



# Regional Development Plan - 17

Braintree – Rayleigh (EPN)

Planner: Howard Green

Version: 2.0

Date: 20/03/2014

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

## Contents

<b>1</b>	<b>EXECUTIVE SUMMARY</b> .....	<b>3</b>
1.1	SUMMARY OF ISSUES ADDRESSED .....	3
1.2	RECOMMENDED STRATEGY .....	4
<b>2</b>	<b>NETWORK CONFIGURATION</b> .....	<b>7</b>
2.1	EXISTING NETWORK .....	7
2.2	NETWORK CHANGES IN PROGRESS .....	7
<b>3</b>	<b>SUMMARY OF ISSUES</b> .....	<b>8</b>
3.1	DEVELOPMENT AREAS .....	8
3.2	ASSET REPLACEMENT .....	8
3.3	SECURITY OF SUPPLY ANALYSIS .....	9
3.4	OPERATIONAL AND TECHNICAL CONSTRAINTS.....	9
3.5	NATIONAL GRID.....	10
<b>4</b>	<b>RECOMMENDED STRATEGY</b> .....	<b>10</b>
4.1	FINANCIAL APPRAISAL AND BENEFITS .....	11
<b>5</b>	<b>REJECTED STRATEGIES</b> .....	<b>12</b>
5.1	BRAINTREE REINFORCEMENT - INSTALLATION OF A THIRD 132/33kV TRANSFORMER.....	12
5.2	COGGESHALL GRID .....	12
<b>6</b>	<b>REFERENCES</b> .....	<b>12</b>
6.1	APPENDICES .....	12
6.2	DOCUMENT HISTORY.....	12
<b>7</b>	<b>DOCUMENT SIGN OFF</b> .....	<b>13</b>

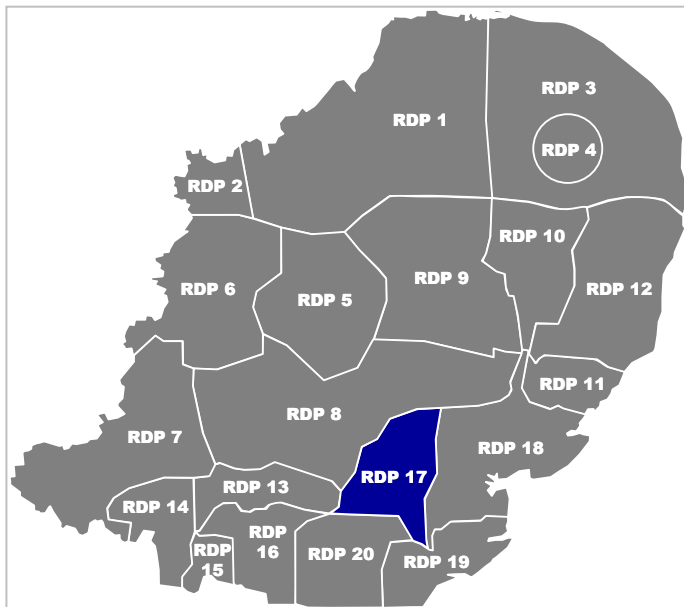
## Braintree – Rayleigh (EPN)

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

### 1 Executive Summary

This Regional Development Plan (RDP) reviews UK Power Networks (UKPN) EPN HV and EHV network of Braintree, Chelmsford and Witham in the North Essex area.

The Braintree – Rayleigh Group consists of the Braintree Exit Point (Grid Supply Point) and the two Rayleigh – Braintree 132KV interconnectors via Chelmsford. Historically Braintree Exit Point was first established in the early 1980's as a single super-grid transformer site operated in parallel via the Rayleigh 132kV interconnectors to the Rayleigh GSP. The closure of Bradwell Power Station in the 1990's led to the need for reinforcement to the group and a second SGT was installed at Braintree in 2006 and a fourth SGT at Rayleigh in 2009. The group provides supplies to approximately 85000 customers and provides a peak maximum demand of 170MVA.



The replacement of the Rayleigh Local 132kV AIS substation with a new 132kV GIS switchboard at Rayleigh Main 400kV substation improves the potential operating arrangements between Rayleigh and Braintree with one limitation. The two SGT's at Braintree cannot be operated in parallel with all four of the Rayleigh SGT's without over stressing the GIS switchgear. Therefore a pair of 132kV circuit breakers are to be installed at Chelmsford East allowing the two groups to operate flexibly and independently when required.

