

Title: Lodge Road

LPN Regional Development Plan

Version: 3.2

Date: March 2014



Lodge Road

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 Executive Summary

This development plan reviews the LPN EHV network supplied from Lodge Road 66kV Grid Supply Point (GSP). With the exception of a double circuit interconnection to the adjacent Willesden GSP (via Moscow Road) the network configuration is radial feeders supplying 11 primary substations with 11kV or 6.6kV distribution voltage. The current aggregated group peak demand is currently 420MW and 370MW for winter and summer respectively which is forecast to reduce by 20 MW following demand transfers to the new Islington GSP.

The most significant proposal is the establishment of a new West End substation which is essential to (a) avoid future derogations at three heavily loaded and space constrained central substations (b) provide points of connection for new customers and reinforce existing groups (c) provide load transfer capability for Leicester Square substation. Land availability is a severe constraint and property investigations are initially directed towards an underground development beneath Hyde Park or Berkley Square with the unobtrusive Leicester Square substation identified as the 'case study' to reassure the Royal Parks and the local community. Based on recent experience installing cables to the new Chapel Street substation it is expected that a new deep tunnel will be required offering the opportunity for coordination with the EHV cable asset replacements in the vicinity of Oxford Street and Piccadilly.

Reinforcement schemes are proposed at two primary substations with a phased programme of reinforcement and reconfiguration planned for Moscow Road involving up rating of the associated 6.6kV network to 11kV and replacement of the 22kV transformers with 66/11kV units.

Selective and targeted asset replacement schemes are proposed to maintain the reliability of switchgear, transformers and cables.

ED1 Proposed Projects >£1M

Reinforcement Schemes

•	Carnaby Street 66/11kV Phase 2 - ITC (4x33.3MVA)	£3.7M
•	Lodge Rd-Carnaby Street - Replace 4x66kV circuits	£9.2M
•	Lithos Road 66/11kV - ITC (add 2x15MVA)	£12.2M
•	West End New 66/11kV Substation - (3x33.3MVA)	£29.3M
•	Construct Lodge Rd to West End cable tunnel	£14.6M
•	Upgrade Victoria Gardens and Imperial College 6.6kV networks	£5.3M

Asset Replacement Schemes

٠	Lithos Rd A - Replace 11kV Switchgear	£2.5M
•	Carnaby St – Replace 11kV switchgear	£2.4M
•	Moscow Rd 22kV – Replace primary transformers and 22kV switchgear	£6.5M
•	Bloomfield Place – Replace primary transformer	£1.1M
•	Lodge Rd-Duke St FFC replacement	£2.6M
•	Moscow Rd -Townmead Rd - 66kV Fluid Filled Cable Replacement	£2.6M

Costs profile

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	50,433	1,466,293	5,929,698	3,706,977	1,836,193	2,268,748	1,870,024	1,881,686	0	0
R		Total Reinforcement	902,828	9,021,348	6,396,131	9,622,440	17,255,831	14,473,579	13,351,691	4,137,582	0	0
		Grand Total	953,260	10,487,641	12,325,829	13,329,417	19,092,024	16,742,327	15,221,715	6,019,268	0	0

Lodge Road

UK Power Networ

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Output Measures – Load Index

Lodge Road Load Index 12 10 2015 No of substations 2023 without 6 Intervention 2023 with 4 Intervention 2 0 2 4 5 1 3 LI Value

If no reinforcement were to be undertaken in ED1 then the number of LI4/5 sites would increase significantly, putting the network at greater risk. It can be seen that the number of substations on the network have reduced from 10, this is mainly due to the removal of the majority of the 6.6kV network in the area.

Output Measures - Health Index

The forecast health indices for 2015 and 2023, with and without intervention, for each plant category are detailed below:



10

5

0

1

2

3

4

5

2023 with

Intervention



2

3

4

5

8

6

4

2 0

1

2023

2023 with

Intervention



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Principal Risks, Dependencies and Assumptions

The aggregated Lodge Road peak group demand is forecast to reduce from 430MW to 400MW between 2015 and 2023 due primarily to the transfer of St Pancras to the new Islington GSP (2017). St Pancras is geographically remote from the central West End area and therefore the overall reduction in demand does not reflect a reduction in demand in the West End area and therefore the new West End substation is proposed.

A proposed deep cable tunnel from Lodge Road to the West End offers the opportunity to optimise reinforcement with cable asset replacement to substations south of the elevated Marylebone Road and Oxford Street.

Lodge Road



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2 Network configuration

2.1 Existing Network

This development plan reviews the LPN EHV network supplied by Lodge Road 66kV Grid Supply Point (GSP) which comprises; 4x 180MVA 275/66kV plus 1x 240MVA 400/275kV super grid transformers (SGT's) connected to a 21 panel GIS switchboard commissioned in 2009. The aggregated group peak demand is 420MW and 370MW for winter and summer respectively

Geographical and network diagrams are included in Appendices A and B.

The GSP supplies the following substations:

Lithos Road

The substation is supplied by $4 \ge 66/11$ kV 15MVA transformers. The site is located at the end of a residential road and is constrained by the geographical obstacles of the London Overground line to the north and the Metropolitan and Jubilee tube lines to the south.

Hyde Park A + B

The two Hyde Park substations are within a combined underground substation building located in a residential area close to the Edgware Road. Each substation is fed by 4 x 66/11kV 15MVA transformers. Work is being carried out in DPCR5 to replace GT3A and GT4A due to poor condition.

