



# **Regional Development Plan**

## **Elstree – Watford South (EPN)**

Planner: Paul Ramsbotham

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Date 14/03/2013

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

**Document History**

<b>Version</b>	<b>Date</b>	<b>Revision Class</b>	<b>Originator</b>	<b>Section Update</b>	<b>Details</b>
1.3	14/03/2014	Major	Paul Ramsbotham	1.2, Appendix D	Expenditure aligned to the 19th February 2014 NAMP version J less indirect costs.
1.3	14/03/2014	Major	Paul Ramsbotham	1,2,3,4,5	RDP narrative updated to reflect latest position
1.3	14/03/2014	Major	Paul Ramsbotham	1.2, Appendix E, Appendix F	LI and HI output measures updated in line with current NAMP plan and RIG tables
1.3	14/03/2014	Minor	Paul Ramsbotham	2.2	Network changes in progress updated to reflect interventions to date
1.3	14/03/2014	Major	Paul Ramsbotham	4	Recommended strategy reflects latest position
1.3	14/03/2014	Major	Paul Ramsbotham	Appendix G	Generation activity reflects latest position
1.3	19/03/2014	Minor	Steve Mould	All sections	All sections checked for consistent section numbering, content etc.
2.0	27/03/2014	Minor	Regulation	All	Final publication

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### 1 Executive Summary

This Regional Development Plan (RDP) reviews UK Power Networks (UKPN) EPN HV and EHV network of Elstree, Watford, Hatch End, Harrow North and Rickmansworth areas of North London, supplied from National Grid Supply Points (GSPs) of Elstree and Watford South.

This RDP represents a developed area of the EPN region, covering Hertfordshire (Dacorum, Three Rivers and Watford) and the London Boroughs of Harrow and Hillingdon, covering an area of circa 370km<sup>2</sup> and a population above 570,000. There are several major towns within the area which include Hemel Hempstead, Watford and Harrow. There is no significant generation in the Elstree 3B & 4 and Watford South group connected to the distribution network.

#### 1.1 Summary of issues addressed

This RDP is primarily focussed on the delivery of 33/11kV Primary and 132/11kV Grid Substation capacity to support the increased load growth (both commercial and residential) across the RDP area. In addition there are numerous projects focussed on the Health Index of switchgear operating at 11, 33 and 132kV. With the exception of switchgear works at Elstree, the asset replacement schemes identified in this RDP are not reconfiguring the existing network, but addressing the issue of ensuring continued security of supply and maintaining a safe a reliable electricity distribution network.

The RDP area is covered by Harrow Council, Hillingdon Council, Watford Council, Three Rivers Council (Abbots Langley/Rickmansworth/ South Oxhey) and Dacorum Council (Hemel Hempstead). The major areas for development include:

- Dacorum Council - Central and East Hemel Hempstead - housing, commercial/industrial
- Watford Council - Central and South Watford – housing, commercial/industrial

It should be noted that there have been data centre connection applications for the Hemel Hempstead area, ranging from 10 to 30MVA. In addition there have also been customers whom have already accepted quotation offers. Whilst in many cases the speculative approach from consultants to large connection applications will not result in the acceptance of an offer, there is a risk that additional unforeseen reinforcement in the form of 132/33kV Grid capacity may be required.

#### 1.2 Recommended strategy

From a load related expenditure perspective the strategy for this RDP area is primarily focussed on the provision of 33/11kV Primary and 132/11kV Grid capacity to cater for the increased load from both commercial and residential developments across the RDP area.

There are numerous projects focussed on the Health Index of switchgear, which encompass 11, 33 and 132kV voltage levels, a selection of these projects includes:

- Piccotts End 132/33kV Grid Substation - replace 33kV Switchgear (2000A)
- Hatch End 132/33kV Grid Substation - replace 33kV switchboard (2000A)
- Watford South 132kV Grid Supply Point - Replace 132kV Switchgear

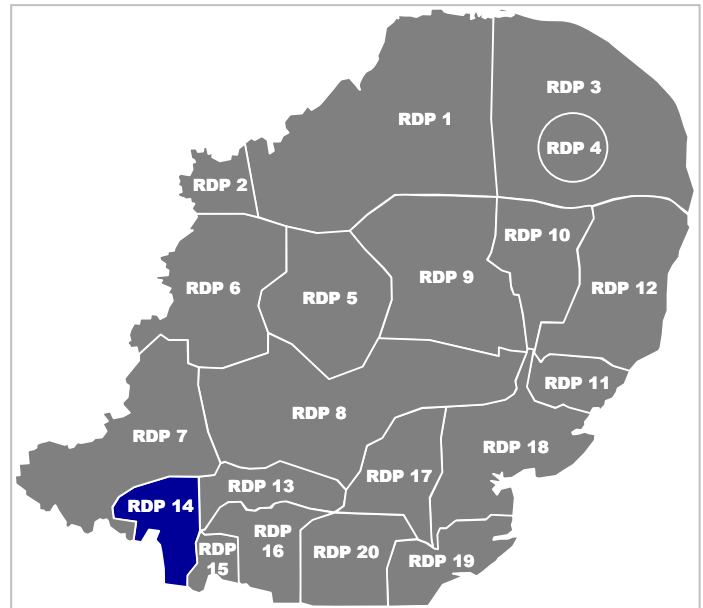


Figure 1 – Area covered by the RDP

**Elstree – Watford South**

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- Elstree GSP 132kV Exit Point - replace 132kV switchgear

The 132kV works underway at Elstree 132kV are driven by National Grid, which will ultimately result in the SGTs supplying the Stanmore circuits being connected onto the new busbars.

With the exception of the Stanmore 132kV circuits at Elstree being connected to the new indoor switchboard, there are no major network reconfigurations proposed within this strategy.

**Investment Profile**

Figure 1 provides the projected expenditure profile for reinforcement and asset replacement projects (LRE and NLRE) in this RDP for both DCPR5 and ED1. This information is taken from the NAMP version 19-02-2014.

RDP	Type	DPCR5 2013-15	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	2020 /2021	2021 /2022	2022 /2023	RIIO-ED1 Total
RDP14	LRE	£0.1m	£1.4m	£0.8m	£0.7m	£0.0m	£0.5m	£2.2m	£3.5m	£1.5m	£10.7m
	NLRE	£4.9m	£0.9m	£1.9m	£4.4m	£2.2m	£2.9m	£2.7m	£3.5m	£2.7m	£21.2m
	TOTAL	£5.0m	£2.3m	£2.7m	£5.1m	£2.2m	£3.5m	£4.8m	£7.0m	£4.2m	£31.8m

Table 1. LRE and NLRE expenditure profile

**Output Measures**

The figure below provides the expected Load Indices (LI) for all substations covered in this RDP at the end of the ED1 period (2022/23). Substations with a projected load index of LI4 and LI5 will be specifically targeted for improvement and are detailed in this document, with the resulting improvement also shown in the figure below.

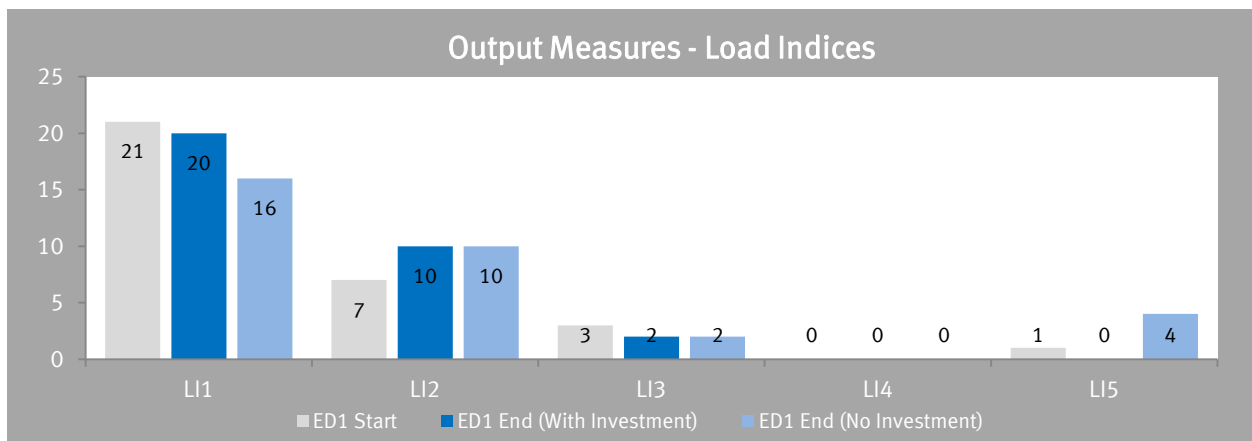
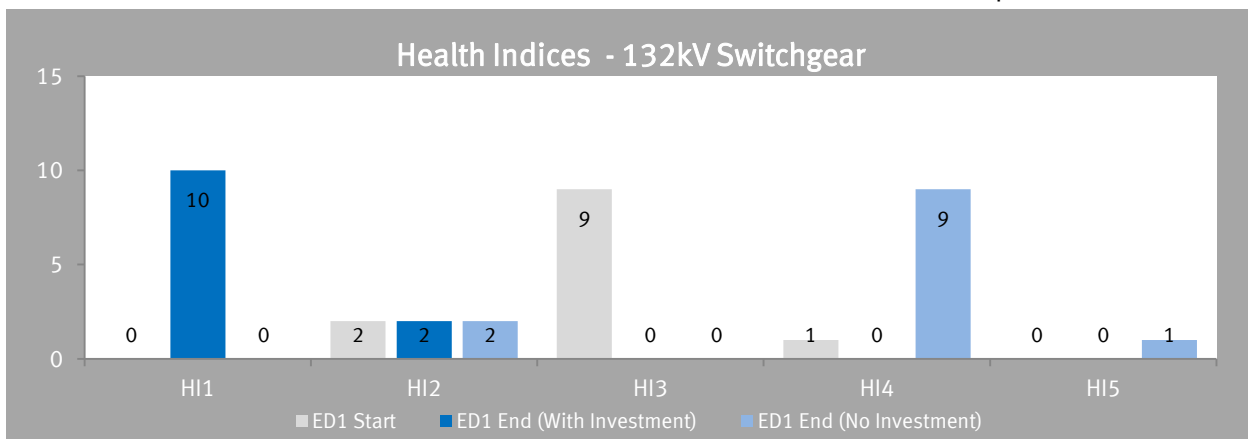


Figure 2.2022/23 Load Indices with and without interventions

The figure below provides the projected health index of various assets covered in this RDP at the beginning and end of ED1, with and without interventions as defined in the NAMP under asset replacement.



**Elstree – Watford South**

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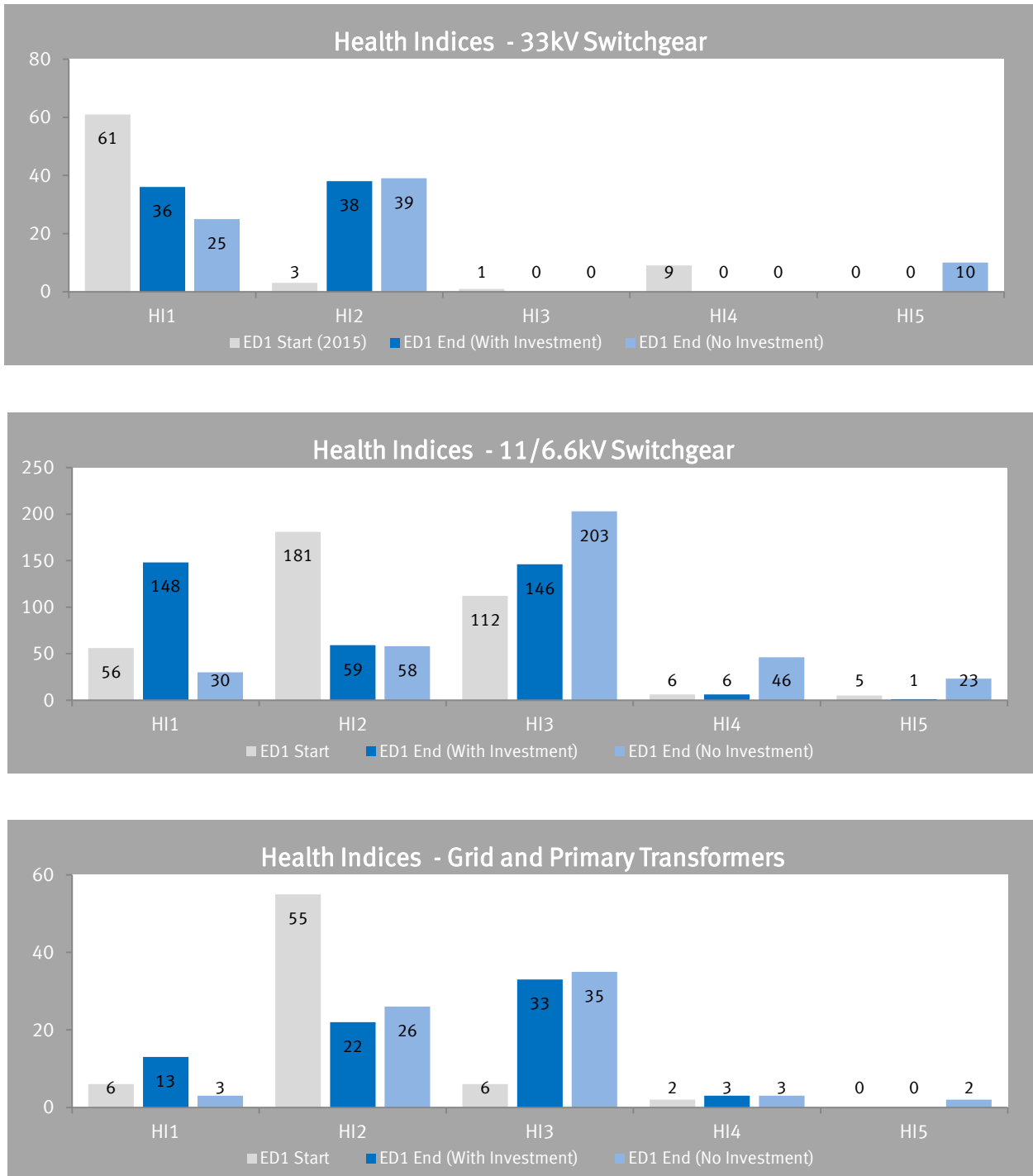


Figure 3. Health Indices by asset category

**Scenarios Considered**

The reinforcement strategy for Elstree-Watford South is defined by individual substation reinforcement to provide capacity at 11kV and the growth forecast does not warrant reinforcement at the 33kV level or above. As such, alternative scenarios were considered for the individual substation reinforcements.