Braintree Grid has seen demand rise at well above average rates for many years and driving reinforcement to the Braintree 33kV group. A new primary substation at Witham called Witham South (formally Howbridge Hall) will secure the demand at Witham and provide approximately 15MVA of transfer off of the Braintree 33kV network on to Maldon Grid. This will secure Braintree through and beyond the ED1 period.

Chelmsford is the capital of Essex and was given 'City' status in 2012. It has substantial local development plans to promote growth principally to the north of the town with a site known as Beaulieu Park. This site has the potential (with neighbouring sites) to provide over 4000 new homes, schools, businesses and a new railway station. It is likely that the 132kV OHL to Chelmsford Nth will require undergrounding in order to allow full development of Beaulieu Park.

#### 1.1 Summary of issues addressed

- 132/33kV Substation Reinforcement.
- Development of the 33kV interconnecting Networks.
- 132/33kV Substation Reinforcement.
- 33/11kV Substation Reinforcement.
- Major Plant Asset Replacement
- Address Fault Level issues.

## Braintree – Rayleigh (EPN)

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

### 1.2 Recommended strategy

The 132kV system between Braintree and Rayleigh supports Chelmsford Nth (132/11kV), BR Springfield (132/25kV) and interconnection to Chelmsford East (132/33kV). Historically these circuits were run solidly interconnected with the Rayleigh 132kV bus-bars but due to the increase in the SGT's in the two groups this will not be possible and new sectionalisation has to be installed at Chelmsford East in 2013.

Braintree Grid 33kV capacity has been managed with load transfers for several years. The demand on the 33kV system continues to rise as Braintree develops as a large urban area in north Essex. In order to remain compliant and improve the security of supplies a second primary is to be provided at Witham (a 40MVA load centre to the south east of Braintree). This second primary substation to be known as Witham South (formally known as Howbridge Hall) will be fed from Maldon Grid on the Rayleigh – Colchester 132kV circuits. The new primary will allow approximately 15MVA of demand to be taken off Witham primary securing its position and therefore off the Braintree 33kV system as well, deferring the reinforcement of the 132/33kV substation. The long term solution for Braintree is likely to be with a third 132/33kV transformer. The 132kV substation was equipped with additional bays in preparation of this and the proposed replacement of the 33kV switchgear due to the fault level issues will again be scoped to allow for the future arrangement. A third grid transformer is not expected to be required for 10+ years.

The 33kV AIS compound at Braintree has some 750MVA equipment that operates at or near to its rating. The age, condition (HI) and type of the switchgear is also driving its replacement along with new generation enquiries within the 33kV system increasing fault levels further. A GIS switchboard will provide a solution to all these issues and facilitate future connection arrangements from a third 132/33kV transformer.

Halstead Primary is not able to maintain voltage regulation across its 11kV network during first circuit outages, as well as the 33/11kV transformers being operated beyond their firm capacity. The 33kV OHL's to Halstead were rebuilt in recent years, due to their poor condition and during the process the lines were also uprated with larger capacity conductors. This allows larger 33/11kV transformers to be installed at Halstead Primary resolving the capacity and voltage issues.

Beaulieu Park at Chelmsford is expected to require the undergrounding of the Chelmsford North 132kV OHL. The line is held on terminable wayleaves and easements that have development clauses that will require the bulk of the costs to be borne by UK Power Networks. A new route is yet to be finalised but is expected to follow a spine road across the development. Undergrounding the 4km section will leave approximately 1.5km of overhead line towards Chelmsford Nth and consideration to it remaining with cable connections in both directions will be necessary.

### Investment Profile

Table 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	RIO-ED1 Total
RDP17	LRE	£7.3m	£2.9m	£0.0m	£0.0m	£1.2m	£1.2m	£2.6m	£5.1m	£0.0m	£13.0m
	NLRE	£3.2m	£0.0m	£0.5m	£1.3m	£1.2m	£3.0m	£0.0m	£0.0m	£0.0m	£6.1m
	TOTAL	£10.4m	£2.9m	£0.5m	£1.3m	£2.5m	£4.2m	£2.6m	£5.1m	£0.0m	£19.1m

Table 1. LRE and NLRE expenditure profile

**Braintree – Rayleigh (EPN)**

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

**Output Measures**

The figure below provides the expected Load Indices (LI) for all substations covered in this RDP at the end of 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 figure 3.