St Pancras A + B

There are 4 x 66/11kV 30MVA transformers at St Pancras that then feed the two switchboards via 8 x 15MVA reactors. There are existing plans to establish a new St Pancras C site, asset condition led, which will be fed from the new Islington GSP. The load at St Pancras A and B would then be transferred to St Pancras C. Details of this project are included in the North London RDP.

Bloomfield Place

Bloomfield Place is a 4 x 12MVA 66/6.6kV substation. The 6.6kV network is islanded with no post fault transfer capability.

Carnaby St

Carnaby St Substation is fed by 4 x 66/22/11kV 36/13.5/22.5 MVA transformers. The tertiary 22kV windings are now earthed and no longer in service as the 22kV network has been decommissioned. The site has significant load issues and there is a current scheme approved to install 5 feeders between Carnaby St and Duke St to maintain P2/6 compliance.

Moscow Road 22kV

Moscow Road 22kV substation is fed at 66kV from Lodge Road, via 4 x 66/22kV 45MVA transformers. The Moscow Road 66kV tee point is also situated on the site. Moscow Road 22kV in turn feeds the 6.6kV substations detailed below.

Moscow Road 6.6kV

Moscow Road 6.6kV is situated on the same site as Moscow Road 22kV. It is fed by 4 x 22/6.6kV 12MVA transformers. Moscow Road 6.6kV is dependent upon secondary transfers to the soon to be decommissioned Amberley Road 6.6kV substation.

Victoria Gardens 6.6kV

Victoria Gardens is located in the Notting Hill area. It is fed by $4 \times 22/6.6$ kV 12MVA transformers and is equipped with a 28 panel Reyrolle C switchboard.

Lodge Road



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Amberley Road 6.6kV

Amberley Road 6.6kV is due to be decommissioned in 2014. The majority of the demand at this 4 x 22/6.6kV 12MVA substation has already been transferred to the new 11kV substation at Amberley Road fed from St. John's Wood.

Imperial College 6.6kV

Imperial College is a 4 x 22/6.6kV 10MVA substation situated within the college grounds. The majority of the demand is from the University however, it also feeds a number of high profile customers including Harrods.

2.2 Embedded Generation

In accordance with ER P2/6 distributed generation can be offset against substation capacity if the aggregated capacity (excluding Diesel and PV) exceeds 5% of the connected load. Table 1 details the generating plants used in the analysis for the Lodge Road Network.

Table 1. Embedded Generation

Generation Plants	Type	DNC	F	pf	DG Output = F*DNC			
	.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	(MVA)	(%)		MVA	MW	MVAr	
Department for Education & Employment	CHP (Long Term Parallel)	2.122	61	0.96	1.29	1.24	0.36	
Royal Free Hampstead NHS Trust	CHP (Long Term Parallel)	5.413	65	1.00	3.12	3.12	0	
Bloomsbury Heat & Power LTD	CHP (Long Term Parallel)	5.625	61	1.00	3.43	3.43	0	
Unknown – Imperial College	CHP (Long Term Parallel)	0.75	53	1.00	0.4	0.4	0	

2.3 Projects in progress

Table 2. NAMP Table J (less indirect costs) 19th February 2014

C-1	Defense	Description	2012/14	2014/15	2015/16	2016/17	2017/10	2010/10	2010/20	2020/21	2021/22	2022/22
Cal.	Reference	Description	2013/14	2014/15	2015/10	2010/17	2017/18	2010/19	2019/20	2020/21	2021/22	2022/23
А	1.51.03.5826	Hyde Park A: Replace T3A & T4A	236,412	952,380	0	0	0	0	0	0	0	0
R	1.33.03.4350	Carnaby Street: S/S Reinforcement Phase 1	3,025,322	0	0	0	0	0	0	0	0	0
R	1.34.02.4340	Lithos Rd 11kV West Group Reconfiguration	650,000	231,000	0	0	0	0	0	0	0	0
R	1.34.02.4399	Amberley Road 6.6kV: Upgrade SE, SW, NE, NW & Central Groups	102,093	0	0	0	0	0	0	0	0	0
R	1.34.05.5901	Bloomfield Pl Emergency Mitigation Works	105,000	0	0	0	0	0	0	0	0	0
R	1.34.02.4342	Moscow Rd: 6.6kV Load Transfers	300,000	1,124,500	0	0	0	0	0	0	0	0
R	1.34.02.4348	Bloomfield Place East Group HV & LV Reinforcement - Install 11kV	100,000	162,500	37,500	0	0	0	0	0	0	0
R	1.34.02.5029	Carnaby Street North Group HV & LV Reinforcement	485,452	485,452	364,096	0	0	0	0	0	0	0
R	1.34.02.5716	Carnaby Street NE Group HV & LV Reinforcement	280,780	210,591	0	0	0	0	0	0	0	0
н	1.29.02.4333	Ranelagh Bridge: Replace Section of Lodge Rd to Moscow Rd FFC	277,080	0	0	0	0	0	0	0	0	0

2.3.1 Asset Replacement

1.51.01.5826 Hyde Park A: Replace T3A & T4A

GT3A and GT4A are due to be asset replaced due to poor condition. The project is scheduled for completion in 2015.

Lodge Road



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1.29.02.4333 Ranelagh Bridge : replace section of Lodge Rd to Moscow Rd FFC

The Lodge Road-Moscow Road No2 cable is routed on a road bridge which crosses the Network Rail main line tracks approaching Paddington and the entrance to an NCP car park. Access to repair an existing leak is very difficult due to the position on a railway bridge over a busy network rail mainline route. The project scope is to replace the section over the bridge.