**RDP Dependencies and Interactions**

## Elstree – Watford South

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

This RDP assumes the work to replace the 132kV bars at Elstree 132 is completed. There is no direct impact to other Regional Development Plans outside of the Elstree 132kV connected network.

## 2 Network Configuration

### 2.1 Existing Network

The Elstree, Watford, Hatch End and Rickmansworth areas of North London are supplied from National Grid exit points located at Elstree and Watford.

The 132kV outdoor switchboard at Elstree 132 is currently being replaced with a new indoor 3 section double bus switchboard, each section of switchboard will be fed via 2 x 275/132kV transformers and run with the bus section breakers open. It is planned that SGT1A and SGT2 (both 180MVA) will be connected to the left section, fed from this section will be Hatch End Grid (132/33kV) via 2 x 132kV circuits and a 132kV dual circuit interconnector to Watford South 132 (Elstree 1A & 2 and Watford South 3A & 3B run solid) via Bushey Mill Grid (132/33kV and 132/11kV), Piccotts End Grid (132/33kV), Lye Green Grid (132/33kV) and Rickmansworth Grid (132/11kV).

The 132kV switchboard at Watford South is split into 2 sections, 1 section is run interconnected with Elstree 132 1A & 2 and has 2 x 120MVA (240MVA total) transformers connected to it via a single circuit breaker. The other section has 1 x 180MVA (SGT4) and 2 x 240MVA (SGT1 and SGT2) transformers connected to it, one of the 240MVA transformers (SGT1) is run open. Fed from this section is Holywell Grid (132/33kV and 132/11kV) and Harrow North Grid (132/33kV).

The Watford, Rickmansworth, Abbots Langley and Merryhill areas are fed from Bushey Mill Grid (132/33kV and 132/11kV), Holywell Grid (132/33kV and 132/11kV) and Rickmansworth Grid (132/11kV). Bushey Mill Grid 132/33kV in turn feeds 6 x 33/11kV Primary substations.

The Berkhamstead, Lye Green, Amersham and Great Missenden areas are fed from Lye Green Grid (132/33kV). Lye Green Grid 132/33kV in turn feeds 6 x 33/11kV Primary substations.

The Hemel Hempstead area is fed from Piccotts End Grid (132/33kV). Piccotts End Grid in turn feeds 5 x 33/11kV Primary substations.

The Hatch End and Pinner areas are fed from Hatch End Grid (132/33kV). Hatch end Grid in turn feeds 3 x 33/11kV Primary substations.

### 2.2 Network changes in progress

#### Piccotts End 132/33kV Grid Substation - replace 33kV Switchgear (2000A)

Piccotts End Grid contains 11 x 3 AEI type HLG1C 33kV circuit breakers and 2 x type OS5 33kV circuit breakers. The associated raft is in poor condition and has suffered earthing strip theft on a number of occasions. It is proposed to replace the switchgear as part of the asset replacement strategy. In view of a history of vandal and vermin damage a GIS board may be appropriate. The CBs are overstressed on make duty (104.3%) but this situation is containable.

#### Piccotts End 132/33kV Grid Substation - Re-Gasket transformers

Piccotts End Grid has 2 x 132/33kV 90MVA Fuller transformers manufactured in 1960. They are fitted with Fuller HS tapchangers that, although require regular maintenance, have experienced no problems. The oil results for both transformers show them to be in good internal condition, however regular oil top ups over the last few years due to significant oil leaks may be affecting these results. The oil leaks are of particular concern as there is a stream that runs along the bottom of the site. It is therefore proposed to carry out regasketing works on both transformers in conjunction with the proposed 33kV switchgear replacement. Due to the oil leaks the transformers are currently OFGEM HI4.

## Elstree – Watford South

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### Hatch End 132/33kV Grid Substation - replace 33kV switchboard (2000A)

The 33kV switchboard at Hatch End Grid is mainly S&C type K30 outdoor switchgear installed around 1963. The highest health index at this site is 7.29 hence the need to replace the switchboard. The transformer and bus section CBs are rated at only 1200A. This value was reached in Jan 04. It is proposed to replace the entire board with 2000A rated units. As the substation is in an urban (mainly housing) area, it is likely that indoor switchgear will be used.

## 3 Summary of Issues

### 3.1 Development areas

The area is covered by Harrow Council, Hillingdon Council, Watford Council, Three Rivers Council (Abbots Langley/Rickmansworth/ South Oxney) and Dacorum Council (Hemel Hempstead). The major areas for development include:

- Central and East Hemel Hempstead - housing, commercial/industrial (St Pauls, Hemel North, Industrial, Hemel East). Figures for the Dacorum area indicate that between 2011 and 2031 some 16,500 additional jobs and 6100 new homes will be created.
- Central and South Watford – housing, commercial/industrial (Holywell 11, Rickmansworth 11 and Westbury). Figures for the Watford area indicate that between 2011 and 2031 some 10,700 additional jobs and 5100 new homes will be created.
- Figures for the Three Rivers area indicate that between 2011 and 2031 some 4,300 additional jobs and 4000 new homes will be created.

The Hemel Hempstead area is also a focus for companies wanting to establish data centres. Issued quotations have recently been accepted for an 8MVA connection. In addition there have been formal quotations issues to Gyron for a30MVA data centre and budget estimates have been requested for additional 10 and 20MVA data centres all in the Hemel Hempstead area.

The number of data centres and the load requirements present the greatest risk to strategies as this area is supplied from Piccotts End 33kV Grid. Whilst there is ample capacity to accommodate the predicted future housing and general commercial requirements, large point load data centres can result in significant additional load increase in a relatively short duration as compared with a large housing developments that may be phased over 15-20years.

### 3.2 Asset Replacement

A list of plant recommended for replacement has been included in the ED1 NAMP plan. Dates given are provisional and will change for operational or other reasons such as reinforcement. Costs are generic for the specific plant only and do not take account of any associated equipment which may need replacing at the same time (e.g. structures/bus/line isolators on outdoor CBs).

#### Watford South/Lye Green 132kV Tower Line (PCD) - 132kV Tower Line Refurbishment

The condition assessment of the Watford South/Lye Green 132kV Tower Line (PCD) has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 33 km of 132kV Tower Line refurbished.

#### Rayners End/Harrow 132kV Tower Line (PC) - 132kV Tower Line Refurbishment

The condition assessment of the Rayners End/Harrow 132kV Tower Line (PC) 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.

#### Elstree/Bushey Mill 132kV Tower Line (PKA) - 132kV Tower Line Refurbishment



### Elstree – Watford South

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The condition assessment of the Elstree/Bushey Mill 132kV Tower Line (PKA) 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.

#### Elstree/Hatch End 132kV Tower Line (PLC) - 132kV Tower Line Refurbishment

The condition assessment of the Elstree/Hatch End 132kV Tower Line (PLC) has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 16 km of 132kV Tower Line replaced.

#### Watford West/Watford South 132kV Tower Line (POB) - 132kV Tower Line Refurbishment

The condition assessment of the Watford West/Watford South 132kV Tower Line (POB) 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.

#### Lye Green 132/33kV Grid Substation - Replace 33kV Switchgear

The condition assessment of the 1965/66/67 SWS EO1 outdoor oil insulated switchgear installed at Lye Green 132/33kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 13 circuit breakers replaced with 13 new circuit breakers.

#### Abbots Central 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1964 FPA BVRP1 indoor oil insulated switchgear installed at Abbots Central 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 9 circuit breakers replaced with 9 new circuit breakers. The 11kV switchboard is part of ED1 asset replacement and reinforcement strategies.

#### Great Missenden 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1961 AEI BVRP1 indoor oil insulated switchgear installed at Great Missenden 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 10 circuit breakers replaced with 10 new circuit breakers.

#### South Ruislip 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1951-61 CPA ALA1 indoor oil insulated switchgear installed at South Ruislip 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 11 circuit breakers replaced with 11 new circuit breakers.

#### Amersham 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1966 AEI JB435/BVRP1 indoor oil insulated switchgear installed at Amersham 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 13 circuit breakers replaced with 13 new circuit breakers.

#### Grove Mill 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1960 FPA BVRP3 indoor oil insulated switchgear installed at Grove Mill 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 12 circuit breakers replaced with 12 new circuit breakers. Several 11kV feeder breakers and the bus section don't have remote control capability. The 11kV switchboard is part of ED1 asset replacement and reinforcement strategies.

#### Rickmansworth 132/11kV Grid Substation - Replace 11kV Switchgear

## Elstree – Watford South

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The condition assessment of the 1968 AEI BVRP2 indoor oil insulated switchgear installed at Rickmansworth 132/11kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 13 circuit breakers replaced with 13 new circuit breakers

### Hartspring 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1964 FPA BVRP1 indoor oil insulated switchgear installed at Hartspring 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 14 circuit breakers replaced with 14 new circuit breakers. Several 11kV feeder breakers and the bus section don't have remote control capability.

### Kings Langley 33/11kV Primary Substation - Retrofit 11kV Switchgear

The condition assessment of the 1964 REY LM23T indoor oil insulated switchgear installed at Kings Langley 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. This project recommends the retrofit of 2 circuit breakers.

### South Ruislip 33/11kV Primary Substations - Replace transformers (11/18/24MVA)

The condition assessment of T3 and T4 installed at South Ruislip has shown that the probability of failure due to degradation of this asset is unacceptable. Completion of this project will see 2 existing transformers replaced with 2 new transformers.

## 3.3 Security of supply analysis

Substation	Demand (MW)	Supply Class	Demand (MVA)			P2/6	Comments
			2015	2018	2021		
Watford South 132	274	D	320	332	341	Compliant	Becomes Group E in 2015
Watford 3A & 3B/Elstree 3B & 4 Group	250	D	294	306	313	Compliant	Becomes Group E in 2021
Watford South 2 & 4	178	D	197	205	211	Compliant	

Table 2. P2/6 Assessment table

## 3.4 Operational and technical constraints

The 132kV switchboard at Watford South cannot be run solid due to fault level issues. This also restricts the reinforcement options at Holywell for the second phase of Sentrum Data Centre (40MVA). The previous option of a 3<sup>rd</sup> Grid Transformer was discarded in favour of the replacement of the existing 60MVA units with 90MVA high impedance Grid Transformers.

SGT3A and 3B at Watford South (2 x 120MVA) are connected to the same 132kV circuit breaker and operate as a single logical 240MVA transformer.

Rickmansworth is normally supplied by 1 x 132/11kV 60MVA (30+30MVA) transformer, however the firm capacity for the site is limited to 30MVA summer, 40MVA winter which is provided by a 33/11kV, 20/40MVA transformer on 'hot' standby (11kV circuit breakers run open).

## 3.5 National Grid

National Grid is planning to replace their circuit breakers at Watford South in 2016/18 due to condition and is currently in the process of replacing the outdoor 132kV switchboard at Elstree.

## Elstree – Watford South

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### Elstree GSP 132kV Exit Point - replace 132kV switchgear

The OB14 circuit breakers at Elstree are at the end of their useful life. Access restrictions are in place due to the known defects. The concrete support structures, aerials, VTs and other associated plant are also in very poor condition. National Grid, who owns the 132kV bus-bar, plans to replace their 132kV switchgear at this site. The UK Power Networks equipment is of the same type and age. Recent operational restrictions affect this switchgear and it is proposed to replace it at the same time. NG has reviewed the possibility of refurbishing the existing AIS switchboard and have concluded that operational and HSE considerations mean that this is not possible. They therefore propose to construct a GIS switchboard. NG are also rationalizing the 132kV substation and will transfer the Stanmore 132kV circuits and Hendon 132kV circuit from dedicated SGTs to the proposed GIS 132kV busbar.

The existing cable tails to Rye House and to Watford South are not matched to the rating of the 400mm OHL. It is therefore proposed to replace these cables.

## 4 Recommended strategy

### 4.1 Description

#### **Watford South 132**

##### Watford South 132kV Grid Supply Point - Replace 132kV Switchgear

The condition assessment of the 1966 REY OBYR14 132kV switchgear installed at Watford South 132kV Grid Supply Point 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. Watford South 132kV has been identified as a substation with a high fault level which restricts the operation to split 132kV nodes.

#### **Elstree 3B & 4**

##### Warners End 33/11kV Primary Substation - ITC (1 x 11/18/24MVA)

The predicted load at Warners End substation will exceed the existing firm capacity, including the transfer capacity to Frogmore/St Pauls substations. It is therefore proposed to install a second transformer. The existing switchgear and existing circuits are rated for the increased load.