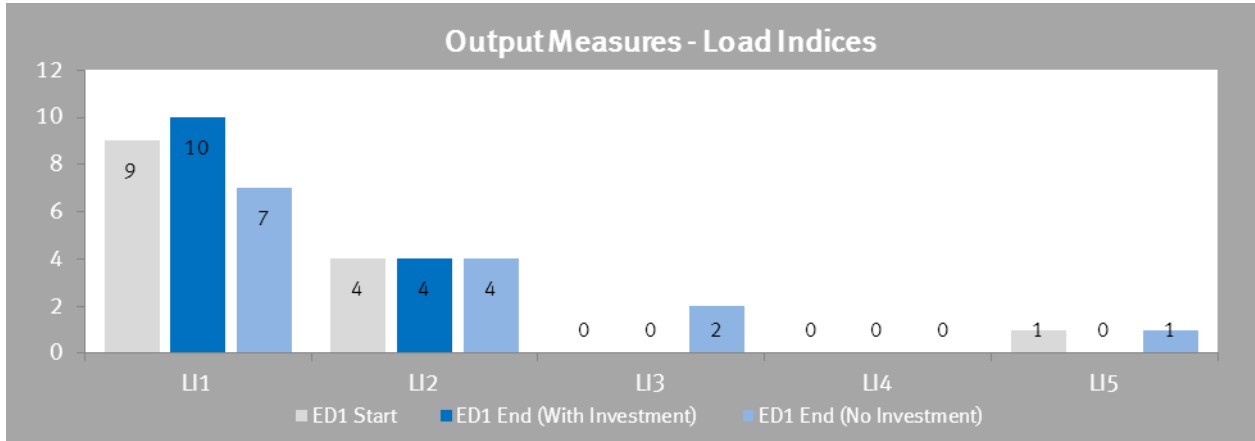
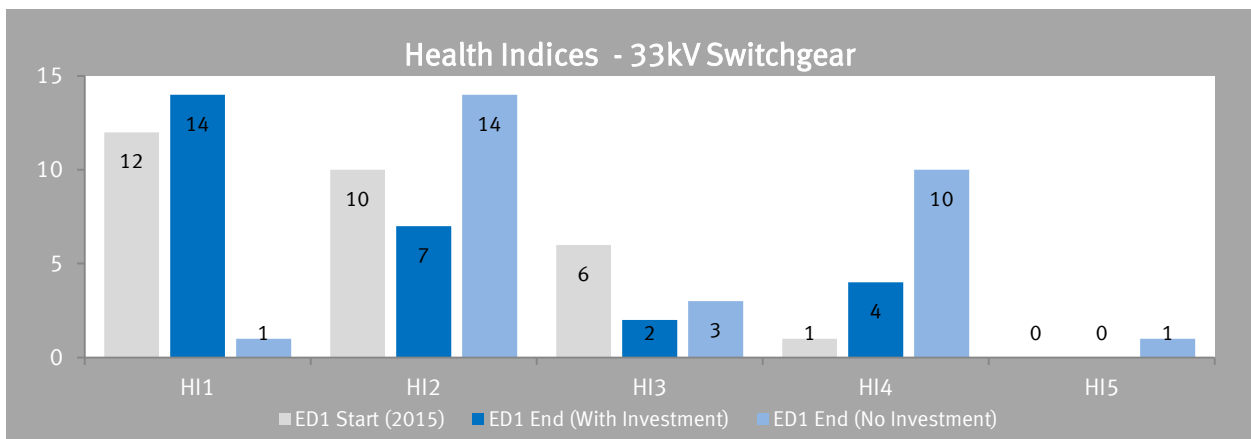
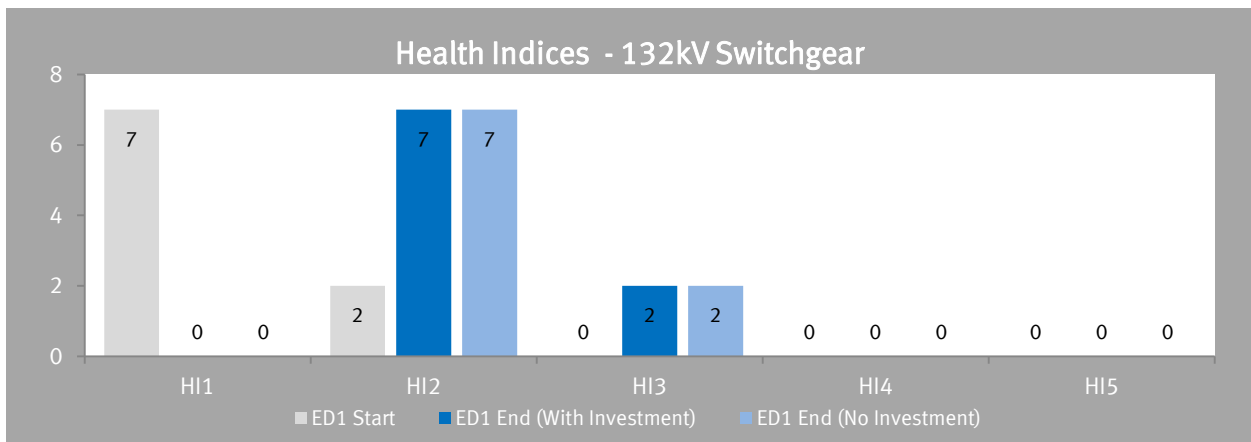