2.3.2 Distribution Network Reinforcement and Reconfiguration

1.34.02.4340 Lithos Road: 11kV West Group Reconfiguration

The Lithos Road West group is being radialised and reconfigured to improve busbar load distribution.

1.34.02.4348 Bloomfield Place: HV and LV reinforcement of the East Group

Bloomfield Place feeder groups are heavily loaded. The scheme consists of internal HV & LV reinforcement of the East Group.

1.34.02.4399 Amberley Road 6.6kV: Upgrade SE, SW, NE, NW and Central groups

On-going programme of work to partially upgrade and reconfigure the SE, NE and Central 6.6kV groups and transfer to the new Amberley Road 11kV switchboard.

1.34.02.5029 Carnaby St: Reconfigure North Group

As part of the switchboard extension works, this project is to reconfigure the North Group to achieve balanced busbar and group loadings.

1.34.02.5716 Carnaby St: Reconfigure NE Group

As part of the switchboard extension works, this project is to reconfigure the North East Group to achieve balanced busbar and group loadings.

1.34.02.4342 Moscow Rd: 6.6kV transfers

Moscow Rd is operating beyond the site firm capacity with Licence compliance maintained by load transfers to Amberley Rd 6.6kV.

The Amberley Rd network is being upgraded to 11kV standards to be transferred to the new 132/11kV substation and facilitate decommissioning of the obsolete 6.6kV switchboard. If no action is taken Moscow Rd 6.6kV will then become non P2/6 compliant. This scheme covers the uprate part of the Moscow Rd 6.6kV network to 11kV and transfer to Amberley Rd.

1.34.05.5901 Bloomfield Place: emergency mitigation works

The scope of this project is to provide an option to transfer load from Bloomfield Place 6.6kV substation to Duke Street 11kV substation by the installation of an 11/6.6kV Auto-Transformer, associated HV switchgear and direct HV interconnector connection between the two main-substations. The transfer facility is required to mitigate the loading risk on the remaining transformers at Bloomfield Place following an N-1 transformer outage scenario.

Lodge Road



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2.3.3 Substation reinforcement

1.33.03.4350 Carnaby St substation reinforcement phase 1

This on-going scheme covers the extension to the existing 11kV switchboard to provide 5 feeder interconnection to Duke Street via Bloomfield Place. This will allow load transfers from Carnaby Street to Duke Street which will keep the site within compliance and will allow outages for the Phase 2 project (increased transformer capacity).

3 Network Development Considerations

3.1 **Development Areas**

3.1.1 Brill Place NW1 1HG



The Francis Crick Institute is a joint project between the University of London and pharmaceutical companies to develop a bio-research centre close to Kings Cross, St Pancras.

Construction is scheduled for completion in 2015 with an estimated maximum demand of 15MVA. The complex is designed to be a sustainable development with combined heat and power (CHP) and solar panels systems including 5.6MVA of standby generation.



The site is to be supplied from St Pancras substation via 4 x 11kV circuits, initially from Lodge Road then transferring to Islington GSP.

3.1.2 HS2 – High Speed 2

The HS2 London terminal is to be constructed adjacent to Euston Station and, although details of the power supply requirements are not yet known, it may have a significant impact on the local network.

Lodge Road

UK Power Networks

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3.1.3 Other

This central London area broadly aligning with the Marylebone Road, Oxford Street and Piccadilly is highly developed urban and no other significant point load development activity has been identified. However, there is continuing pressure through the normal referral process for new connections requiring both capacity and switch positions. Summer peak demands are also expected to increase during office hours with the continuing increase of air conditioning.

3.2 Asset Health

It should be noted that HIs presented in the RDP will not align with the RIGS. The HIs 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 forecast asset health index (without intervention) for switchgear and transformers are tabulated below;

Table 3. HV Circuit Breakers (6.6 and 11kV)

			2015					2023		
Substation	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
BLOOMFIELD PLACE 6.6KV			20	8					12	16
CARNABY ST 11 KV	19		31	5		19			20	16
HYDE PARK ESTATE A 11KV	5	12	16			5		17	11	
HYDE PARK ESTATE B 11KV		14	15				7	22		
IMPERIAL COLLEGE 6.6KV		16	9				1	16	8	
LITHOS RD A			24	11	3				8	30
MOSCOW RD 6.6KV			1	18	10					29
ST. PANCRAS A		2	21					15	8	
ST. PANCRAS B	3	2	16	5	1		3	2	7	15
VICTORIA GDNS 6.6KV		8	20					15	13	

Table 4. EHV Circuit breakers (22kV)

			2015			2023				
Substation	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
MOSCOW RD 22KV		19	5					20	4	

Table 5. 66kV & 132kV Circuit Breakers

			2015					2023		
	No.	No.			No.	No.				
Substation	HI1	HI2	No. HI3	No. HI4	HI5	HI1	No. HI2	No. HI3	No. HI4	No. HI5
LODGE RD B 66KV	21					3	18			
MOSCOW RD 66KV				2						2

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Table 6. Transformers

			2015					2023		
Substation	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
AMBERLEY RD 6.6KV			n/a					n/a		
BLOOMFIELD PLACE 6.6KV		3			1		3			1
CARNABY ST 11 KV		4					2	2		
HYDE PARK ESTATE A 11KV	4					4				
HYDE PARK ESTATE B 11KV		2	2				2	1	1	
IMPERIAL COLLEGE 6.6KV			3	1				1	1	2
LITHOS RD A		3	1					4		
MOSCOW RD 22KV		1	1	2				1		3
MOSCOW RD 6.6KV		2	2					4		
ST. PANCRAS A			1	3				1		3
VICTORIA GDNS 6.6KV		2	2					4		