##### Merryhill 33/11kV Primary Substation - ITC (2 x 20/40MVA)

The predicted load at Merryhill substation will exceed the existing site firm capacity. It is therefore proposed to replace the existing transformers with larger units. The existing switchgear is not rated for this increased load but will be replaced as part of this project. The existing circuits supplying the transformers are not fully rated for the maximum transformer capacity but more than adequate for the anticipated peak load.

##### Pinner Green 33/11kV Substation - ITC (1x11/18/24MVA)

The predicted load at Pinner Green Primary will exceed the existing firm capacity. It is therefore proposed to install a new 33/11kV 11/18/24MVA transformer, and utilise the existing 33kV U/G FF cable (currently running at 11kV) and connect this to the new 33kV switchgear at Hatch End Grid.

#### **Watford South 3A & 3B**

##### Berkhamstead 33/11kV Primary Substation - ITC (2 x 20/40MVA) and 2 x 33kV Circuits

The predicted load at Berkhamstead Primary substation will exceed the existing firm capacity, including the transfer capacity. It is therefore proposed to replace the existing transformers with larger units. The existing switchgear is not fully rated for this increased load. It is therefore proposed to replace this switchgear. The

### Elstree – Watford South

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existing circuits supplying the transformers are not fully rated for the larger units. It is therefore proposed to replace both of these circuits.

### Watford South 2 & 4

#### Greenhill 33/11kV Primary Substation - ITC (18/30/40MVA), switchgear and cables

The predicted load at Greenhill substation will exceed the existing firm capacity, including the transfer capacity to Kenton & Wealdstone substations. It is therefore proposed to replace the existing transformers with larger units. The existing switchgear is not fully rated for this increased load. It is therefore proposed to replace this switchgear. The existing circuits supplying the transformers are not fully rated for the larger units. It is therefore proposed to replace one of these circuits and double up the existing circuits to provide the second fully rated circuit.

#### Frogmore 33/11kV Primary Substation - 11kV Load Transfer to Warners End

The predicted load at Frogmore substation will exceed the existing rating. Whilst it is possible to increase the capacity a more economical solution would be to transfer load to Warners End substation.

### Innovation: Demand Side Response

Studies have been undertaken to identify suitable sites for participation in smart demand response to reduce peak load with a view to delay proposed reinforcement work.

## 4.2 Financial Appraisal and Benefits

Information regarding Load Indices and Health Indices as part of OFGEM output measures are available in the Appendices.

The financial expenditure is shown in the Appendices.

## 5 Rejected Strategies

### 5.1 Warners End

#### Transfer load to Frogmore and St Pauls (£0.8m)

In order to keep Warners End firm for the ED1 period a minimum of approximately 5MVA of winter load needs to be moved onto Frogmore and St Pauls. This will use up the majority of the spare 11kV capacity for the whole area which is undesirable.

### 5.2 Merryhill

#### Transfer load to Hartspring (£0.4m)

In order to keep Merryhill firm for the ED1 period a minimum of approximately 5MVA of winter load needs to be moved onto Hartspring. This will use up the majority of the spare 11kV capacity for the whole area which is undesirable.

### 5.3 Frogmore

#### Frogmore Primary: ITC (2 x 20/40MVA) and 11kV Switchboard (£2.5m)

Replace the 2 x 12/24MVA transformers with 2 x 20/40MVA transformers and the 1200A 11kV switchboard with a 2000A 11kV switchboard. This option has been rejected because the neighbouring substation at Warners End is due to be reinforced and it is more economical to transfer load across to Warners End.

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 EPN Area
Reference 2	132kV Network HV Schematic Operating Diagrams East of England (date)
Reference 3	33kV Network HV Schematic Operating Diagrams East of England (date)
Reference 4	Dacorum and Watford Council development strategy
Reference 5	Current and forecast asset health information (HI) as per 2013 RIIO-ED1 submission

### 6.1 Appendices

Appendix	Description
Appendix A	Geographical diagram
Appendix B	Single Line Diagram – Existing Network
Appendix C	Single Line Diagram – Recommended Strategy
Appendix D	Detailed costs for recommended strategy
Appendix E	Output Measures – Load Indices (LI)
Appendix F	Output Measures – Health Indices (HI)
Appendix G	Generation Heat Map

### 6.2 Document History

Version	Date of Issue	Author	Details
1.0	06/02/2013	Paul Ramsbotham	Final Version for SMT approval
1.1	20/05/2013	Nuno da Fonseca Paul Ramsbotham	Published
1.2	24/06/2013	Paul Ramsbotham	Updates to reflect new position for RIIO-ED1
1.3	14/03/2014	Paul Ramsbotham	Updated with 19 <sup>th</sup> February 2014 NAMP, EPN HI List and latest LI information

**Elstree – Watford South**

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
Paul Ramsbotham	Infrastructure Planner		19/03/14
Nuno da Fonseca	Infrastructure Planning Manager (EPN)		

**Approval by:**

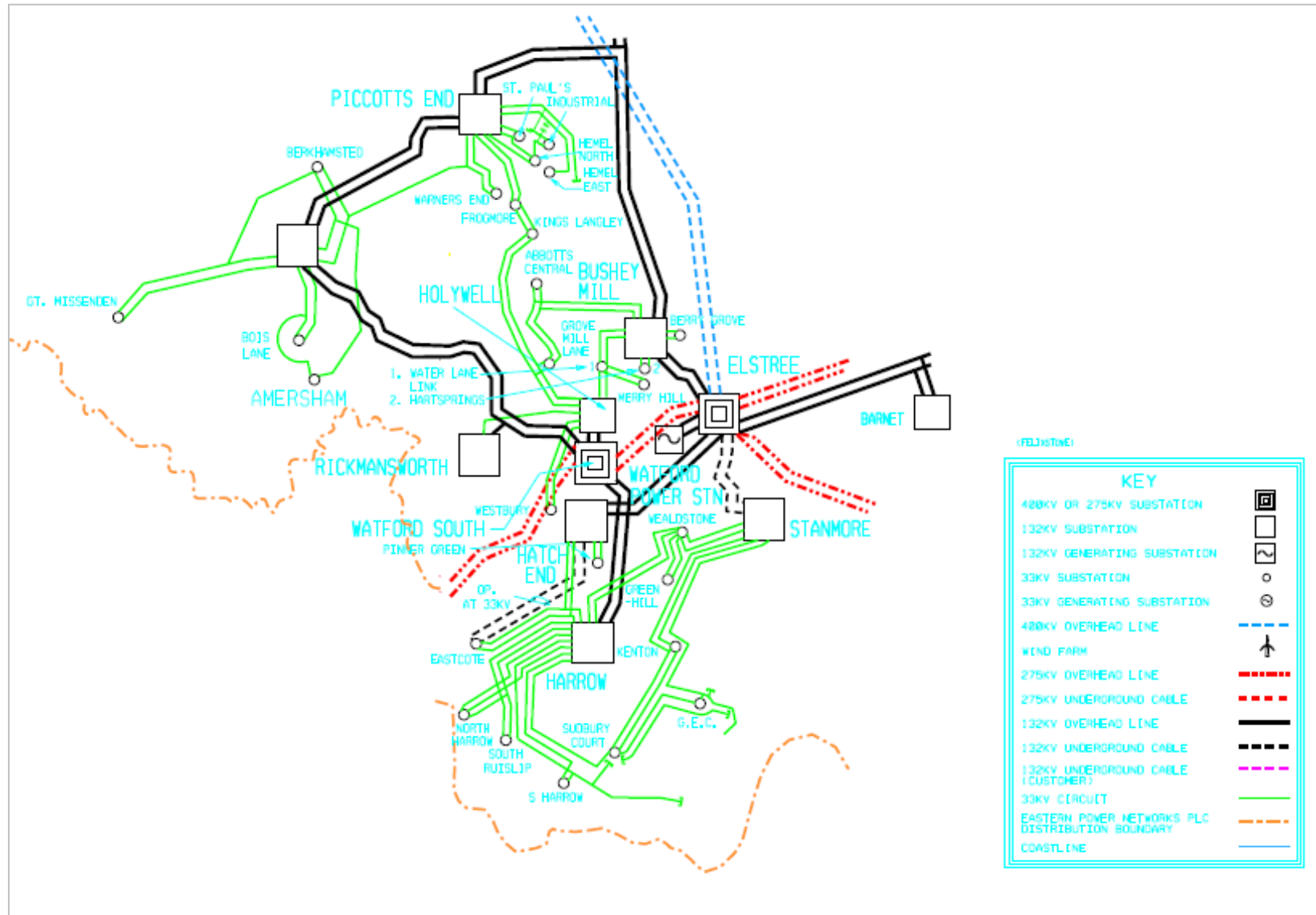
Name	Role	Signature	Date
Robert Kemp	Head of System Development		20/03/14
Barry Hatton	Director of Asset Management		