Figure 2. Load Indices (LI)

The figures 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.



**Braintree – Rayleigh (EPN)**

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

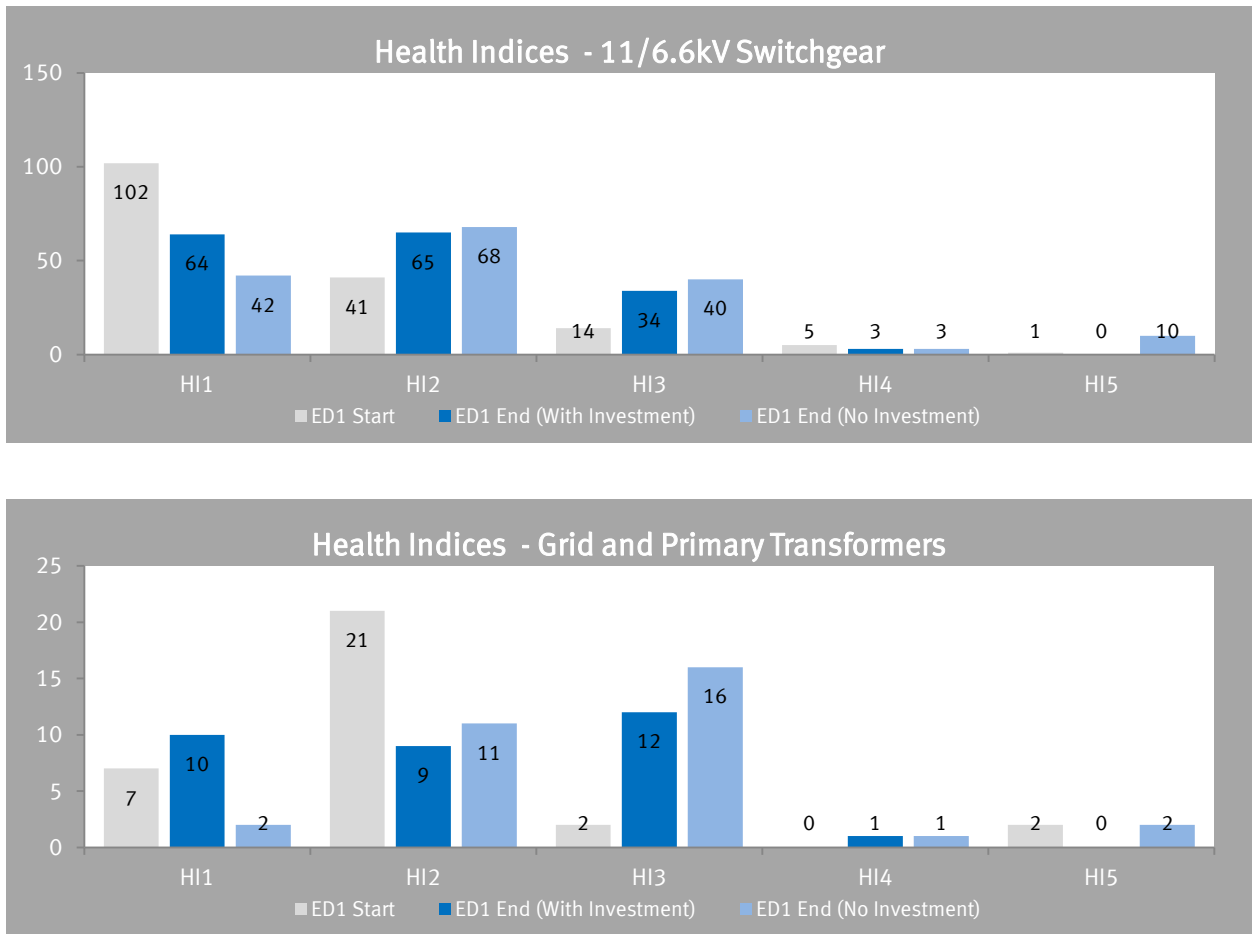


Figure 3. Health Indices by asset category

**Scenarios Considered**

- Demand growth from Planning Load Estimates (PLE’s) up to 2023.
- Major Generation sites disconnected
- Compliance with P2/6 Standard for Security of Supply and operational flexibility of the 132kV and 33kV networks.
- Imperial College model.

**RDP Dependencies and Interactions**

- Demand increase occurs at predicted rate.
- New Developments within reasonable demand parameters.
- Demand increase occurs at predicted rate.
- Completion of the Rayleigh Main 132kV works.

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

## 2 Network configuration

### 2.1 Existing Network

Braintree BSP is equipped with two 240MVA 400/132kV super-grid transformers and has a dual circuit 132kV interconnection to Rayleigh Main BSP. Once the 132kV sectional circuit breakers have been installed at Chelmsford East Grid, the combination of the 2 Braintree and 4 Rayleigh SGT's along with the 132kV interconnection will provide a flexible and durable EHV network.

The 33kV network from Braintree Grid is a mixture of cable systems in the urban areas and overhead lines in the rural. Beyond Braintree itself, Witham is the largest load centre fed via three 33kV circuits to a single three 33/11kV transformer substation. Due to the differing network impedances the transformers at Witham do not share demand equally and therefore the primary has a reduced maximum capacity compared with transformer capacity. The demand at Witham is at 100% but has been known to be higher during times of economic prosperity. Without any alternative 33kV into Witham security relies on the 11kV alternative feeds from neighbouring rural primary substations at Tiptree and Marks Tey. During the catastrophic failure of the 11kV switchboard at Witham in 2004 approximately 20MW of portable generation was brought in to maintain supplies, high-lighting the vulnerability of the Witham 11kV network. A new primary called Howbridge Hall has been identified for some years and following extended negotiations to obtain a site and cable routes it is ready to go forward into construction during 2013. This new primary will allow a permanent transfer of approximately 15MVA and is expected to be able to manage twice that under emergency conditions.