Table 7. Fluid Filled Cables EHV

			2015					2023		
Circuit Name Containing Section	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
DUKE ST-BLOOMFIELD PL 6.6KV		2					2			
LODGE RD 66KV-CARNABY ST 11KV		2					1	1		
LODGE RD 66KV-DUKE ST		6	3		1		2	7		1
LODGE RD 66KV-HYDE PARK ESTATE A		2	2				2	2		
LODGE RD 66KV-LITHOS RD A		6	2					8		
LODGE RD 66KV-MOSCOW RD 22KV		10					8	2		
LODGE RD 66KV-ST PANCRAS A		3	7		2			9	1	2
MOSCOW RD 22KV-TOWNMEAD RD				1	3					4



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3.3 Security of supply and load index analysis

Table 8 shows the load growth predicted on the Lodge Road Network. Where loads exceed the substation firm capacity plus any post fault transfer capability are shown in orange.

Table 8. P2/6 Analysis

Sub-station	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 (M W)	Winter 21/22 Summer 2021 (MW)	Winter 22/23 Summer 2022 (M W)
Amberley Road	6.6kV	43.24		0.97	20.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Amberley Road	6.6kV	32.76		0.91	15.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bloomfield	6.6kV	39.50		0.96	32.63	32.94	27.91	28.38	28.75	29.19	29.63	30.09	30.57	3109	3163
Bloomfield	6.6kV	33.84	0.00	0.94	36.31	36.63	31.31	31.81	32.21	32.66	33.14	33.62	34.12	34.68	35.25
Carnaby Street	11kV	85.12		0.97	66.14	67.23	68.85	70.48	71.81	73.31	74.87	76.48	78.13	79.95	81.82
Carnaby Street	11kV	63.45	15.71	0.94	64.46	65.49	67.03	68.57	69.83	7126	72.73	74.26	75.82	77.55	79.32
Hyde Park A	11kV	58.27		0.996	43.22	43.73	44.52	45.34	46.01	46.78	47.58	48.42	49.28	50.30	51.34
Hyde Park A	11kV	43.65	0.00	0.97	43.33	43.82	44.57	45.35	46.00	46.73	47.49	48.29	49.11	50.09	51.08
Hyde Park B	11kV	58.50		1	42.78	43.43	44.41	45.41	46.22	47.15	48.12	49.11	50.14	5129	52.48
Hyde Park B	11kV	44.37	3.96	0.986	44.17	44.80	45.77	46.75	47.55	48.46	49.41	50.38	51.39	52.53	53.69
Imperial College	6.6kV	35.51		0.95	22.67	22.75	22.87	23.00	23.11	23.24	23.37	23.51	23.65	23.83	24.01
Imperial College	6.6kV	28.20		0.94	23.73	23.81	23.93	24.07	24.18	24.31	24.44	24.58	24.72	24.91	25.09
Lithos Road	11kV	56.75	1.24	0.97	53.33	53.83	54.65	55.55	56.30	57.16	58.09	59.05	60.05	6139	62.73
Lithos Road	11kV	42.30		0.94	38.78	39.13	39.72	40.35	40.89	4150	42.16	42.84	43.55	44.51	45.45
Lodge Road 66kV	66kV	905.50		0.96	437.56	421.90	424.42	433.67	363.26	369.10	375.21	38152	388.06	395.82	403.69
Lodge Road 66kV	66kV	808.70		0.96	380.47	369.03	370.19	378.17	314.13	319.23	324.56	330.06	335.75	342.46	349.26
Moscow Road	6.6kV	39.90	2.53	0.97	39.03	39.58	40.45	41.36	42.11	42.96	43.85	44.77	45.72	46.90	48.08
Moscow Road	6.6kV	33.12		0.92	28.56	28.95	29.57	30.21	30.73	3134	31.97	32.62	33.29	34.12	34.96
Moscow Road 22kV	22kV	155.60		0.96	114.80	95.58	96.95	98.37	99.55	100.90	102.32	103.78	105.30	107.19	109.09
Moscow Road 22kV	22kV	120.15		0.89	95.33	80.67	8172	82.81	83.71	84.74	85.83	86.95	88.11	89.57	91.03
St Pancras A	11kV	49.85	15.84	0.95	37.45	37.68	39.20	41.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00
St Pancras A	11kV	41.40		0.92	33.19	33.38	34.67	36.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
St Pancras B	11kV	49.85	2.01	0.95	32.60	32.87	33.32	33.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
St Pancras B	11kV	42.30		0.94	30.62	30.87	3127	31.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00
St Pancras Total	11kV	99.70		0.95	69.34	69.85	7182	74.82	-0.71	-0.71	-0.71	-0.71	-0.71	-0.71	-0.71
St Pancras Total	11kV	83.70		0.93	63.68	64.13	65.81	68.37	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12
Victoria Gardens	6.6kV	38.30		0.93	33.96	34.20	34.59	34.99	35.33	35.72	36.13	36.55	36.99	37.56	38.12
Victoria Gardens	6.6kV	32.40		0.9	28.23	28.42	28.73	29.05	29.32	29.62	29.95	30.28	30.63	3108	3153

Table 9. Substation LI Profile (without Investment)