# Regional Development Plan

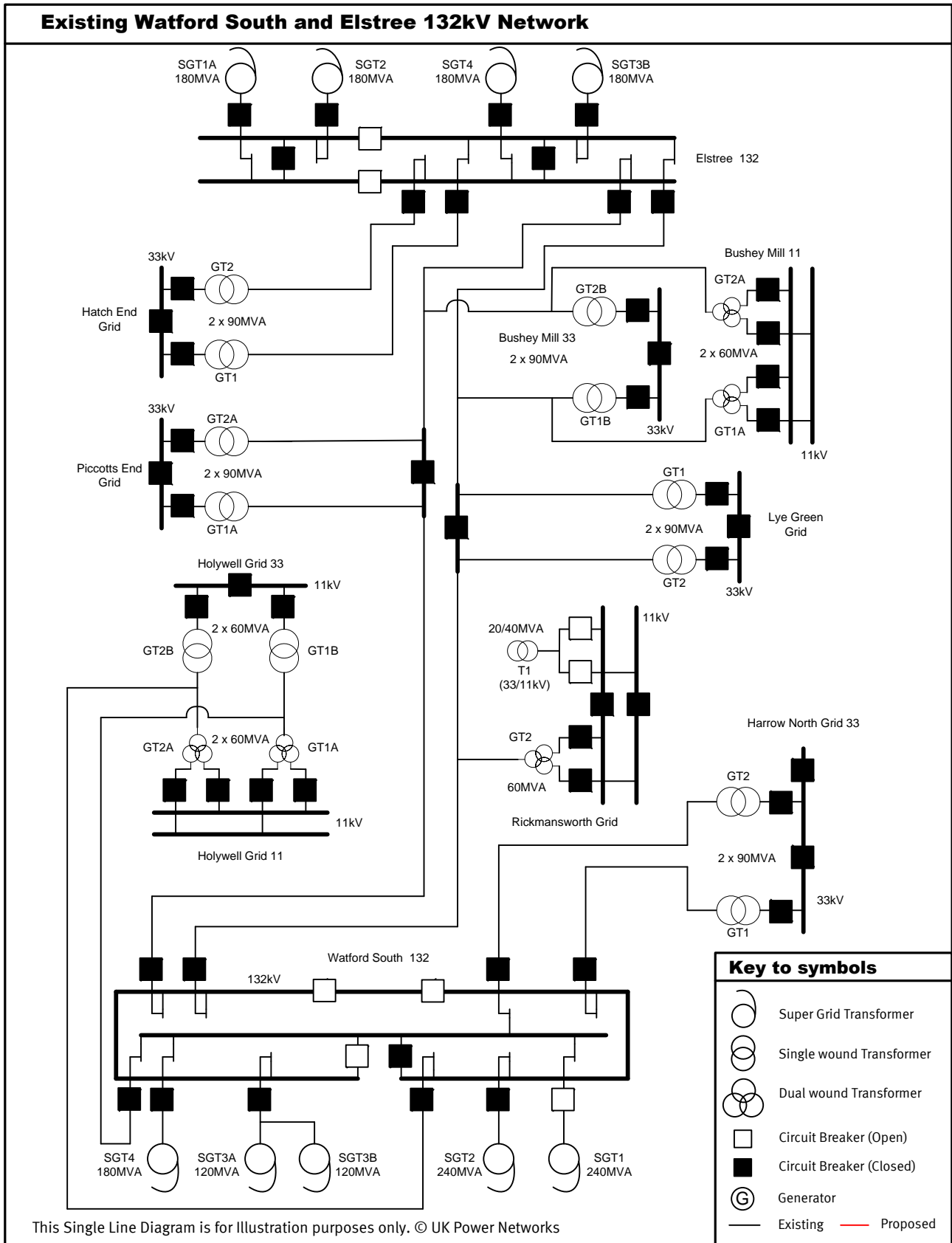


## Elstree – Watford South

### APPENDIX A: GEOGRAPHICAL DIAGRAM

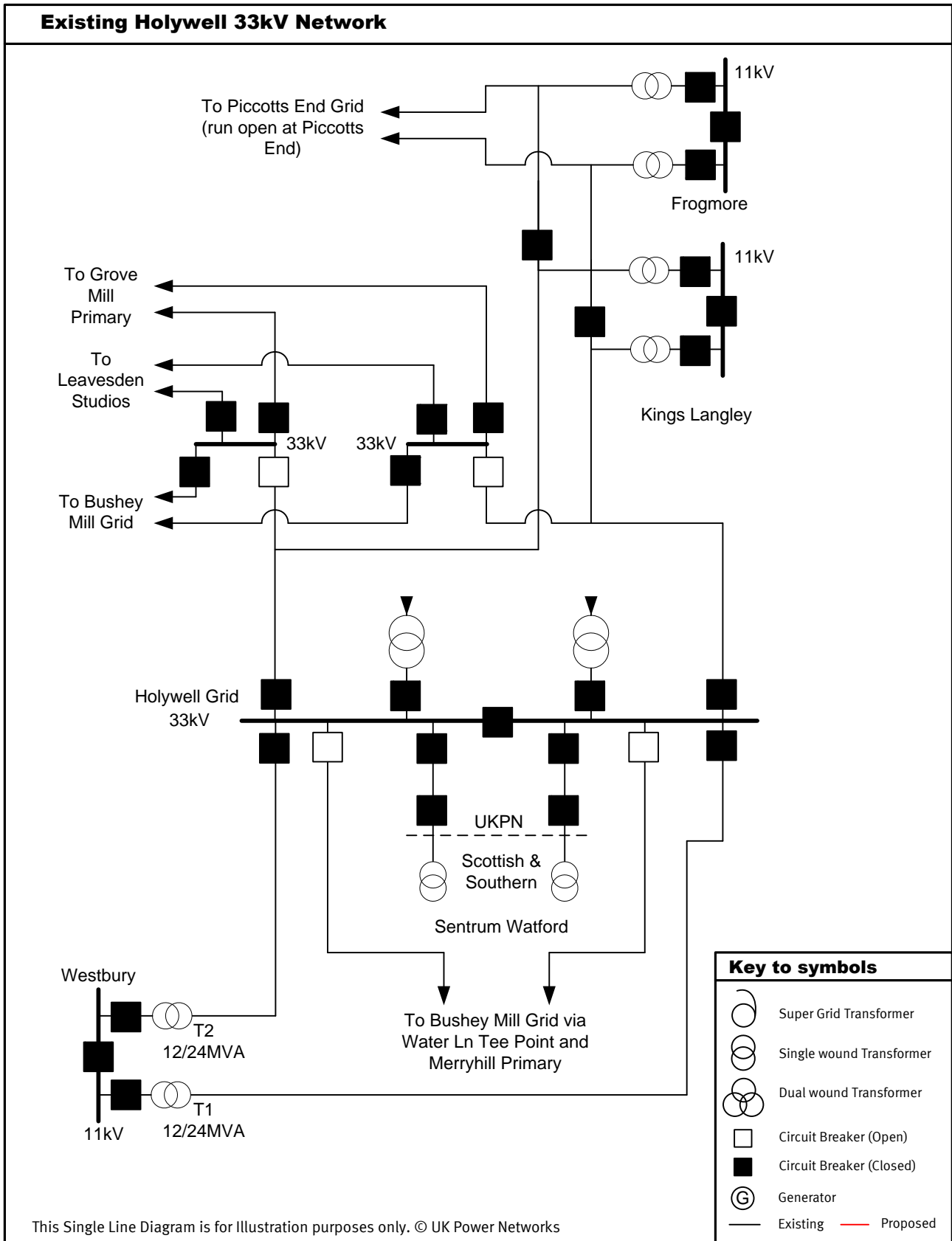


### APPENDIX B: SINGLE LINE DIAGRAM – EXISTING NETWORK

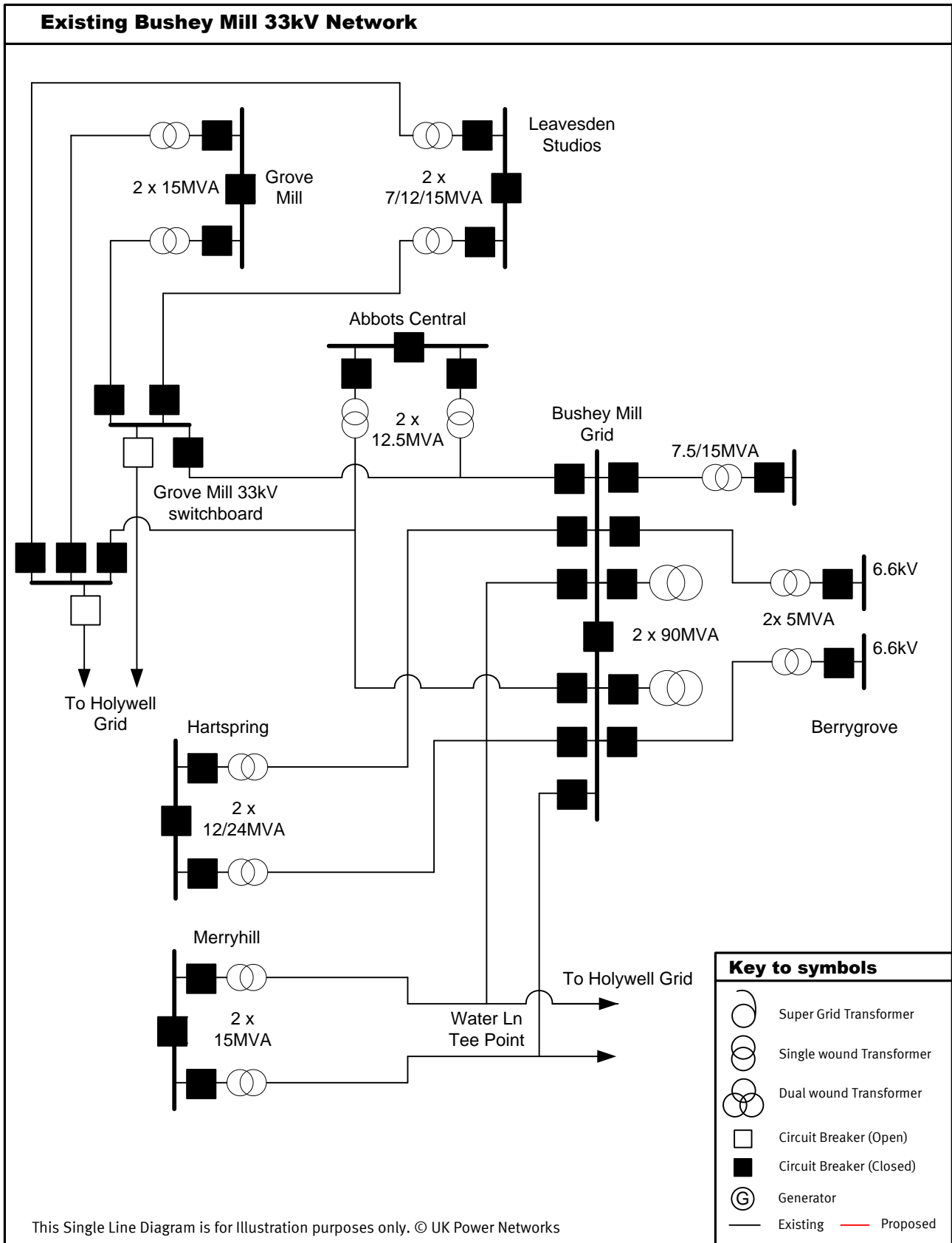


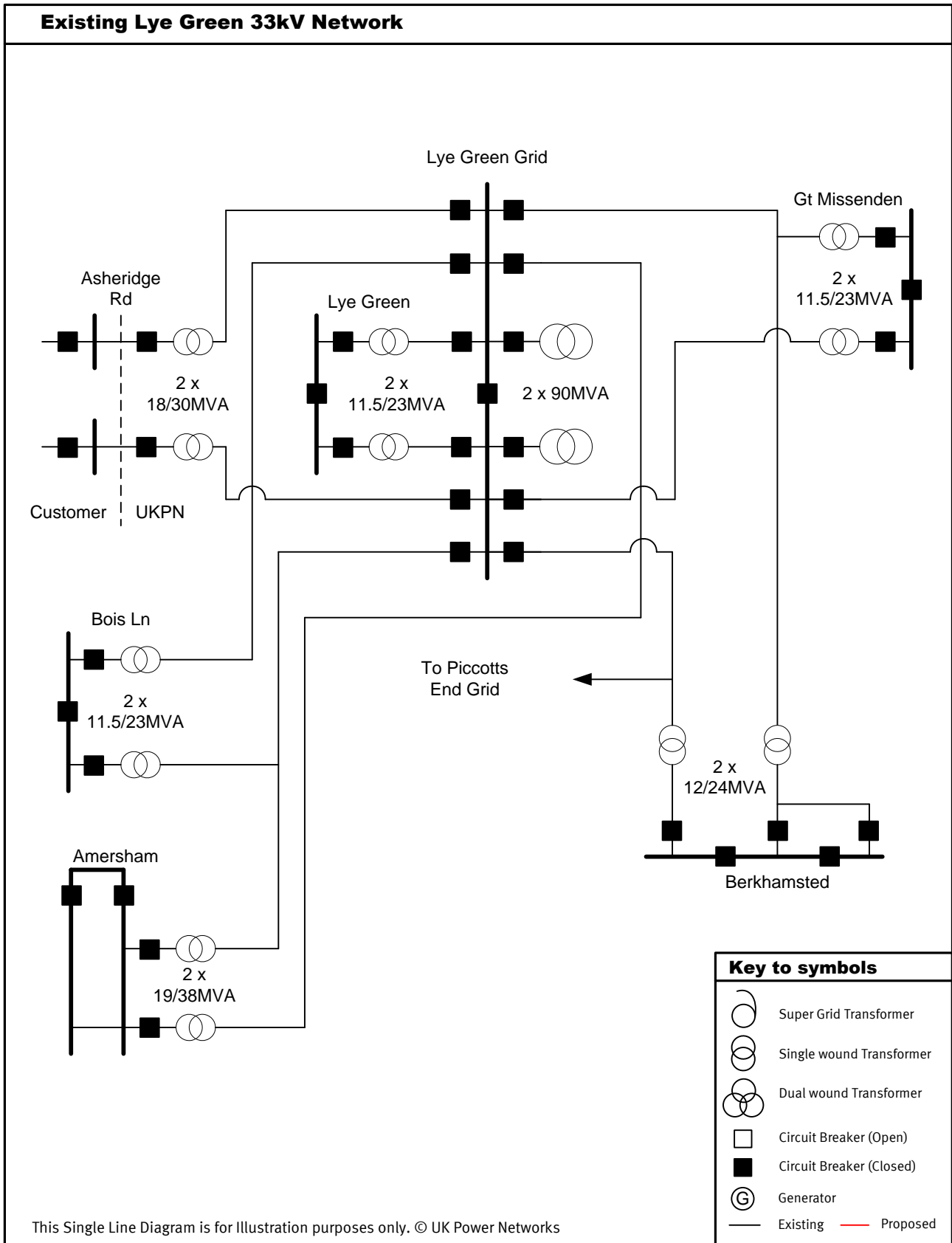


## Elstree – Watford South

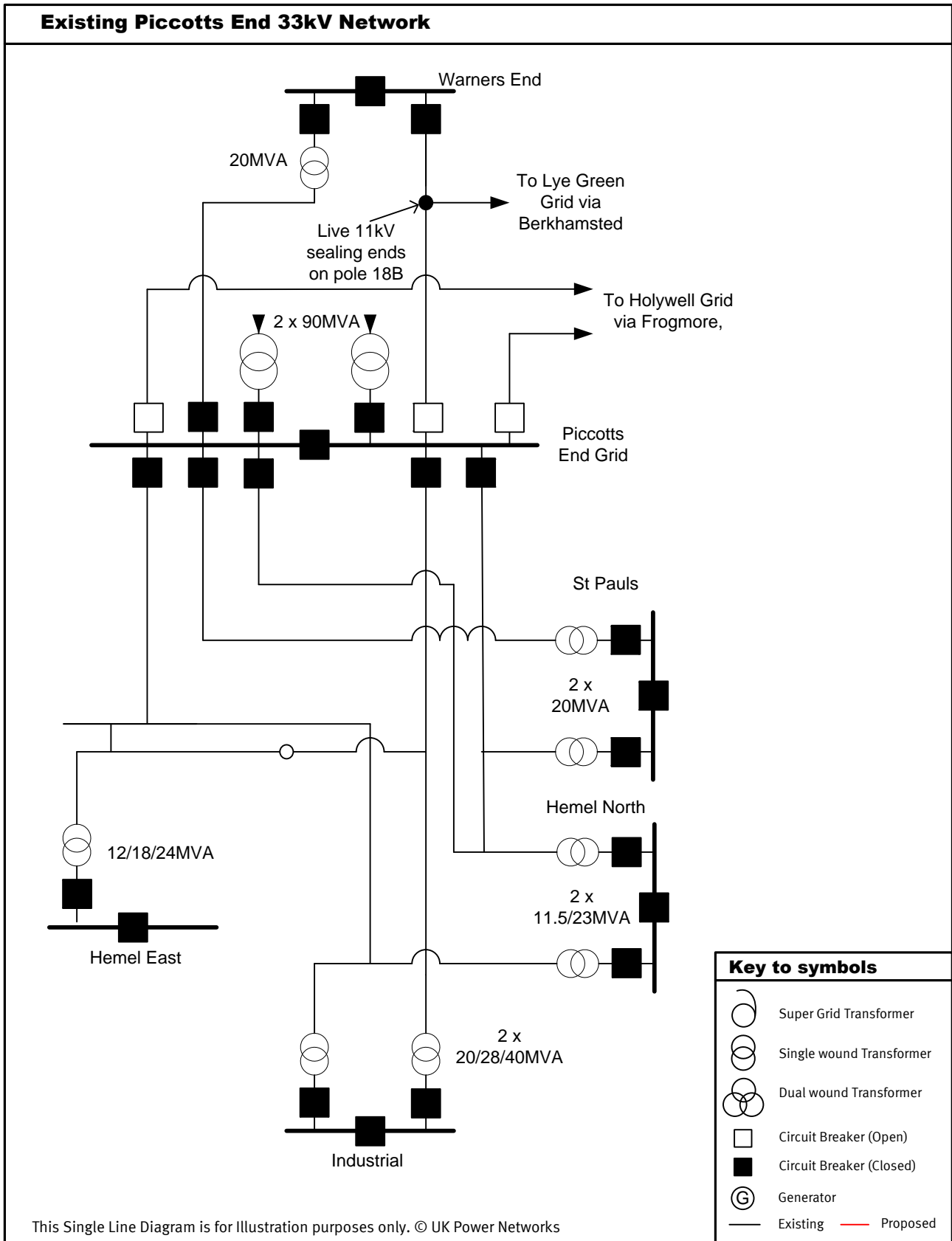


