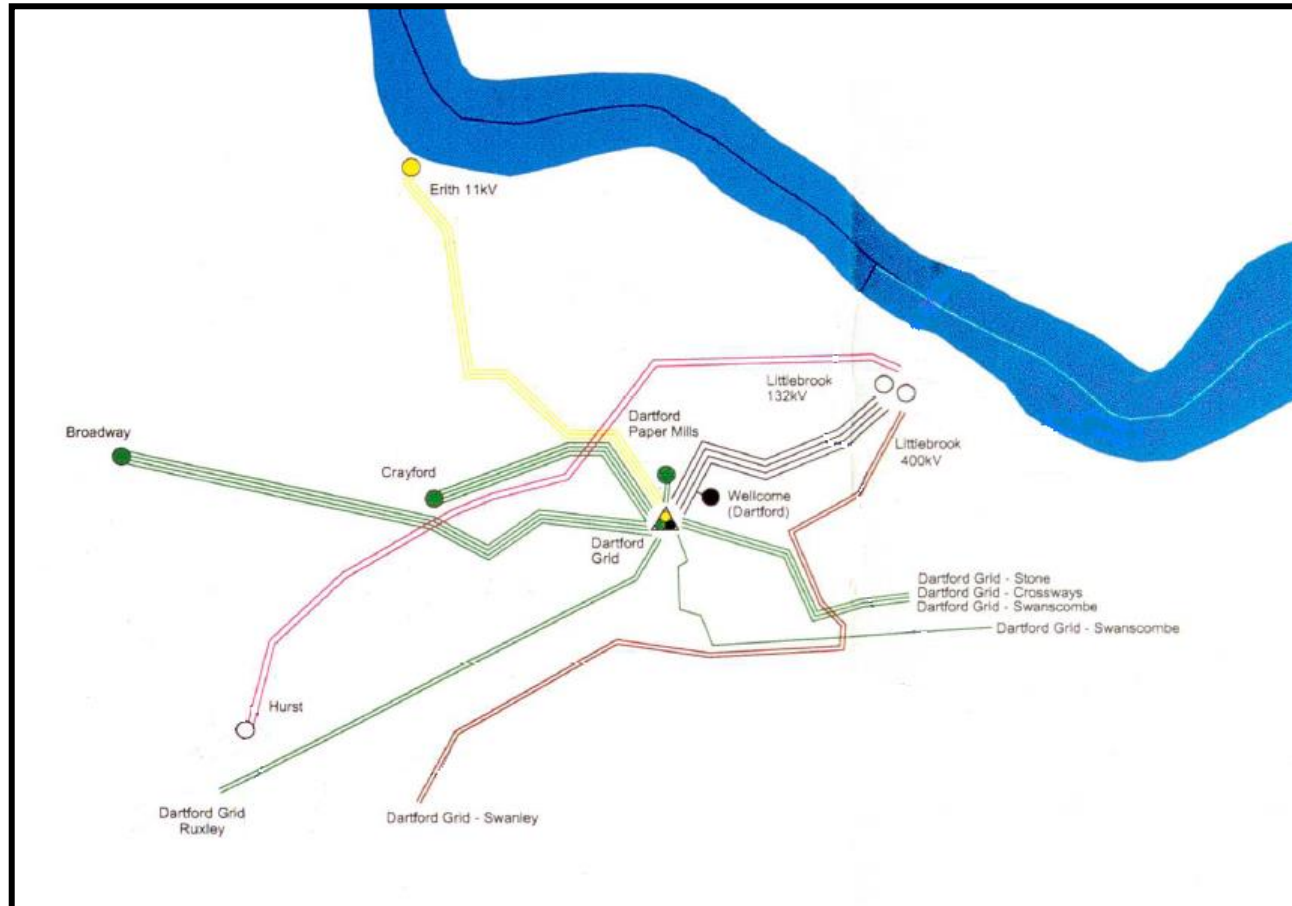
**Approval by:**

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

# Regional Development Plan

## Dartford

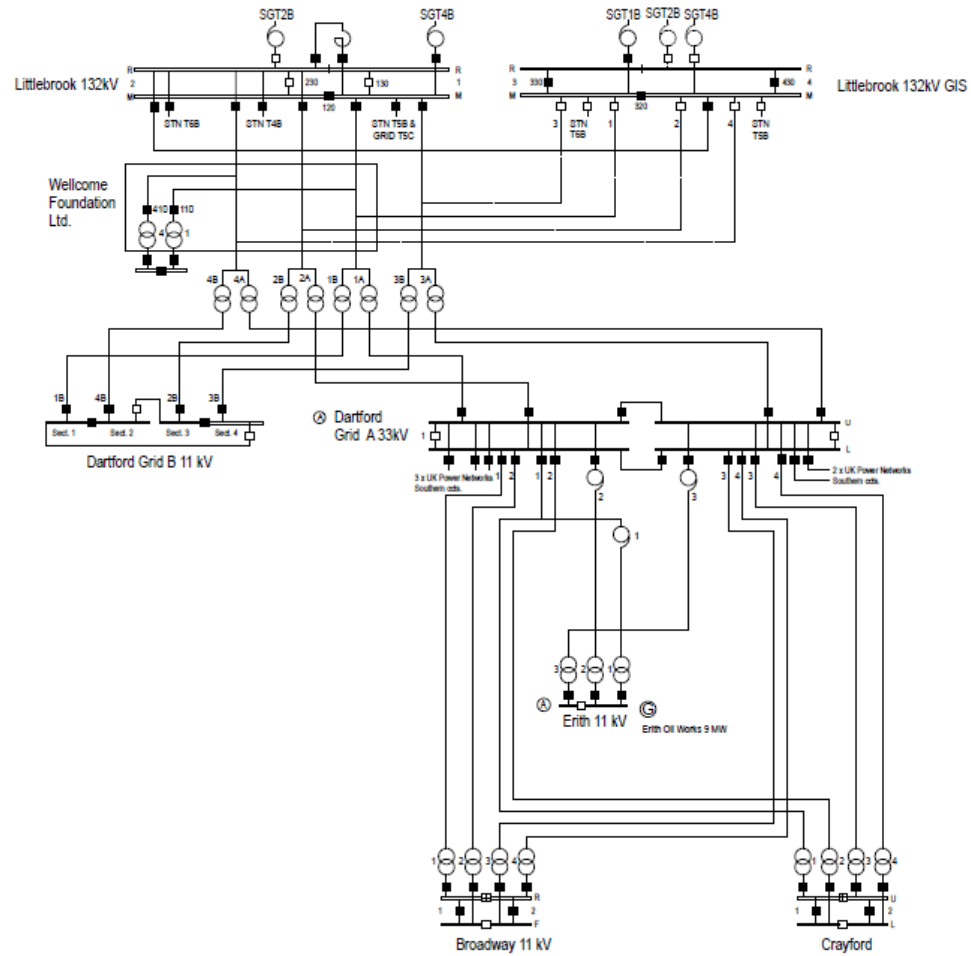
### APPENDIX A: GEOGRAPHICAL DIAGRAM



# Regional Development Plan

## Dartford

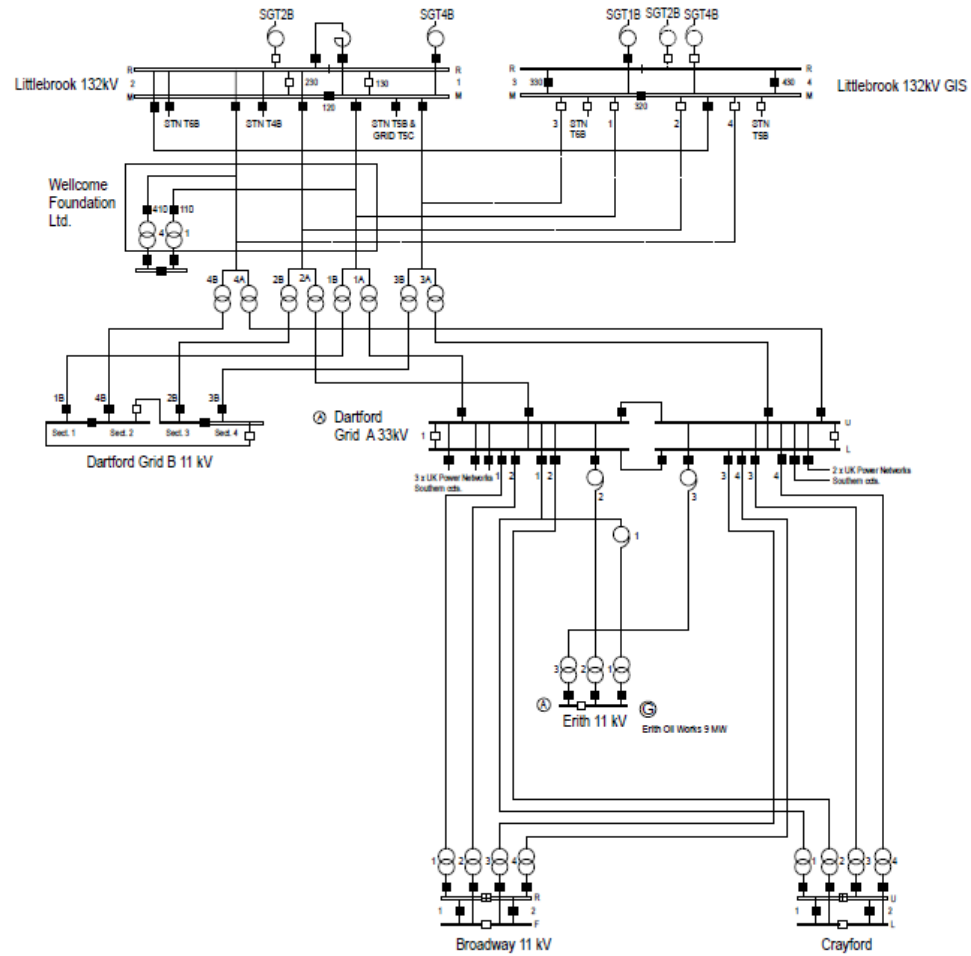
### APPENDIX B: SINGLE LINE DIAGRAM – EXISTING NETWORK



# Regional Development Plan

## Dartford

### APPENDIX C: SINGLE LINE DIAGRAM – RECOMMENDED STRATEGY





# Regional Development Plan



## Dartford

### APPENDIX D: P2/6 ASSESSMENT TABLE

Sub-station	P2/6	Type of substation	Secondary Voltage	Firm Capacity (MW)	Transfer (MW)	P. F.	Winter 12/13 Summer 2012 (M W)	Winter 13/14 Summer 2013 (M W)	Winter 14/15 Summer 2014 (M W)	Winter 15/16 Summer 2015 (M W)	Winter 16/17 Summer 2016 (M W)	Winter 17/18 Summer 2017 (M W)	Winter 18/19 Summer 2018 (M W)	Winter 19/20 Summer 2019 (M W)	Winter 20/21 Summer 2020 (M W)	Winter 21/22 Summer 2021 (M W)	Winter 22/23 Summer 2022 (M W)