Cubstation	Voltage W	Load	Index
Substation	voltage kv	2015	2023
Amberley Road	22/6.6	n/a	n/a
Bloomfield	66/6.6	5	5
Carnaby Street	66/11	5	5
Hyde Park A	66/11	2	5
Hyde Park B	66/11	4	5
Imperial College	22/6.6	2	2
Lithos Road	66/11	3	5
Moscow Road	22/6.6	1	3
Moscow Road 22kV	66/22	1	1
St Pancras A	66/11	2	4
St Pancras B	66/11	1	2
Victoria Gardens	22/6.6	2	3
Moscow Road 66/11	66/11	n/a	n/a
West End	66/11	n/a	n/a

Lodge Road

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

3.4 Operational and technical restrictions

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 technical restrictions on the Lodge Rd network:

Camden Hampstead Road Cable Bridge 0021 TQ2923482995

Fulham Chelsea Harbour Drive over Chelsea Creek Cable Bridge 0044 TQ2626276934 Camden Delancy St Cable Bridge 0022 TQ2869983565

Westminster Amberley Road Cable Bridge 0065 TQ2545881921

No operational restrictions have been identified.

3.5 National Grid

3.6 National Grid are developing their programme to asset replace the 4 remaining 180MVA 275/66kV transformers with 240MVA 400/66kV units. Depending on timetable for the transfer of St Pancras to Islington and the establishment of the new West End substation it is expected that the additional 60MVA of capacity per transformer will allow a reduction from 5 to 4 transformers.**Smart Demand Response**

Two sites have been identified as suitable for implementation of Demand Side Response (DSR) in ED1:

- Moscow Rd: 5MVA of DSR will be used to mitigate impact during the substation replanting to increase capacity at the site by reducing loading e.g. to widen outage windows
- Hyde Park A : 5MVA of DSR will be used to mitigate the risk of load growth until the new West End substation is built (2020)



Lodge Road



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

4 Recommended Strategy

The network strategy for East London is designed to ensure:

- Continued adherence to the security of supply criteria defined in Engineering Recommendation P2/6
- Maintaining reliable network operation by asset replacement, or refurbishment, of poorly performing equipment identified through asset condition monitoring (HI) techniques

With the exception of the proposed new West End Substation and reconfiguration of the Moscow Road network, adopting this framework results in no major network reconfigurations.

The proposals are summarised below:

4.1 Asset Replacement

4.1.1 Switchgear

7799 - Bloomfield Place 6.6kV - retrofit switchgear

The condition assessment of the 1968 AEI QF Oil Switchgear installed at Bloomfield Place 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 the refurbishment of the 28 circuit breakers.

7802 - Carnaby St – Replace 11kV Switchgear

Condition assessment of this AEI QF oil filled switchgear has shown that it has a high probability of failure due to degradation, with an HI5 predicted during ED1. The project proposes the replacement of 36 x 11kV circuit breakers.

7804 - Lithos Road – Replace 11kV Switchgear

A condition assessment of this AEI QF oil filled switchgear has shown that it has a high probability of failure due to degradation. The project proposes the replacement of 38 x 11kV circuit breakers.

Delivery of the project is to be optimised with the reinforcement of the site by 2018.

2750 - Moscow Road – Replace 66kV Switchgear

This oil filled OW407 66kV switchgear was installed in 1952 and is suffering from worn mechanisms and decomposing VIR insulated secondary wiring. This project has been raised to replace them with 2 x GIS dead tank circuit breakers within the existing outdoor compound.

4.1.2 Transformers

The requirement for transformer asset replacements has been identified at 3 sites.

8513 - Bloomfield Place – replace primary transformer T1

T1 at Bloomfield Place has shown significant deterioration in DGA results since mid-2011 indicative of a developing fault. Regular oil sampling has shown that the fault has stabilised but it still poses significant network risk from future fault. T1 will therefore be replaced on asset health.

7868 - Moscow Road 22kV- replace primary transformers GT1, GT2, GT3, GT4

The condition assessment of the 1962/63 Ferranit Primary Transformers with Ferranti EC4 tap changers and the 1965 Yorshire Electric Primary Transformer with Fuller HS tap changer installed at Moscow Rd 66/22kV Primary 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

Lodge Road



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requirements; therefore this project recommends their replacement. It is proposed to replace the existing 66/22kV transformers by 66/11kV units.

The scheme will also include a new 11kV switchboard that will feed the Victoria Gardens, Imperial College and Moscow Rd networks after they are upgraded from 6.6 to 11kV. The 22kV board will be decommissioned. This scheme is linked to the upgrade of 6.6kV networks to 11kV (HV reinforcement schemes), asset replacement scheme at Imperial College (below), decommissioning of 6.6kV switchboard at Moscow Rd and Victoria Gardens.

7867 – Imperial College 6.6kV– replace primary transformer T1, T2, T3, T4

The condition assessment of the 1960/64 Hackbridge Hewitt Primary Transformers with AEI M21 tap changers installed at Imperial College 22/6.6kV Primary 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 their replacement. Completion of the project will see 4 Primary Transformers replaced with three 11/6.6kV autotransformers previously in use at Islington B. This project runs in conjunction with the LRE schemes to upgrade the 6.6kV network in the Moscow Road/Imperial College areas.

4.1.3 Cables

7950 and 7957 - 66kV FFC replacement

Selective replacement of sections on the Moscow Road –Townmead and Lodge Road-Carnaby Street fluid filled circuits are proposed.