Much of the 33kV overhead line network was established in the early 1950's and several routes have been rebuilt to modern specifications, including Braintree – Halstead, Halstead – Wethersfield and the Braintree – Coggeshall/Witham (only two of the three circuits). The remaining lines requiring replacement in the future will be the Braintree to Dunmow and Braintree – Witham T3.

Halstead is a remote town in the northern part of Essex that has limited 11kV interconnection and suffers from poor voltage regulation during outage conditions and operates at 100% of primary transformer capacity. The proposal is to rebuild the substation with new 20/40MVA 33/11kV transformers resolving both voltage and capacity problems.

Chelmsford North has undergone major refurbishment following the grid transformer failure in 2008. This has allowed additional capacity to be released from the 132/11kV dual wound transformers as extra 11kV feeders have been installed.

Chelmsford East Grid is also undergoing asset replacement of the remaining 60MVA 132/33kV transformer and transformer/ bus section 33kV circuit breakers that will provide additional capacity at 33kV.

Looking ahead at Chelmsford it is envisaged that a new 132/33kV substation will be possible at the existing BR Springfield site once it has been decommissioned from its current use. This New Springfield 132/33kV substation will be able to meet the demand from the large areas of development taking place to the north of Chelmsford. It will also provide additional 11kV interconnection to the 132/11kV at Chelmsford North. This work is not expected to be necessary until sometime into ED2 (or beyond).

### 2.2 Network changes in progress

Braintree Grid/Coggeshall 33kV OHL Circuits – Asset Replacement, single circuit rebuild.

Braintree Grid/Witham 33kV OHL circuit – Asset Replacement, single circuit rebuild.

Chelmsford South 33/11kV – Asset Replacement of 33/11kV transformers and 11kV switchgear.

Witham South – New Primary Substation. Reinforcement of Braintree (via demand transfer) and increased security and network performance at Witham Primary.

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

### 3 Summary of Issues

#### 3.1 Development areas

Chelmsford has substantial plans to develop land to the north creating housing, schools and commercial sites as well as incorporating a railway station and new links to the nearby A12 trunk road and through to Braintree and Stansted to the north and west. The area to the north includes Beaulieu Park, Broomfield and Belstead Farm. To the east of Chelmsford there are still large areas within the A12 trunk road undeveloped that will be infilled in the fullness of time.