Broadway	YES		11kV	57.33	22.74	0.98	48.91	49.24	49.80	50.41	50.92	51.50	52.09	52.70	53.33	54.15	54.99
Broadway	YES		11kV	42.30		0.94	32.62	32.83	33.19	33.58	33.91	34.29	34.67	35.06	35.47	36.00	36.54
Crayford	YES		11kV	56.75		0.97	31.26	31.51	31.93	32.39	32.77	33.21	33.65	34.10	34.56	35.17	35.79
Crayford	YES		11kV	42.75		0.95	21.88	22.05	22.33	22.64	22.90	23.19	23.49	23.79	24.10	24.51	24.93
Dartford B	YES		11kV	56.16		0.96	41.14	41.62	42.42	43.27	43.97	44.76	45.58	46.40	47.24	48.34	49.46
Dartford B	YES		11kV	42.30	10.97	0.94	31.87	32.23	32.83	33.46	33.99	34.59	35.19	35.81	36.44	37.27	38.11
Dartford B 1B & 4B	YES		11kV	28.10		0.96	18.49	18.73	19.12	19.55	19.90	20.30	20.70	21.11	21.53	22.08	22.65
Dartford B 1B & 4B	YES		11kV	21.15		0.94	15.88	16.08	16.41	16.76	17.05	17.37	17.71	18.04	18.39	18.84	19.30
Dartford B 2B & 3B	YES		11kV	28.10		0.96	22.66	22.90	23.29	23.72	24.07	24.47	24.87	25.29	25.71	26.26	26.82
Dartford B 2B & 3B	YES		11kV	21.15		0.94	15.99	16.15	16.42	16.71	16.95	17.21	17.49	17.77	18.05	18.43	18.81
Dartford Grid 33kV	YES		33kV	166.73		0.95	113.95	114.67	116.02	117.48	118.71	119.90	121.13	122.39	123.69	125.48	127.31
Dartford Grid 33kV	YES		33kV	130.95		0.97	85.24	85.76	86.73	87.78	88.67	89.50	90.37	91.26	92.17	93.43	94.73
Erith	YES		11kV	26.44		0.98	18.09	18.20	18.38	18.56	18.71	18.87	19.05	19.22	19.40	19.61	19.83
Erith	YES		11kV	23.03		0.93	18.18	18.30	18.47	18.65	18.79	18.96	19.13	19.30	19.47	19.68	19.89
Wellcome Foundation	YES	Customer		37.44		0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wellcome Foundation	YES	Customer		27.60		0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00