4.2 Reinforcement

6105 - Establish new 66/11kV West End Substation (High Value Project, combined with 8483)

Bloomfield Place, Hyde Park A and Hyde Park B substations are forecast to reach the limit of the site firm capacity by the end of ED1. Site assessments have confirmed that due to space constraints, extension of the existing sites is not feasible. This project therefore proposes to establish a new 3 x 33.3MVA 66/11kV substation in the West End of London.

Furthermore, a new substation will offer significant benefits for load transfers from the adjacent to Leicester Square substation during the proposed transformer asset replacement while creating capacity headroom and switch positions to reinforce the local 11kV interconnected groups.

A suitable site for the new substation has not yet been identified with the possible use of Park Lane or Berkley Square being investigated for an underground substation. The project costs include for land purchase and associated legal fees.

The scope of the project includes:

- Land purchase of appropriate site
- Install 3 x 33.3MVA 66/11kV transformers
- Install 38 panel double busbar 11kV switchboard
- Install 132kV (operated at 66kV) cable between Lodge Road and new substation in tunnel (see next project)

The upgrading of Bloomfield Place 6.6kV network, its transfer and the transfers of some of Hyde Park, Duke St groups to the new substation are not included in this project, but will be dealt with under separate HV schemes.

Lodge Road



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

8483 - Construct Lodge Rd to West End Cable Tunnel

In order to facilitate the connection of the aforementioned West End substation, it will be necessary to construct a deep cable tunnel between Lodge Road and the new substation site. This scheme includes all aspects of the legal, design and construction elements of the tunnel. The cable costs are included in the substation project.

It is expected that the tunnel will also offer a solution for replacing the Lodge Road to Carnaby Street FFC to avoid a problematic open-cut route.

6107, 6109 and 8349 – upgrade of Victoria Gardens and Imperial College networks to 11kV, decommissioning of Victoria Gardens 6.6kV and decommissioning of Moscow Rd 6.6kV

Moscow Road and Victoria Gardens substations load indices are currently 4 and 3 respectively and will be deteriorating in ED1. Furthermore due to asset condition issues with Moscow Road 6.6kV switchgear (HI4 & 5) and Moscow Road 66/22kV transformers (3 units HI5 by 2023), it is proposed that the majority of the 6.6kV network fed from Moscow Road 22kV is upgraded to 11kV and supplied by establishing a new 66/11kV substation at Moscow Road (asset replacement scheme). This will then enable the decommissioning of Moscow Rd 6.6kV and Victoria Gardens 6.6kV substations.

The Imperial College network will be upgraded to 11kV, apart from the private network feeding the college and museums.

Substation	Firm C (M	apacity W)	Year out of Firm (excl. transfers)
	Winter	Summer	
Moscow Road 6.6kV	39.9	33.1	2014/15 (W)
Victoria Gardens	38.3	32.4	2023/24 (W)
Amberley Road 6.6kV	43.2	32.8	N/A to be decommissioned in 2013
Imperial College	35.5	28.2	Post 2023

Table 10. Moscow Road 6.6kv Network: Review of Substation Firm Capacities

As a summary, the network strategy in the area will consist of:

- A new substation will replace the existing Moscow Road 66/22kV. The scope of the works will
 include the decommissioning of existing 66/22kV transformers as load reduces on Moscow Road
 22kV (due to load being transferred to Amberley Road 11kV) and installation 4 x 66/11kV 30MVA
 transformers in their place. A new 50 panel 11kV switchboard will be installed at Moscow Road (in
 the existing 6.6kV switchroom and extended as the 6.6kV board is decommissioned and supplies
 are moved to Amberley Road 11kV).
- Moscow Road 66kV circuits from Lodge Road are to be retained and reused to feed the new 66/11kV transformers.
- Upgrade Victoria Gardens network to 11kV and transfer loads to a new satellite 11kV switchboard at Victoria Gardens. Some of the Victoria Gardens feeders will be transferred to Moscow Road, while a new Moscow Road to Victoria Gardens interconnector will provide supplies to the Victoria Gardens satellite 11kV switchboard.
- Upgrade Imperial College network, apart from the private network feeding the college and museums, to 11kV and transfer to Moscow Road 11kV
- Install 3 x 11/6.6kV 18MVA auto transformers from Islington at Imperial College site in order to maintain the 6.6kV loads that remain

Lodge Road



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 Upgrade NE and NW groups at Moscow Rd 6.6kV to 11kV and transfer, via ex 22kV cables, to Amberley Rd 11kV

It is recommended that site disposal of Victoria Gardens is not completed, and it is retained for reuse in the medium to lo longer term. This is due to the difficulty in securing substation sites in central London but does not preclude renting or leasing the site until needed for network purposes.

4349 - Carnaby St Reinforcement – Phase 2

Carnaby Street substation is currently LI5 with P2/6 compliance maintained by significant post fault transfers to Leicester Square and Shorts Gardens. Additional transfers to Duke Street will be available once Carnaby St. Phase 1 project is complete (see schemes in progress) which will allow to take outages on the transformers during the reinforcement scheme. The ITC scheme is required to keep the site within compliance in ED1 due to the high load growth in the area.

The scope of the works includes:

• Replacement of existing transformers with 4 new 66/11kV 33.3MVA transformers

8637 – Lodge Rd-Carnaby St cable replacement

Following the replacement of the 66/11kV transformers, the incoming circuits are the limiting factor. It is proposed to replace the four circuits, using the new St John's Wood to West End tunnel. This will allow to fully utilise the rating of the new transformers.