## Elstree – Watford South

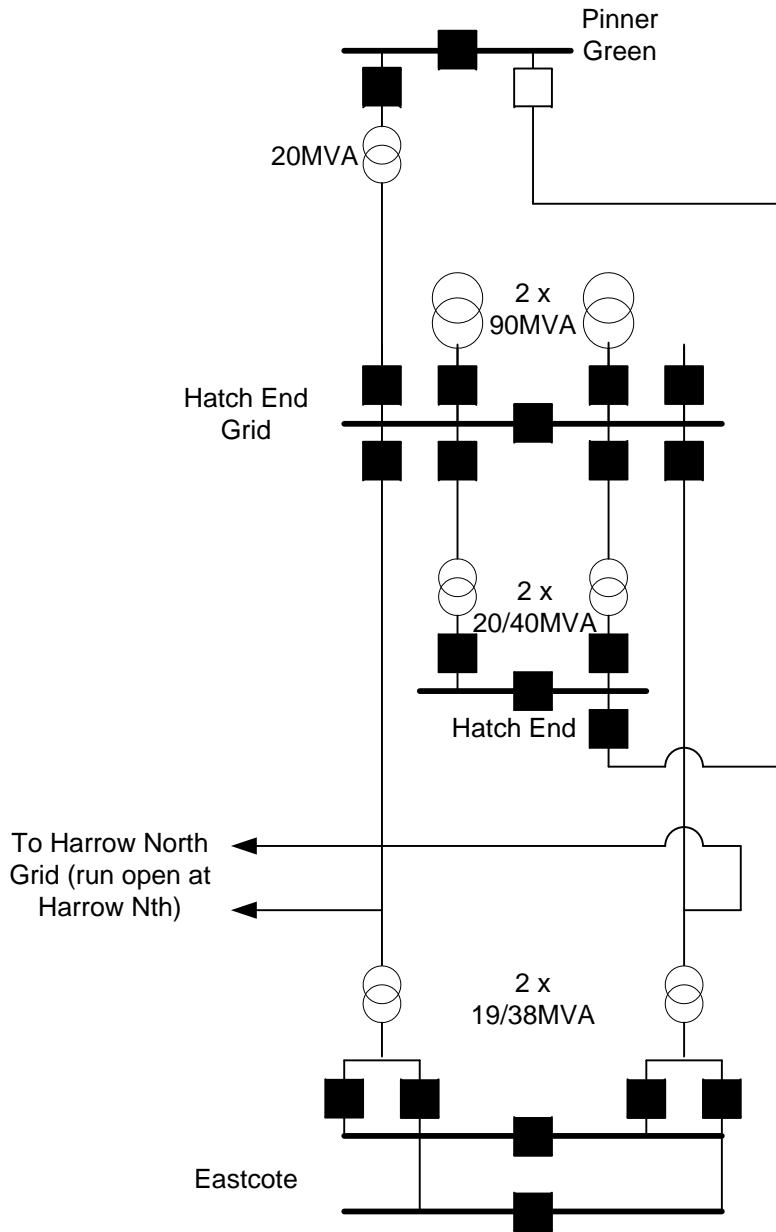




## Elstree – Watford South



### Existing Hatch End 33kV Network



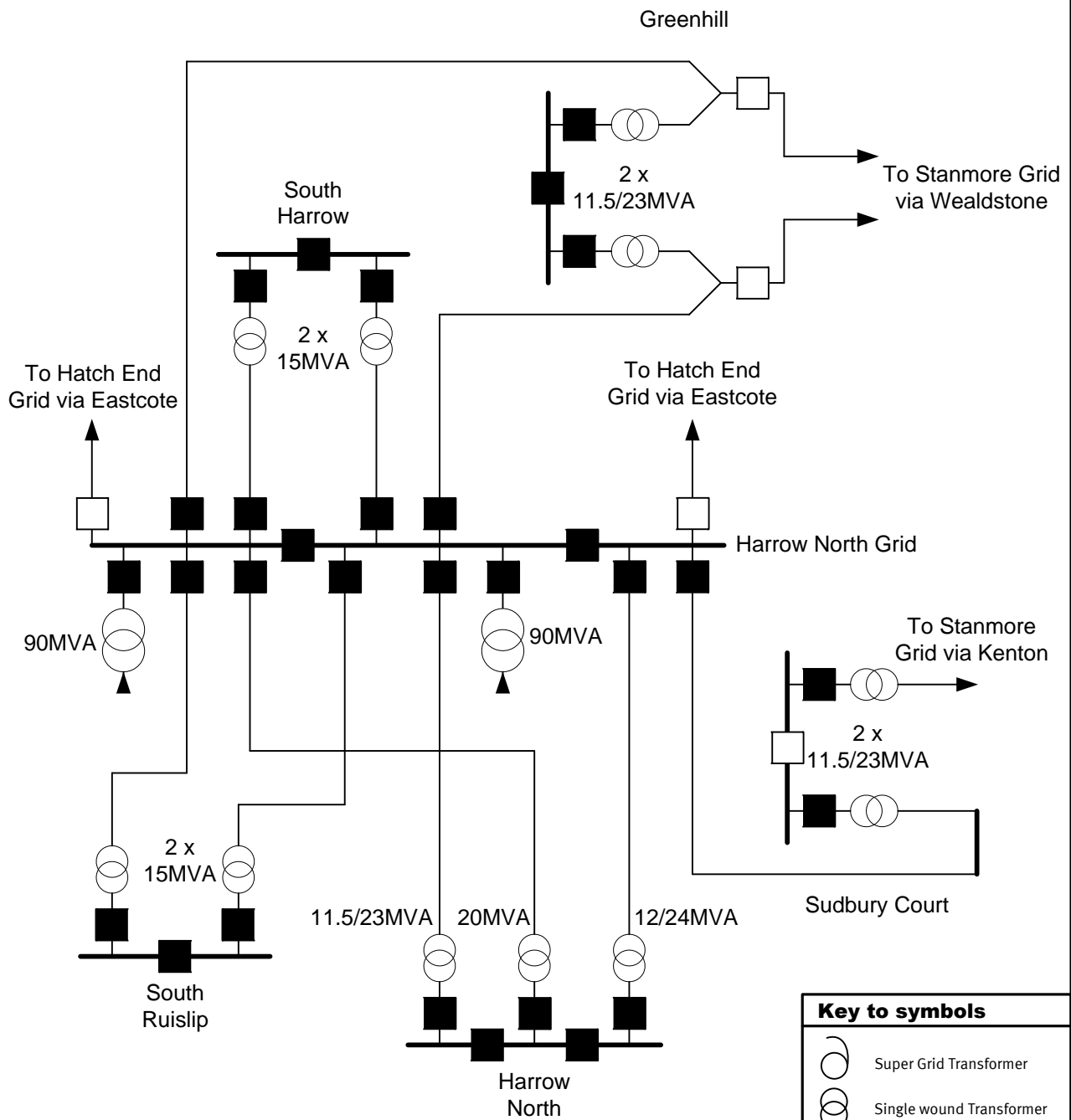
#### Key to symbols

	Super Grid Transformer
	Single wound Transformer
	Dual wound Transformer
	Circuit Breaker (Open)
	Circuit Breaker (Closed)
	Generator
	Existing
	Proposed