Braintree has undergone much expansion through the 1990's and 2000's and has benefitted from brown field redevelopment and a new A120 bypass. New areas continue to be identified for new developments. Similarly Witham has had redevelopment of several brown field sites but has few new sites identified for development.

#### 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).

##### Rayleigh/Chelmsford East 132kV Tower Line (PSA) – refurbish

The condition assessment of the Rayleigh/Chelmsford East 132kV Tower Line (PSA) has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 28 km of 132kV Tower Line refurbished.

##### Braintree/Chelmsford East 132kV Tower Line (PSB) - 132kV Tower Line Refurbishment (770A(W))

The condition assessment of the Braintree/Chelmsford East 132kV Tower Line (PSB) has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 31 km of 132kV Tower Line refurbished.

##### South Chelmsford/East Chelmsford 132kV Tower Line (PCF) - 132kV Tower Line Refurbishment

The condition assessment of the South Chelmsford/East Chelmsford 132kV Tower Line (PCF) has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 4 km of 132kV Tower Line replaced.

##### Braintree Grid/Witham 33kV OHL circuit – 33kV wood pole OHL replacement

The condition assessment of the Braintree Grid/Witham 33kV OHL circuit has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising CI and CML performance, therefore this project recommends the replacement. Completion of the project will see 12 km of 33kV OHL circuit replaced.

##### South Chelmsford 33kV OHL circuit - 33kV wood pole OHL replacement

The condition assessment of the South Chelmsford 33kV OHL circuit has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 0.4 km of 33kV OHL circuit replaced.

##### Braintree Grid/Dunmow 33kV OHL circuit - 33kV wood pole OHL replacement

The condition assessment of the Braintree Grid/Dunmow 33kV OHL circuit has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 17 km of 33kV OHL circuit replaced.

##### Braintree Grid/Lake & Elliot 33kV OHL circuit – 33kV wood pole OHL replacement



**Braintree – Rayleigh (EPN)**

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

The condition assessment of the Braintree Grid to Lake & Elliot Primary 33kV OHL circuit has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising CI and CML performance, therefore this project recommends the replacement. Completion of the project will see 0.3 km of 33kV OHL circuit replaced.

South Chelmsford 33/11kV Primary Substation – 11kV Switchboard & 33/11kV Transformer replacement

The 11kV switchboard is a Switchgear and Cowans type FA manufactured in 1960. It has no remote control functions and no replacement truck options. The highest health index is HI5 (OFGEM). It is proposed to replace the switchboard to provide these added functions. The 33/11kV transformers have developed serious tapchanger defects rendering them unable to tap causing voltage regulation problems. The transformers are to be replaced

Completion of this project will see the existing 10 oil circuit breakers replaced by 12 new breakers and 2 new 12/24MVA 33/11kV transformers.

**3.3 Security of supply analysis**

With the additional SGT's in recent years at Braintree and Rayleigh the security at 132kV is adequately catered for as is much of the 33kV network. Due to the rural nature of the remote primary substations and their extensive 11kV systems voltage regulation is often the greater issue regarding capacity availability.

Table 2. P2/6 Assessment table

Substation	Demand (MW)	Supply Class	Demand (MVA)			P2/6	Comments
			2015	2018	2022		
Braintree 132kV Group	170	B	179	188	198	Compliant	
Braintree 33kV Group	106	B	107	95	101	Compliant	With Howbridge Hall Transfer
Witham	38.5	C	39.5	39.9	40.6	Compliant	Reliant on 11kV manual transfer
Halstead	20.8	C	21.2	21.8	22.7	Compliant	Reliant on 11kV manual transfer

**3.4 Operational and technical constraints**

The 33kV switchgear at Braintree operates within 10% of the fault level capacity under normal operation. However when Braintree and Rayleigh operate interconnection under first circuit outage conditions the fault level at Braintree regularly exceeds its 750MVA switchgear rating. A restriction is in place on the 33kV compound rather than operating with the bus-section open as this would pose operational issues to the 33kV network. When access is required the operating arrangement is checked and switching undertaken to reduce the fault level on the 33kV bus bars.

The network fed from this Supply Point Group interconnects at Low Voltage between the Supply points with some Super Grid parallels at 33kV 11kV and LV.