5744 - Lithos Road – Increased Transformer Capacity

Lithos Road will be non-compliant with P2/6 by 2017/18. The P2/6 analysis already includes the use of the fans fitted onto the transformers in the winter firm. As it is not possible to further increase the rating of the existing transformers, additional transformers are required to maintain compliance.

This project is to install 2 x 15MVA 66/11kV transformers at Lithos Road. The scope of the project includes:

- Install 2 new 132kV rated (run at 66kV) circuits from Lodge Road to Lithos Road MSS
- Install 2 x66kV breakers at Lodge Road
- Install 2 x 15MVA 66/11kV transformers
- Install 15 panel 11kV switchboard to accept new transformers and allow for some additional feeders
- New auto switching scheme

Table 11. Summary of Transformer capacity changes

Substation	Driver	Commissioning Year	Scope of works	Existing Firm capacity	Planned Firm capacity
Moscow Road 66/22	Asset Replacement	2017	Replace 4 x transformers with 4 x 30MVA 66/11kV transformers Replace 22kV switchboard with 50 panel 11kV switchboard	135MVA	90MVA (as 66/11kV substation)
West End 66/11	Reinforcement	2020	Establish new 3 x 33.3MVA 66/11kV substation	n/a	66MVA
Carnaby St 66/11	Reinforcement	2016	Replace transformers with 33.3MVA units	67.5MVA	129.9MVA
Lithos Road	Reinforcement	2018	Install 2 x 15MVA transformers Extend 11kV Switchboard	58.5MVA	78MVA
Carnaby St 66/11	Reinforcement	2021	Replace 66kV cables		

Lodge Road



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4.3 Costs and phasing

Table 12 below, details the projects proposed for the remainder of DPCR5 and ED1.

Table 12. Summary of Proposed Interventions

Cat.		Reference	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
A	1.48.09.2750	Moscow Rd 66kV: Switchgear	0	0	0	138,332	270,579	0	0	0	0	0
A	1.50.01.7799	Asset Replacement Bloomfield Place 6.6kV - Retrofit 6.6kV Switchgear	0	0	0	0	0	146,836	290,212	0	0	0
A	1.50.01.7802	Carnaby St 11 kV - Replace 11kV Switchgear	0	0	0	0	339,178	1,202,084	901,564	0	0	0
A	1.50.01.7804	Lithos Rd A - Replace 11kV Switchgear	0	0	0	345,254	1,226,437	919,828	0	0	0	0
A	1.51.01.7868	Moscow Rd 22kV - Replace Primary Transformers (GT1, GT2,	50,433	1,059,083	3,681,574	1,664,273	0	0	0	0	0	0
A	1.51.01.8513	Bloomfield Place: Replace Primary Transformer T1	0	386,434	688,939	0	0	0	0	0	0	0
A	1.51.03.7867	Imperial College 6.6kV - Replace Primary Transformers (T1,T2, T3,	0	20,776	279,184	279,184	0	0	0	0	0	0
н	1.29.01.7950	Moscow Rd 22kV-Townmead Rd (Circuit 1-A.Circuit M2, Circuit 1-L-	0	0	0	0	0	0	678,248	1,881,686	0	0
н	1.29.01.7957	Lodge Rd 66kV-Duke Street (Circuit 4-A) - 66kV FFC	0	0	1,280,000	1,279,934	0	0	0	0	0	0
R	1.33.01.4349	Carnaby Street 66/11kV Phase 2 - ITC (4x33.3MVA)	148,812	520,841	1,507,444	1,507,444	0	0	0	0	0	0
R	1.33.01.5744	Lithos Road 66/11kV - ITC (add 2x15MVA)	0	0	92,152	2,580,264	7,372,183	2,124,273	0	0	0	0
R	1.33.01.6109	Victoria Gardens 22/6.6kV - Decommissioning	0	0	0	134,635	0	0	0	0	0	0
R	1.33.07.6105	West End New 66/11kV Substation - (3x33.3MVA)	185,136	6,475,241	2,776,135	3,700,009	3,700,009	6,012,853	5,947,829	463,291	0	0
R	1.34.07.6107	Decommissioning of Moscow Rd 6.6kV	0	0	0	134,636	0	0	0	0	0	0
R	1.34.07.8349	Upgrade Victoria Gardens and Imperial College Networks to 11kV	443,267	1,773,066	1,773,066	1,329,799	0	0	0	0	0	0
R	1.35.05.8556	Demand Side Response at Moscow Rd	0	75,000	75,000	75,000	0	0	0	0	0	0
R	1.35.05.8560	Demand Side Response at Hyde Pk A	75,000	75,000	75,000	75,000	75,000	75,000	0	0	0	0
R	1.37.09.8343	Construct Lodge Rd to West End Cable Tunnel	50,613	102,200	97,333	85,653	6,108,640	6,261,453	1,894,107	0	0	0
R	1.37.09.8637	Lodge Rd-Carnaby Street - Replace 4x66kV circuits	0	0	0	0	0	0	5,509,755	3,674,291	0	0

4.4 HI / LI Improvement

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

Asset Health Indices

Table 13. HV Circuit Breakers (11kV)

			2015					2023		
Substation	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
BLOOMFIELD PLACE 6.6KV			20	8			28			
CARNABY ST 11 KV	19		31	5		55				
HYDE PARK ESTATE A 11KV	5	12	16			5		17	11	
HYDE PARK ESTATE B 11KV		14	15				7	22		
IMPERIAL COLLEGE 6.6KV		16	9				1	16	8	
LITHOS RD A			24	11	3	53				
MOSCOW RD 6.6KV			1	18	10			n/a		
ST. PANCRAS A		2	21					n/a		
ST. PANCRAS B	3	2	16	5	1			n/a		
VICTORIA GDNS 6.6KV		8	20					n/a		
MOSCOW RD 11KV						50				
VICTORIA GDNS 11KV						18				
WEST END 11KV						38				