This Single Line Diagram is for Illustration purposes only. © UK Power Networks

## Elstree – Watford South

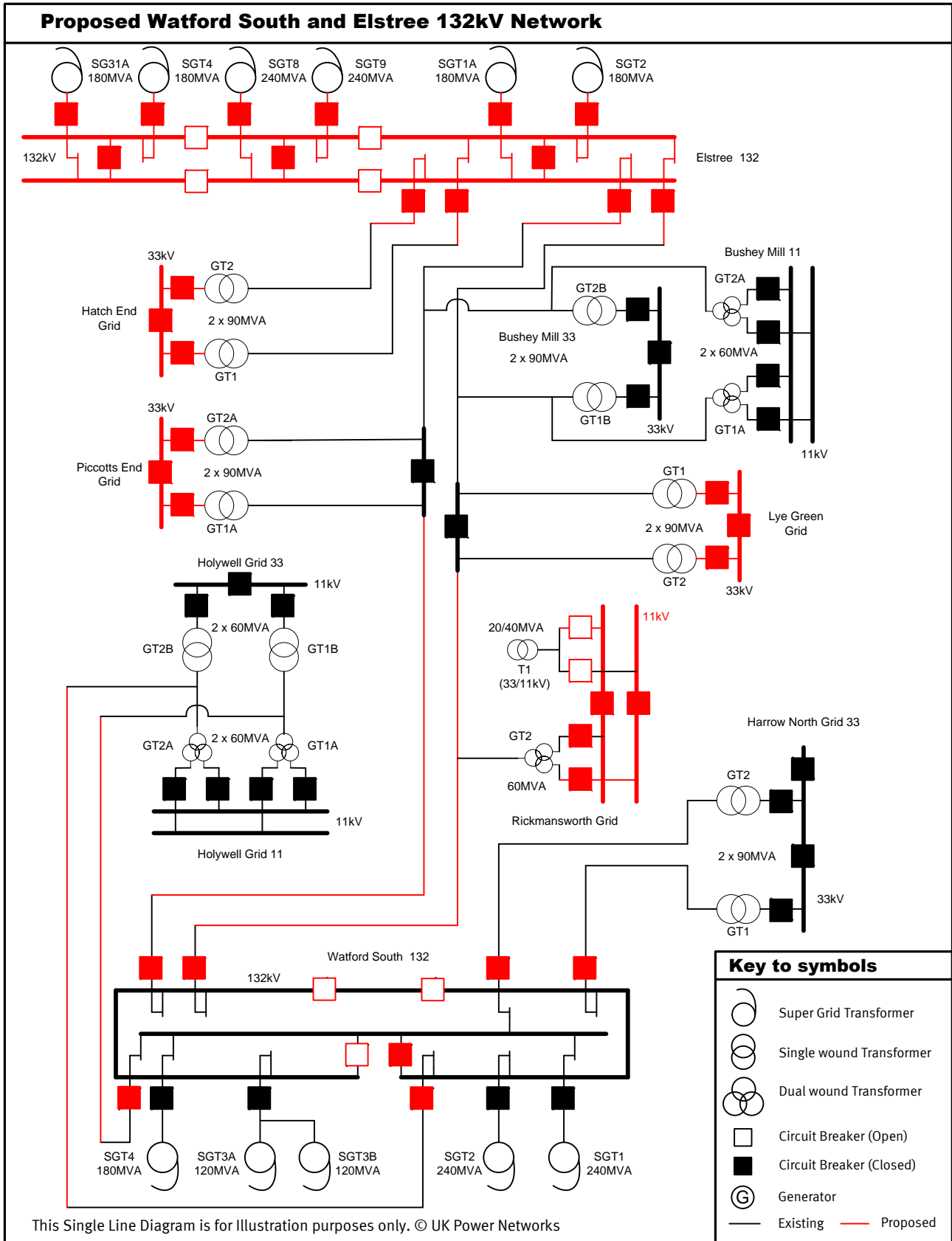
### Existing Harrow North 33kV Network



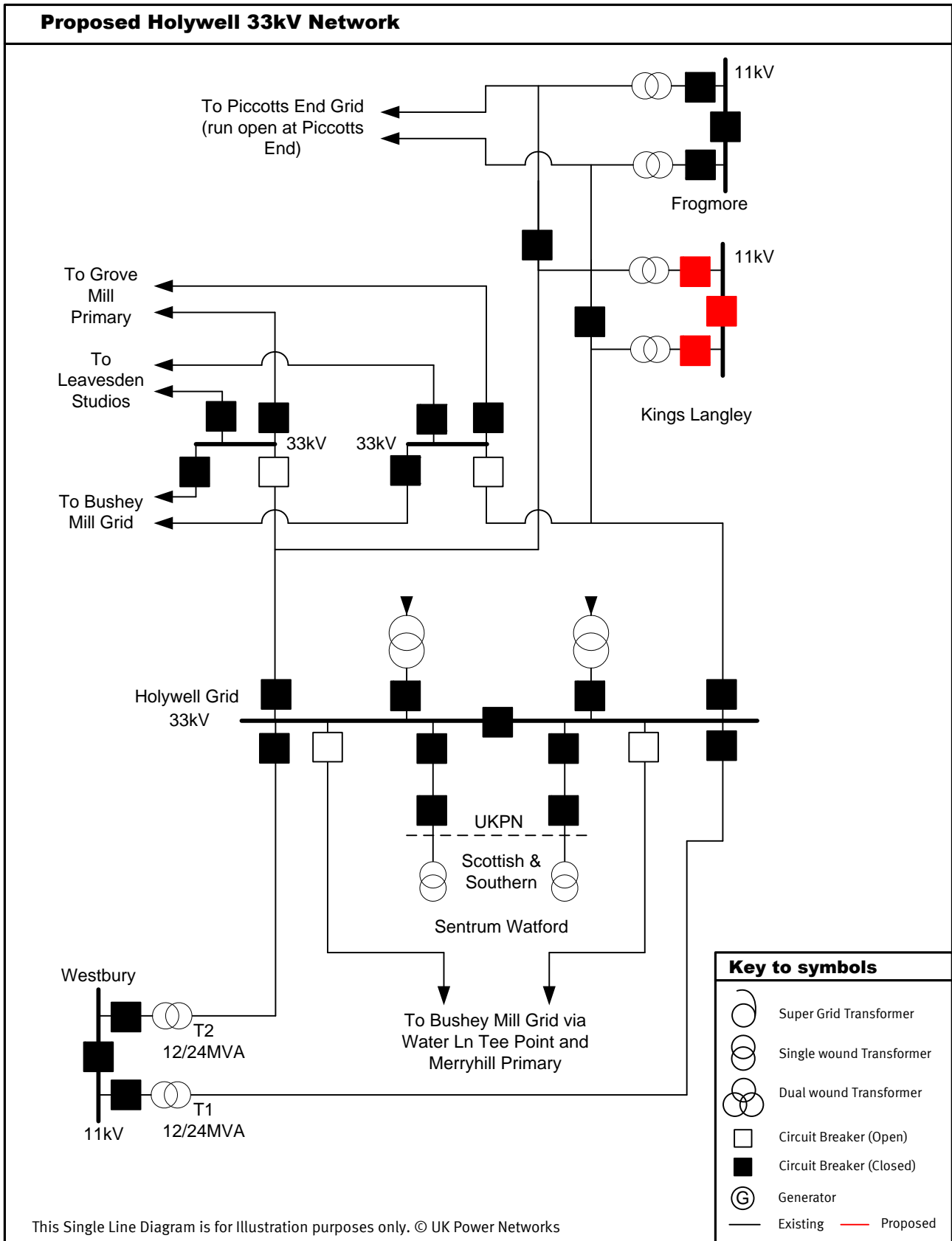
Key to symbols	
	Super Grid Transformer
	Single wound Transformer
	Dual wound Transformer
	Circuit Breaker (Open)
	Circuit Breaker (Closed)
	Generator
	Existing
	Proposed