There are potential harmonic issues associated with the Springfield BR Supply Point near the Chelmsford North Tee point and may require the installation of a set of 132kV CB's to allow it to be supplied from Rayleigh to allow a higher fault level to be maintained. Alternatively other running arrangements with a split 132kV bus-bar at Rayleigh and maintaining a Braintree parallel are also possible. These options require further investigation. It is understood that Network Rail is also in discussion with National Grid regarding a possible 400/25kV connection to replace BR Springfield that will resolve the issue with harmonics.

Chelmsford with its 132/11kV and 132/33kV grid substations that can be fed from different GSP's has potential supergrid parallels across its 11kV and LV networks. Care when switching and linking is essential.

### Braintree – Rayleigh (EPN)

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

### 3.5 National Grid

Other than the completion of the National Grid works at Rayleigh Main there are no other works directly affecting the Braintree – Rayleigh group.

National Grid are to establish a new 400kV circuit between Bramford Supergrid near Ipswich to the Braintree – Pelham 400kV circuit near Twinstead. This will include the surrender of the UK Power Networks 132kV circuit along the same route from Twinstead to Bramford. In order to maintain security of the 132kV system a new 400/132kV exit point is to be established at Twinstead providing supplies to Belchamp Grid substation and interconnection to the Pelham and Wymondley group. An option to provide a 132kV link from Braintree to the Twinstead 132kV line was considered by National Grid and discounted as it would face increased opposition, provide no additional benefits and cost more than an exit point at Twinstead.

It is possible in the future a 132kV link could be considered from the new Twinstead substation to Braintree to Colchester to provide demand transfer, relieving load on the Bramford – Rayleigh interconnectors.

## 4 Recommended strategy

The 132kV system between Braintree and Rayleigh supports Chelmsford Nth (132/11kV), BR Springfield (132/25kV) and interconnection to Chelmsford East (132/33kV). Historically these circuits were run solidly interconnected with the Rayleigh 132kV bus-bars but due to the increase in the SGT's in the two groups this will not be possible and new sectionalisation is to be installed at Chelmsford East.

Braintree Grid 33kV has been managed with load transfers for several years to defer major reinforcement. As the demand on the 33kV system continues to rise as Braintree develops as a large urban area in north Essex. In order to remain compliant and improve the security of supplies a second primary is to be provided at Witham a 40MVA load centre to the south east of Braintree. This second primary substation to be known as Howbridge Hall will be fed from Maldon Grid on the Rayleigh – Colchester 132kV circuits. The new primary will allow approximately 15MVA of demand to be taken off Witham primary securing its position and off the Braintree 33kV system deferring the reinforcement of the 132/33kV substation. The long term solution for Braintree is likely to be with a third 132/33kV transformer. The 132kV substation was equipped with additional bays in preparation of this and the proposed replacement of the 33kV switchgear due to the fault level issues will again be scoped to allow for the future arrangement. A third grid transformer is not expected to be required for 10+ years.

Halstead Primary is not able to maintain voltage regulation across its 11kV network during first circuit outages particularly during winter months as well as the 33/11kV transformers being operated beyond their firm capacity. The 33kV OHL's were rebuilt in recent years due to their poor condition and during the process were also uprated with larger conductors. This allows larger 33/11kV transformers to be installed at Halstead Primary resolving the capacity and voltage issues.

Beaulieu Park is expected to require the undergrounding of the Chelmsford North 132kV OHL. The line is held on terminable wayleaves and easements with development clauses that will require the bulk of the costs to be borne by UK Power Networks. A new route is yet to be finalised but is expected to follow a spine road across the development. Undergrounding the 4km will leave approximately 1.5km of overhead line towards Chelmsford Nth and consideration will be required to it remaining with cable connections in both directions.

The reinforcement projects identified below are listed in appendix D.

#### Chelmsford East Local 33/11kV Primary Substation - ITC (2x 11/18/24MVA)

The load predicted by the Planning Load Estimates and with the added localised higher demand growth rate is expected to exceed the rating of the 14MVA ONAF transformers within the ED1 period. The 2012/13 winter demands increased by 1MVA above the predicted levels from 2011/12, reflecting the increased new connection activity in the area.

### Braintree – Rayleigh (EPN)

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

It is proposed to install 12/24MVA 33/11kV transformers and once reinforced the additional capacity would also support any further growth on South Chelmsford Primary via improved 11kV interconnection, deferring costly expensive reinforcement works there. The 11kV switchgear at Chelmsford East Local has already been replaced due to its condition and would not need any further reinforcement.