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Table 14. EHV Circuit breakers

ĺ				2015			2023					
	Substation	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	
	MOSCOW RD 22KV		19	5					n/a			

Table 15. 66 and 132kV Circuit Breakers

			2015					2023		
	No.	No.			No.	No.				
Substation	HI1	HI2	No. HI3	No. HI4	HI5	HI1	No. HI2	No. HI3	No. HI4	No. HI5
LODGE RD B 66KV	21					5	18			
MOSCOW RD 66KV				2		2				

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
AMBERLEY RD 6.6KV			n/a					n/a		
BLOOMFIELD PLACE 6.6KV		3			1	1	3			
CARNABY ST 11 KV		4				4				
HYDE PARK ESTATE A 11KV	4					4				
HYDE PARK ESTATE B 11KV		2	2				2	1	1	
IMPERIAL COLLEGE 6.6KV			3	1			3			
LITHOS RD A		3	1			2		4		
MOSCOW RD 22KV		1	1	2				n/a		
MOSCOW RD 6.6KV		2	2					n/a		
ST. PANCRAS A			1	3				n/a		
VICTORIA GDNS 6.6KV		2	2					n/a		
MOSCOW RD 11kV						4				
WEST END						3				

Table 17. Fluid Filled Cables EHV

			2015					2023		
Circuit Name Containing Section	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5	No. HI1	No. HI2	No. HI3	No. HI4	No. HI5
DUKE ST-BLOOMFIELD PL 6.6KV		2					2			
LODGE RD 66KV-CARNABY ST 11KV		2								
LODGE RD 66KV-DUKE ST		6	3		1		2	7		
LODGE RD 66KV-HYDE PARK ESTATE A		2	2				2	2		
LODGE RD 66KV-LITHOS RD A		6	2					8		
LODGE RD 66KV-MOSCOW RD 22KV		10					8	2		
LODGE RD 66KV-ST PANCRAS A		3	7		2					
MOSCOW RD 22KV-TOWNMEAD RD				1	3					

Fluid Filled Cables are replaced with solid cables, so their HI value is no longer calculated

Lodge Road



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Projected Load Indices (With Investment)

Substation	Voltage kV	2023 Load Index	
Substation	voltage kv	Without Investment	With Investment
Amberley Road	22/6.6	n/a	n/a
Bloomfield	66/6.6	5	1
Carnaby Street	66/11	5	1
Hyde Park A	66/11	5	5
Hyde Park B	66/11	5	5
Imperial College	22/6.6	2	1
Lithos Road	66/11	5	2
Moscow Road	22/6.6	3	n/a
Moscow Road 22kV	66/22	1	n/a
St Pancras A	66/11	4	n/a
St Pancras B	66/11	2	n/a
Victoria Gardens	22/6.6	3	n/a
Moscow Road 66/11	66/11	n/a	2
West End	66/11	n/a	1

Alternatives considered

4.1 Alternative Option 1 – Replant Bloomfield Place at 11kV

Estimated Cost: £7.2m (excluding 11kV network works and land purchase)

This option would require new 66/11kV transformers and a new 11kV switchboard to be installed at Bloomfield Place, with the Bloomfield Place being upgraded to 11kV. This was rejected as there is insufficient space on site to carry out these works and a new site would need to be obtained which, even if available, would significantly increase the cost. In addition, replanting Bloomfield Place would not provide mitigation for Hyde Park A or B.

4.2 Alternative Option 2 – Retain Moscow Road area Network at 6.6kV

Estimated Cost: £3.6m (excluding asset replacement schemes)

In order to maintain compliance with P2/6 it is necessary to increase the capacity of this 6.6kV network. If it were retained at 6.6kV then this would require ITC projects at Moscow Road and Victoria Gardens. As there are asset condition problems at Moscow Road 22kV, Moscow Road 6.6kV and Imperial College 6.6kV and a large amount of equipment needs to be replaced anyway, in addition to the fact that 6.6kV as a network voltage is to be phased out, this option was rejected.



Lodge Road

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

5 References

References	Description
Reference 1	Planning Load Estimates LPN Area 2011 – 2023 (Feb 2013, Element Energy)
Reference 2	Primary Distribution Systems Standard Running Arrangements 2013 Overview Diagrams
Reference 3	NAMP LPN Table J Less Ind 19 th February 2014
Reference 4	Asset Condition Reports July 2013

5.1 Appendices

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

5.2 Document History

Version	Date of Issue	Author	Details
1.0	December 2012	S Green	First draft
2.0	June 2013	S Motte	ED1 Plan: initial submission
3.0	March 2014	S Motte	ED1 Plan: resubmission
3.1	March 2014	S Motte	Format changes

Lodge Road



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

6 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		
Barry Hatton	Director of Asset Management		



Lodge Road

APPENDIX A: GEOGRAPHICAL DIAGRAM





Lodge Road

APPENDIX B: SINGLE LINE DIAGRAM – EXISTING NETWORK

Lodge Road Network





Lodge Road

Lodge Road Network - continued





Lodge Road

APPENDIX C: SINGLE LINE DIAGRAM – RECOMMENDED STRATEGY

Moscow Road 66/11kV Substation





Lodge Road

New West End 66/11kV Substation

Lithos Road

Carnaby St