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

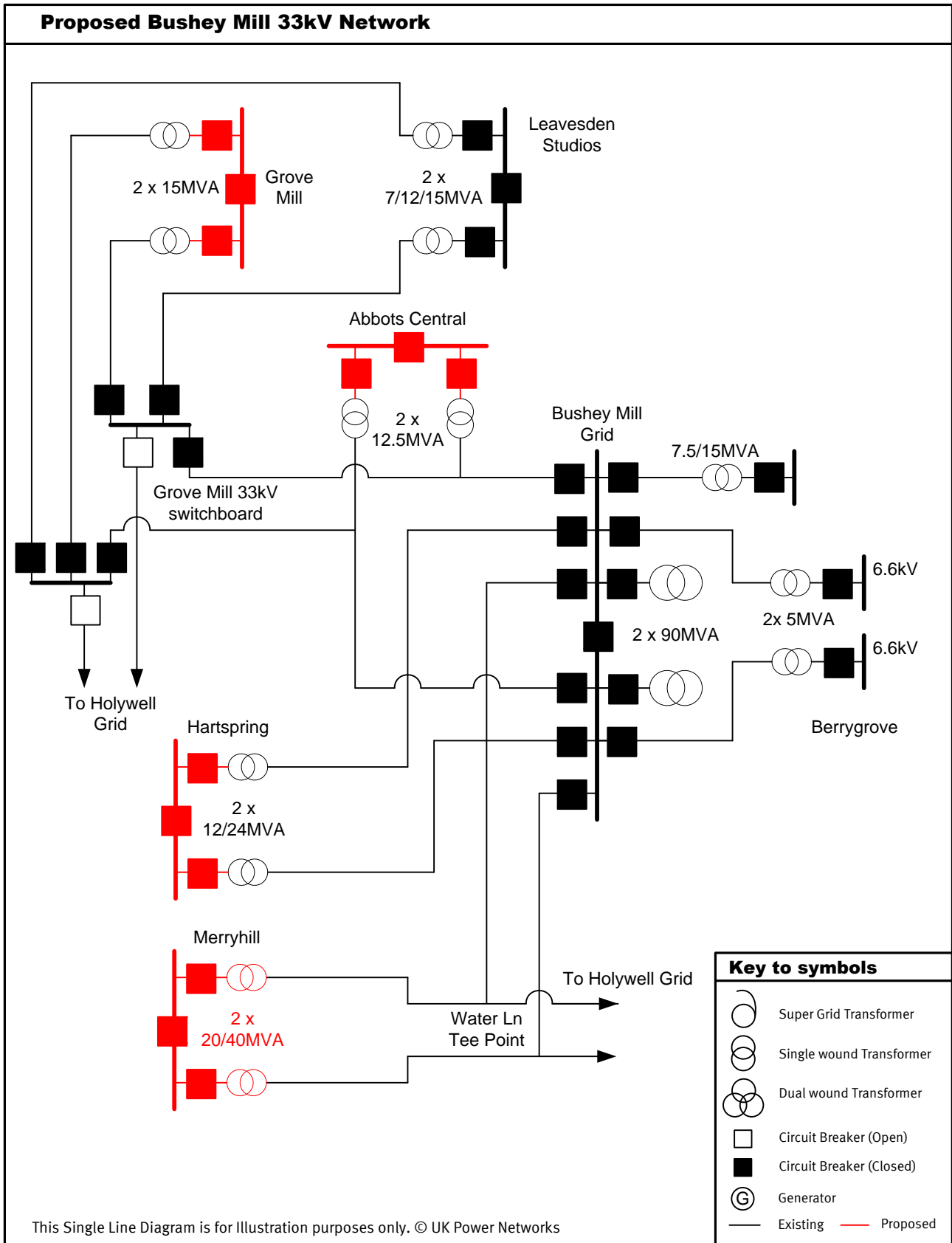


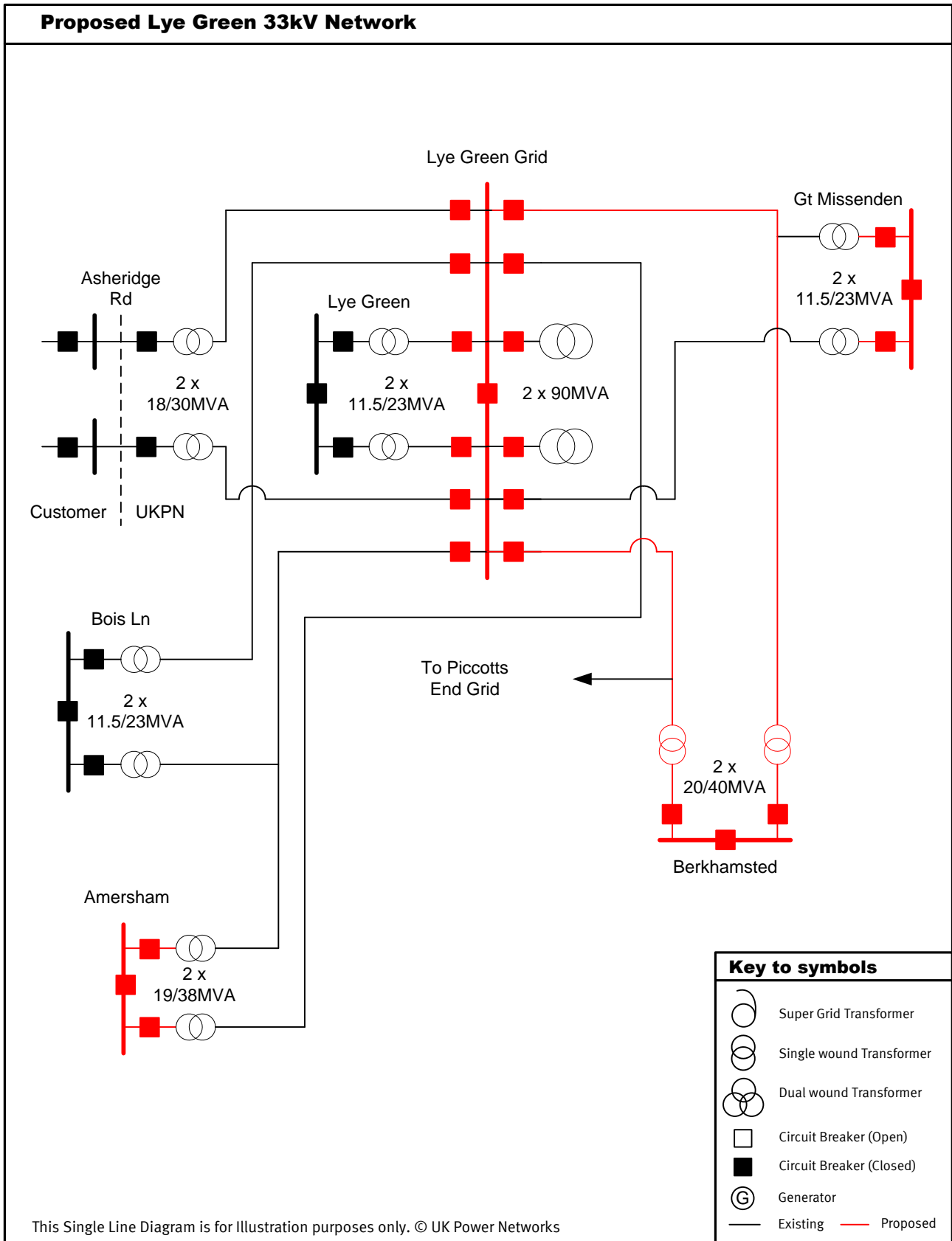
## Elstree – Watford South

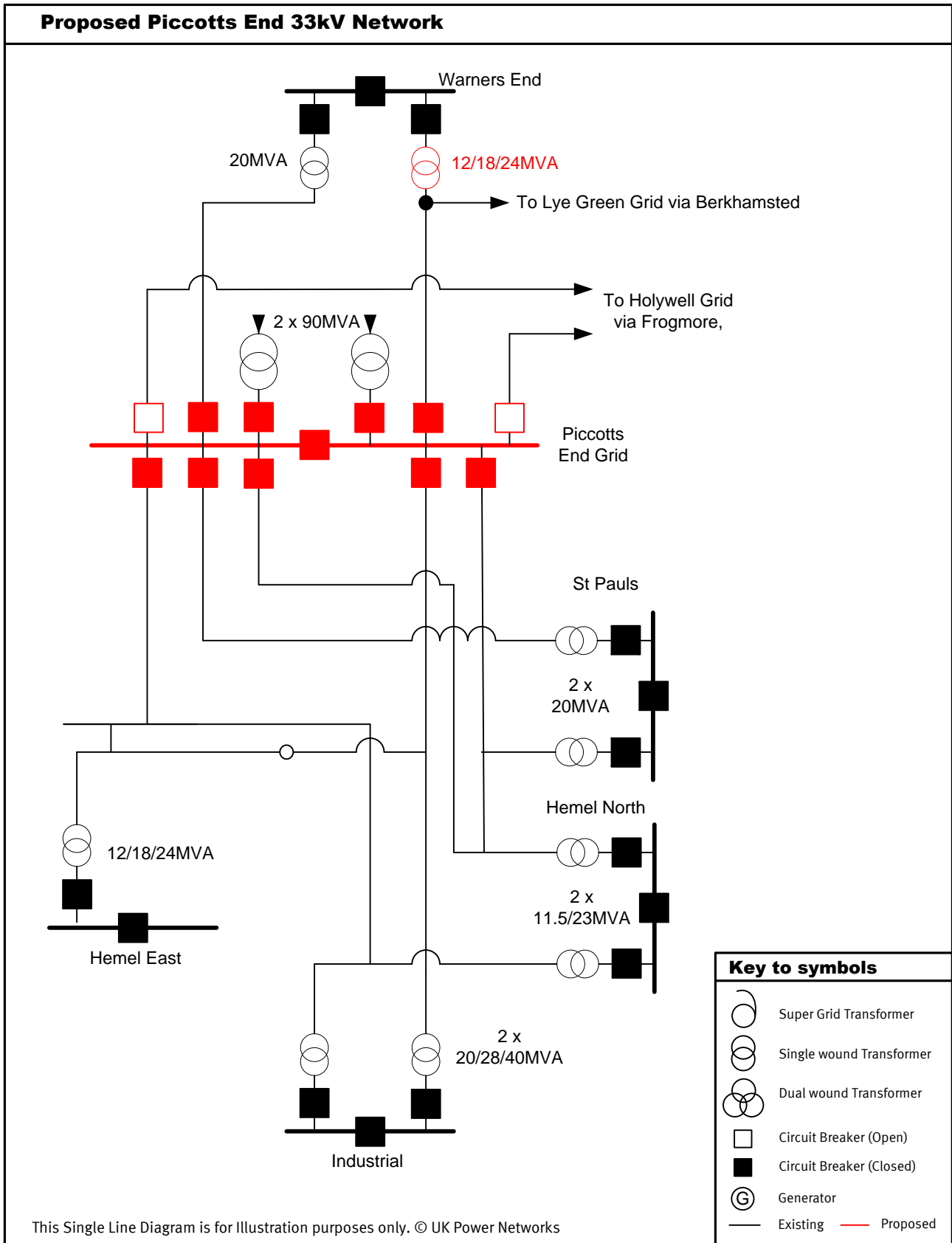




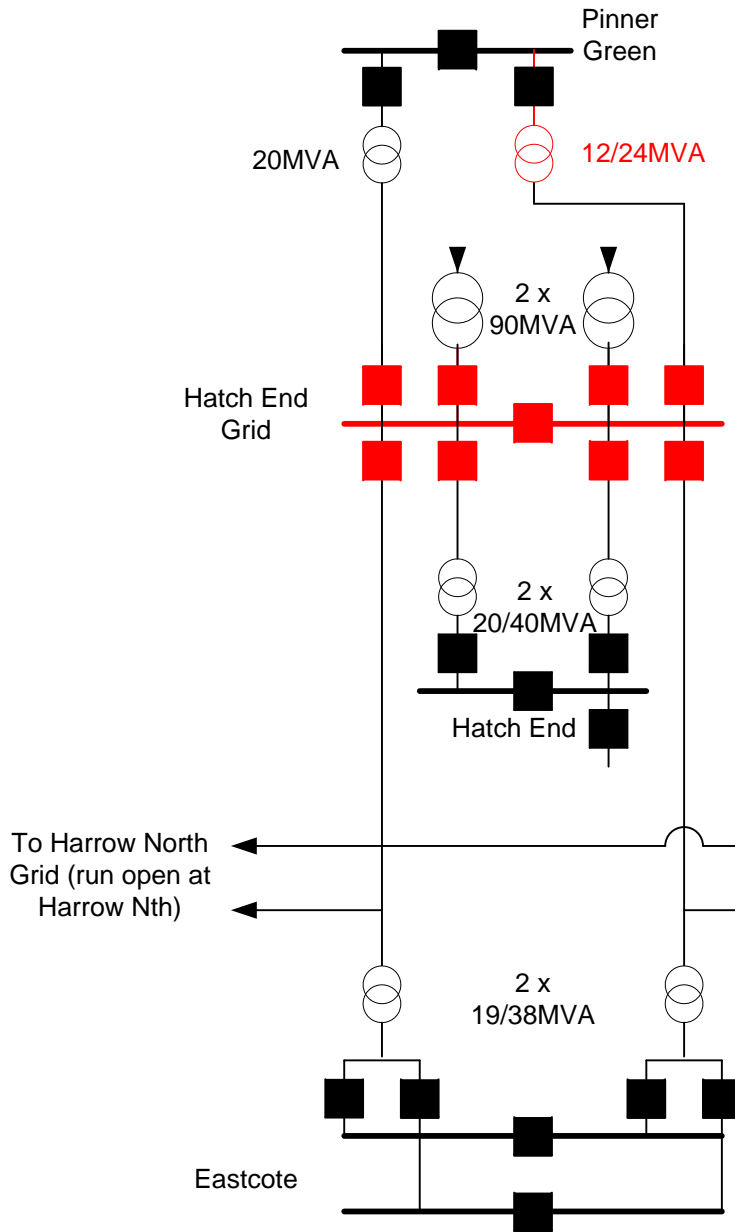
## Elstree – Watford South







### Proposed Hatch End 33kV Network

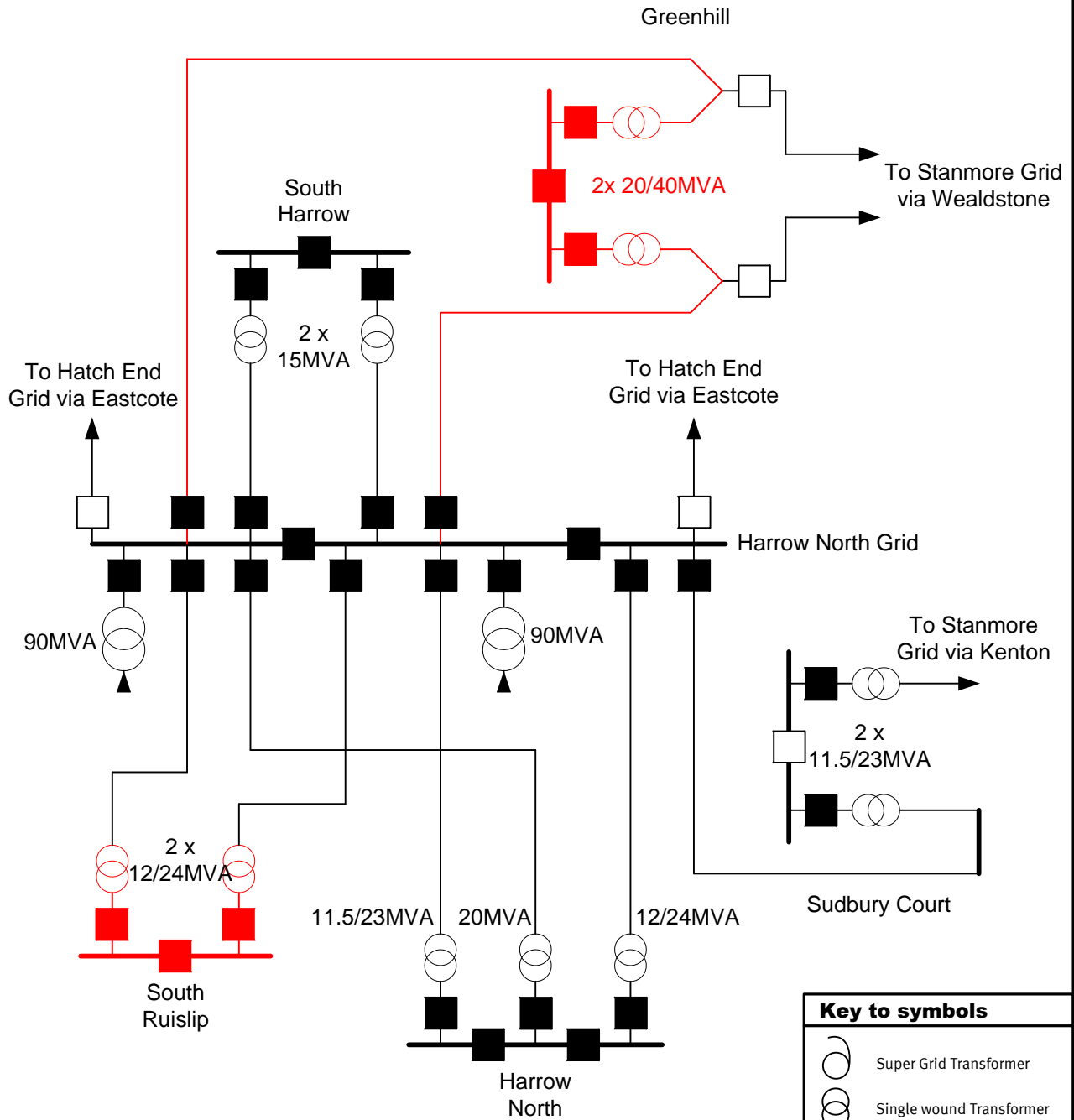


#### Key to symbols

- Super Grid Transformer
- Single wound Transformer
- Dual wound Transformer
- Circuit Breaker (Open)
- Circuit Breaker (Closed)
- Generator
- Existing  Proposed

This Single Line Diagram is for Illustration purposes only. © UK Power Networks

### Proposed Harrow North 33kV Network



Key to symbols	
	Super Grid Transformer
	Single wound Transformer
	Dual wound Transformer
	Circuit Breaker (Open)
	Circuit Breaker (Closed)
	Generator
	Existing
	Proposed

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# Regional Development Plan



## Elstree – Watford South

### APPENDIX D: DETAILED COSTS FOR RECOMMENDED STRATEGY

NAMP version: Table J Less Ind Baseline 19-02-2014

Cat	Namp Line	Project ID	Description	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
A	1.02.03	2786	PCD - Watford South - Lye Green - Conductor Replacement				509,293	1,530,599					
A	1.02.03	7538	PC - Rayners End - Harrow - Conductor Replacement									262,713	788,140
A	1.02.03	7542	PKA - Elstree - Bushey Milll - Conductor Replacement								108,176	324,528	
A	1.02.03	7544	PLC - Elstree - Hatch End - Conductor Replacement								247,260	741,779	
A	1.02.03	7557	POB - Watford West - Watford South - Conductor Replacement			30,907	92,722						
A	1.02.05	5658	PC - Harrow North/Watford South - PC 79 Feasibility Work	80,000									
A	1.47.08	5899	Piccotts End 132/33kV Grid S/S - Replace 33kV Switchgear (Building)	11,250									
A	1.48.02	2452	Hatch End 33/11kV Primary Substation - Replace 33kV Switchboard (2000A)	765,921									
A	1.48.02	2507	Lye Green 132/33kV Grid Substation - Replace 33kV Switchgear							79,648	1,146,934	264,727	
A	1.48.06	7601	Watford South 132kV Grid Supply Point - Replace 132kV Switchgear				1,265,799	2,862,868	2,164,170	1,767,384			
A	1.48.11	2289	Piccotts End 132/33kV Grid Substation - Replace 33kV Switchgear (2000A)	952,856	1,475,119								
A	1.50.01	3315	Great Missenden 33/11kV Primary Substation - Replace 11kV Switchgear						39,111	823,146			
A	1.50.01	5499	South Ruislip 33/11kV Primary Substation - Replace 11kV Switchgear		39,247	849,362							
A	1.50.01	7627	Abbots Central 33/11kV Primary Substation - Replace 11kV Switchgear								234,836	555,100	
A	1.50.01	7628	Amersham 33/11kV Primary Substation - Replace 11kV Switchgear									253,523	672,178

## Elstree – Watford South

### DETAILED COSTS FOR RECOMMENDED STRATEGY

NAMP version: Table J Less Ind Baseline 19-02-2014

Cat	Namp Line	Project ID	Description	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
A	1.50.01	7644	Grove Mill 33/11kV Primary Substation - Replace 11kV Switchgear							252,267	653,264		
A	1.50.01	7659	Rickmansworth 132/11kV Grid Substation - Replace 11kV Switchgear									467,818	1,162,223
A	1.50.01	7692	Hartspring 33/11kV Primary Substation - Replace 11kV Switchgear								279,043	673,399	
A	1.50.01	7695	Kings Langley 33/11kV Primary Substation - Retrofit 11kV Switchgear										48,979
A	1.51.03	5896	South Ruislip 33/11kV Primary Substations - Replace Transformers (11/18/24MVA)	283,465	1,133,888								
A	1.51.11	5898	Piccotts End 132/33kV Grid Substation - Re-Gasket Transformers	50,000	128,000								
R	1.33.01	4203	Warners End 33/11kV Primary Substation - ITC (1x 12/18/24MVA)				214,000	492,000					
R	1.33.01	5402	Merryhill 33/11kV Primary Substation - ITC (2 x 20/30/40MVA) & 11kV Switchgear		119,253	1,431,041	490,112						
R	1.33.01	5409	Greenhill 33/11kV Primary Substation - ITC (18/30/40MVA), Switchgear and Cables							290,448	953,780	666,208	
R	1.33.01	5608	Pinner Green 33/11kV Substation - ITC (1x11/18/24MVA)						11,970	248,488	637,988		
R	1.33.01	6201	Berkhamstead 33/11kV Primary Substation - ITC (2 x 20/30/40MVA), 11kV Switchgear and 33kV Circuits								585,747	2,831,112	1,505,817
R	1.34.02	6338	Frogmore 33/11kV Primary Substation - 11kV Load Transfer to Warners End				84,134	252,403					

## Elstree – Watford South

### APPENDIX E: OUTPUT MEASURES – LOAD INDICES

PLE information to Table CV102 (LI) – OFGEM definition and Element Energy growth forecast.

Substation	Season	First Limitation	FC NOW (MVA)	DPCR5 Intervention		RIIO-ED1 without intervention				RIIO-ED1 with Intervention			P2/6 End of ED1	
				NAMP	FC ED1 Start (MVA)	2014 (S) 14/15 (w)	2022 (S) 22/23 (W)	2014 (S) 14/15 (w)	2022 (S) 22/23 (W)	NAMP	Driver	2022 (S) 22/23 (W)	P2/6 Class	Comply
Abbots Central	W	Switchgear	15.2		15.2	10.5	11.1	LI1	LI1	7627	16.3	LI1	B	Yes
Berkhamsted	W	Circuit Rating	21.5		21.5	18.9	20.8	LI2	LI3	6201	21.5	LI3	C	Yes
Bois Lane	W	Transformer	18.0		18.0	11.2	12.1	LI1	LI1		18.0	LI1	C	Yes
Bushey Mill Grid 11	S	Transformer	60.0		60.0	28.8	30.7	LI1	LI1		60.0	LI1	C	Yes
Bushey Mill Grid 33	W	Switchgear	114.3		114.3	62.5	66.3	LI1	LI1		114.3	LI1	D	Yes
Eastcote Primary	W	Transformer	38.0		38.0	31.5	36.9	LI2	LI3		38.0	LI3	C	Yes
Frogmore	W	Transformer	24.0		24.0	20.5	22.0	LI2	LI2	6338	24.0	LI2	C	Yes
Great Missenden	W	Switchgear	15.2		15.2	12.4	13.6	LI2	LI1	3315	23.0	LI1	C	Yes
Greenhill	S	Transformer	15.0		15.0	14.7	15.8	LI3	LI5	5409	30.0	LI1	C	Yes
Grove Mill	W	Aux equipment	15.0		15.0	12.9	14.1	LI2	LI2		15.0	LI2	C	Yes
Harrow North	W	Transformer	36.0		36.0	27.6	31.2	LI1	LI2		36.0	LI2	C	Yes
Harrow North Grid 33	W	Switchgear	114.3		114.3	74.8	82.3	LI1	LI1		114.3	LI1	D	Yes
Hartspring	W	Transformer	24.0		24.0	16.9	17.4	LI1	LI1		24.0	LI1	C	Yes
Hatch End Grid	W	Switchgear	38.1	2452	38.1	18.3	19.8	LI1	LI1		38.1	LI1	C	Yes
Hatch End Grid 33	W	Switchgear	68.6		78.0	60.6	69.1	LI1	LI2		78.0	LI2	D	Yes
Hemel East	W	Backfeed	10.3		10.3	8.0	8.4	LI1	LI2		10.3	LI2	B	Yes
Hemel North	S	Transformer	17.3		17.3	11.7	12.2	LI1	LI1		17.3	LI1	C	Yes
Holywell Grid	S	Transformer	60.0		60.0	40.0	43.4	LI1	LI1		60.0	LI1	C	Yes



# Regional Development Plan



## Elstree – Watford South

### OUTPUT MEASURES – LOAD INDICES

Substation	Season	First Limitation	FC NOW (MVA)	DPCR5 Intervention		RIIO-ED1 without intervention				RIIO-ED1 with Intervention			P2/6 End of ED1	
				NAMP	FC ED1 Start (MVA)	2014 (S) 14/15 (w)	2022 (S) 22/23 (W)	2014 (S) 14/15 (w)	2022 (S) 22/23 (W)	NAMP	Driver	2022 (S) 22/23 (W)	P2/6 Class	Comply
Holywell Grid 33	W	Transformer	78.0		78.0	65.3	68.9	LI2	LI2		78.0	LI2	D	Yes
Industrial	S	Transformer	15.0		15.0	12.0	12.2	LI1	LI2		15.0	LI2	C	Yes
Kings Langley	W	Transformer	18.0		18.0	11.3	12.3	LI1	LI1		18.0	LI1	C	Yes
Lye Green	W	Transformer	23.0		23.0	14.7	16.0	LI1	LI1		23.0	LI1	C	Yes
Lye Green Grid 33	W	Switchgear	114.3		114.3	86.4	98.0	LI1	LI2		114.3	LI2	D	Yes
Merryhill	W	Transformer	19.5		19.5	20.8	22.4	LI5	LI5	5402	29.2	LI1	C	Yes
Piccotts End Grid 33	S	Transformer	90.0		90.0	47.1	49.1	LI1	LI1		90.0	LI1	C	Yes
Pinner Green	W	Backfeed	12.9		12.9	12.6	14.1	LI3	LI5	5608	24.0	LI1	C	Yes
Rickmansworth	W	Backfeed	29.0		29.0	24.1	26.3	LI2	LI2		29.0	LI2	C	Yes
South Harrow	W	Transformer	19.5		19.5	15.2	16.5	LI1	LI2		19.5	LI2	C	Yes
South Ruislip	W	Transformer	19.5	5896	22.2	10.6	11.9	LI1	LI1		22.2	LI1	B	Yes
St Pauls	W	Transformer	24.0		24.0	16.2	17.1	LI1	LI1		24.0	LI1	C	Yes
Warners End	W	Circuit Rating	9.7		9.7	9.3	14.5	LI3	LI5	4203	24.0	LI1	C	Yes
Westbury	W	Transformer	24.0		24.0	18.0	19.1	LI1	LI1		24.0	LI1	C	Yes

## Elstree – Watford South

### APPENDIX F: OUTPUT MEASURES - HEALTH INDICES

Substation	132kV Switchgear														
	ED1 Start (2015)					ED1 End (2023) No Investment					End of ED1 (2023) With Investment				
	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
LYE GREEN GRID		1					1					1			
PICCOTTS END GRID		1					1					1			
WATFORD SOUTH 132			9	1				9	1		10				
<b>TOTAL</b>		<b>2</b>	<b>9</b>	<b>1</b>		<b>2</b>		<b>9</b>	<b>1</b>		<b>10</b>	<b>2</b>			

Substation	33kV Switchgear														
	ED1 Start (2015)					ED1 End (2023) No Investment					End of ED1 (2023) With Investment				
	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
GROVE MILL PRIMARY	8					8					8				
HARROW NORTH GRID	16					15	1				15	1			
HATCH END GD & PRIMARY	9					9					9				
HOLYWELL GRID	14					14					14				
KINGS LANGLEY PRIMARY		2					2					2			
LYE GREEN GRID	2	1	1	9		2	1			10	13				
PICCOTTS END GRID	12					12					12				
<b>TOTAL</b>	<b>61</b>	<b>3</b>	<b>1</b>	<b>9</b>		<b>25</b>	<b>39</b>			<b>10</b>	<b>36</b>	<b>38</b>			

## Elstree – Watford South

### OUTPUT MEASURES - HEALTH INDICES

Substation	11/6.6kV Switchgear														
	ED1 Start (2015)					ED1 End (2023) No Investment					End of ED1 (2023) With Investment				
	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
ABBOTS CENTRAL PRIMARY		3	6					7	2		9				
AMERSHAM PRIMARY		5	8					8	5		13				
ASHERIDGE ROAD PRIMARY	2					2					2				
BERKHAMSTED PRIMARY		7	6		1		3	5	4	2	14				
BERRYGROVE PRIMARY		2						2					2		
BOIS LN PRIMARY		6	3					8	1			3	6		
BUSHEY MILL 132/11KV GRID	25	3				28					28				
EASTCOTE PRIMARY		20					2	18				2	18		
FROGMORE PRIMARY			12					10	2				10	2	
GREENHILL PRIMARY		3	7					10			10				
GROVE MILL PRIMARY		1	10	1				4	5	3	12				
GT MISSENDEN PRIMARY		1	9					1	3	5	10				
HARROW NORTH GRID		20						5	15			5	15		
HARTSPRING PRIMARY		2	11		1			5	6	3	14				
HATCH END GD & PRIMARY	2	9	2	1		2		11		1	2		11		1
HEMEL NORTH PRIMARY		11	2					6	7			6	7		
HOLYWELL GRID		25						2	23			2	23		
INDUSTRIAL PRIMARY	3	10				3		10			3		10		
KINGS LANGLEY PRIMARY		10	2					3	7	2		5	7		
LYE GREEN PRIMARY	11					11					11				
MERRYHILL PRIMARY		5	4		3			6	2	4	12				
PINNER GRN PRIMARY		4	8					12					12		
RICKMANSWORTH GRID		8	11					8	6	5	13		6		
SOUTH RUISLIP PRIMARY		2	5	4				5	2	4	11				
ST PAULS PRIMARY		12						7	5			7	5		
SUDBURY COURT PRIMARY	12					12					12				
WARNERS END PRIMARY		2	6					4	4				4	4	
WESTBURY PRIMARY	1	10						1	10			1	10		
<b>TOTAL</b>	<b>56</b>	<b>181</b>	<b>112</b>	<b>6</b>	<b>5</b>	<b>30</b>	<b>58</b>	<b>203</b>	<b>46</b>	<b>23</b>	<b>148</b>	<b>59</b>	<b>146</b>	<b>6</b>	<b>1</b>

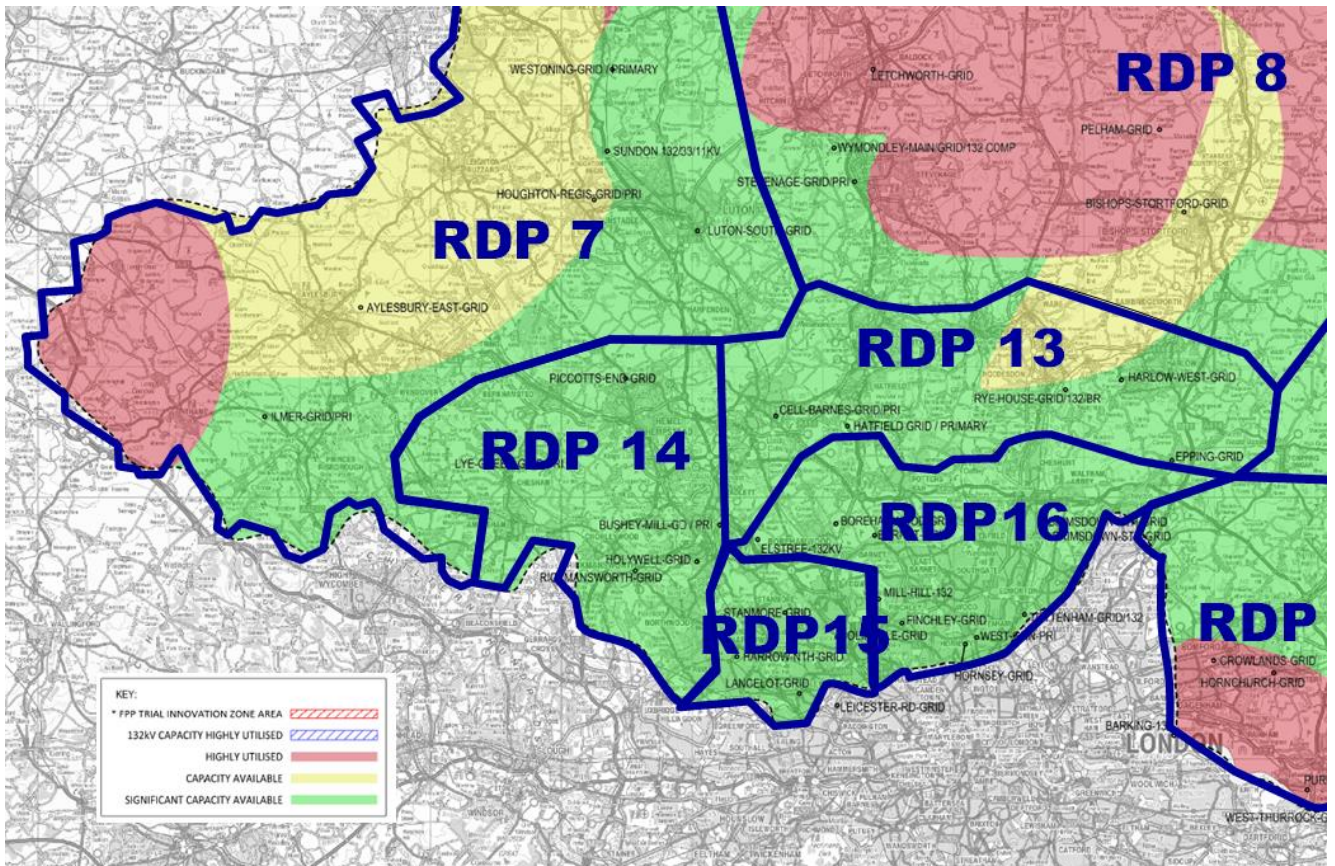
### OUTPUT MEASURES - HEALTH INDICES

Substation	Grid and Primary Transformers														
	ED1 Start (2015)					End of ED1 (2023) No Investment					End of ED1 (2023) With Investment				
	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
ABBOTS CENTRAL PRIMARY		2					2					2			
AMERSHAM PRIMARY		2					2					2			
ASHERIDGE ROAD PRIMARY	2						2					2			
BERKHAMSTED PRIMARY		2					2				2				
BERRYGROVE PRIMARY		2						2					2		
BOIS LN PRIMARY		1	1					2					2		
BUSHEY MILL 132/11KV GRID		3					1	2				1	2		
EASTCOTE PRIMARY		2						2					2		
FROGMORE PRIMARY		2					1	1				1	1		
GREENHILL PRIMARY		2					2				2				
GROVE MILL PRIMARY		2					2					2			
GT MISSENDEN PRIMARY		2						2					2		
HARROW NORTH GRID	1	4					2	3				2	3		
HARTSPRING PRIMARY		2					2					2			
HATCH END GD & PRIMARY	3		1			3		1			3		1		
HEMEL EAST PRIMARY		1						1					1		
HEMEL NORTH PRIMARY		2						2					2		
HOLYWELL GRID		2	2					3	1				3	1	
INDUSTRIAL PRIMARY		2						2					2		
KINGS LANGLEY PRIMARY		2					1	1				1	1		
LYE GREEN GRID		2						2					2		
LYE GREEN PRIMARY		2					2					2			
MERRYHILL PRIMARY		2						2			2				
PICCOTTS END GRID			2						2					2	
PINNER GRN PRIMARY		1						1			1		1		
RICKMANSWORTH GRID		2					1	1				1	1		
SOUTH HARROW PRIMARY		2					2					2			
SOUTH RUISLIP PRIMARY				2						2	2				
ST PAULS PRIMARY		2						2					2		
SUDBURY COURT PRIMARY		2						2					2		
WARNERS END PRIMARY		1						1			1		1		
WESTBURY PRIMARY		2					2					2			
<b>TOTAL</b>	<b>6</b>	<b>55</b>	<b>6</b>	<b>2</b>		<b>3</b>	<b>26</b>	<b>35</b>	<b>3</b>	<b>2</b>	<b>13</b>	<b>22</b>	<b>33</b>	<b>3</b>	

## Elstree – Watford South

### APPENDIX G: GENERATION HEAT MAP

The heat map presented in this page is indicative of the capability of the high voltage electrical network to accept connection of new generation equipment. The area in red indicates that the network in that area is effectively at saturation point with respect to generation connections. The amber and green areas indicate parts of the network that currently have limited and spare capacity to connect new generation equipment at HV or above.



Eastern Power Networks Generation Capacity Map 14-01-2014