#### Writtle St & West Chelmsford FFC Circuits – reinforce

The predicted load on the Writtle Street Primary teed West Chelmsford Primary 33kV circuits from Chelmsford East Grid will exceed the rating of the 0.45cu (637amp) FFC circuits within the ED1 period under N-1 conditions. It is not possible to permanently reduce the load on the circuits without compromising operational and performance requirements.

It is therefore proposed to replace these circuits from Chelmsford East Grid to Writtle Street Primary (approximately 5km) where the tee points to West Chelmsford circuits are located. The existing 33kV circuits are fluid filled cables and whilst there is no discernible loss in performance it is likely that they will require asset replacement in the foreseeable future and their replacement would bring their asset replacement forward.

The 33kV circuits are approximately 5km in length through the urban suburbs of Chelmsford.

#### Braintree GSP 132/33kV Exit Point - Replace 33kV switchboard (Fault Level)

The 33kV fault level at Braintree Grid Substation exceeds the rating of the existing switchgear and is only managed with operational restrictions. Eight of the 33kV circuit breakers are Switchgear and Cowans K1, the transformer circuit breakers are Reyrolle OMT3 and the bus-section is SWS EO1. The remaining three circuit breakers are modern SF6/vacuum type. The fault rating of the older 33kV circuit breakers (circa 1955) is only 750MVA and the potential fault level is 846MVA.

It is therefore proposed to replace the existing switchgear with a new GIS installation comprising 17 circuit breakers to meet existing and future requirements.

#### Witham South Proposed 33/11kV Primary Substation - New Substation

A new primary substation called Witham South is to be built on the outskirts of Witham in Essex. This will provide additional 11kV capacity to support Witham Primary substation by way of an 11kV transfer (approximately 15MVA) and therefore a transfer of 33kV demand from the heavily loaded 33kV bus-bar at Braintree Grid. It will also establish new 11kV circuits in the area reducing circuit lengths and customer numbers per circuit and will reduce CI and CML impact during fault outages in the area.

The new substation is to be fed via nearly 10km of dual circuit 33kV cabling from Maldon Grid, connected to the Rayleigh Group network. The new substation will have 12/24MVA transformers and a 13 panel 11kV switchboard and be interconnected with the local 11kV infrastructure to provide further benefits.

#### Halstead 33/11kV Primary Substation – ITC (2 x 30MVA 33/11kV)

Halstead Primary substation has reached its 19MVA firm capacity is not able to maintain voltage regulation across its 11kV network during first circuit outages particularly during winter months. The substation is to be reinforced with new 18/30/40MVA transformers, new 11kV switchgear and 33kV cables between the OHL terminal poles and the substation.

## 4.1 Financial Appraisal and Benefits

Appendices' E & F provides the changes to Load Indices and Health Indices that would take place from the proposed projects. The financial expenditure is shown in Appendix D.

**Braintree – Rayleigh (EPN)**

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

**5 Rejected Strategies**

**5.1 Braintree Reinforcement - Installation of a third 132/33kV transformer**

Whilst this is expected to be needed at some point in the future it was discounted as the first choice for several reasons. A third transformer would not address the 'Witham' security issue or provide CI CML benefits from new 11kV circuits from the new primary substation. The overall cost to provide the new Witham primary and 33kV capacity at Braintree was approximately 50% greater than the current proposal.

**5.2 Coggeshall Grid**

A previous proposal involved establishing a new 132/33kV substation at Coggeshall. This would provide transfer capacity from Braintree 33kV and be the first step towards a 132kV interconnector to the Rayleigh/Colchester circuits. The estimated cost of this was over £20m. In addition to the cost the proposal also fails to address the 'Witham' issue.

**6 References**

References	Description
Reference 1	Planning Load Estimates EPN Area 2011 – 2023 (DNE)
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	Council Masterplans, etc...

**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 Index Table (LI)
Appendix F	Output Measures – Health Index Table (HI)
Appendix G	Generation Heat Map

**6.2 Document history**

Version	Date of Issue	Author	Details
1.2	20/05/2013	Nuno da Fonseca Howard Green	Published
1.3	24/06/2013	Howard Green	Final Version

**Braintree – Rayleigh (EPN)**

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

1.4	20/03/2014	Howard Green	Aligned with ED1
-----	------------	--------------	------------------

**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
Howard Green	Infrastructure Planner		19/03/14
Nuno Da Fonseca	Infrastructure Planning Manager (EPN)		

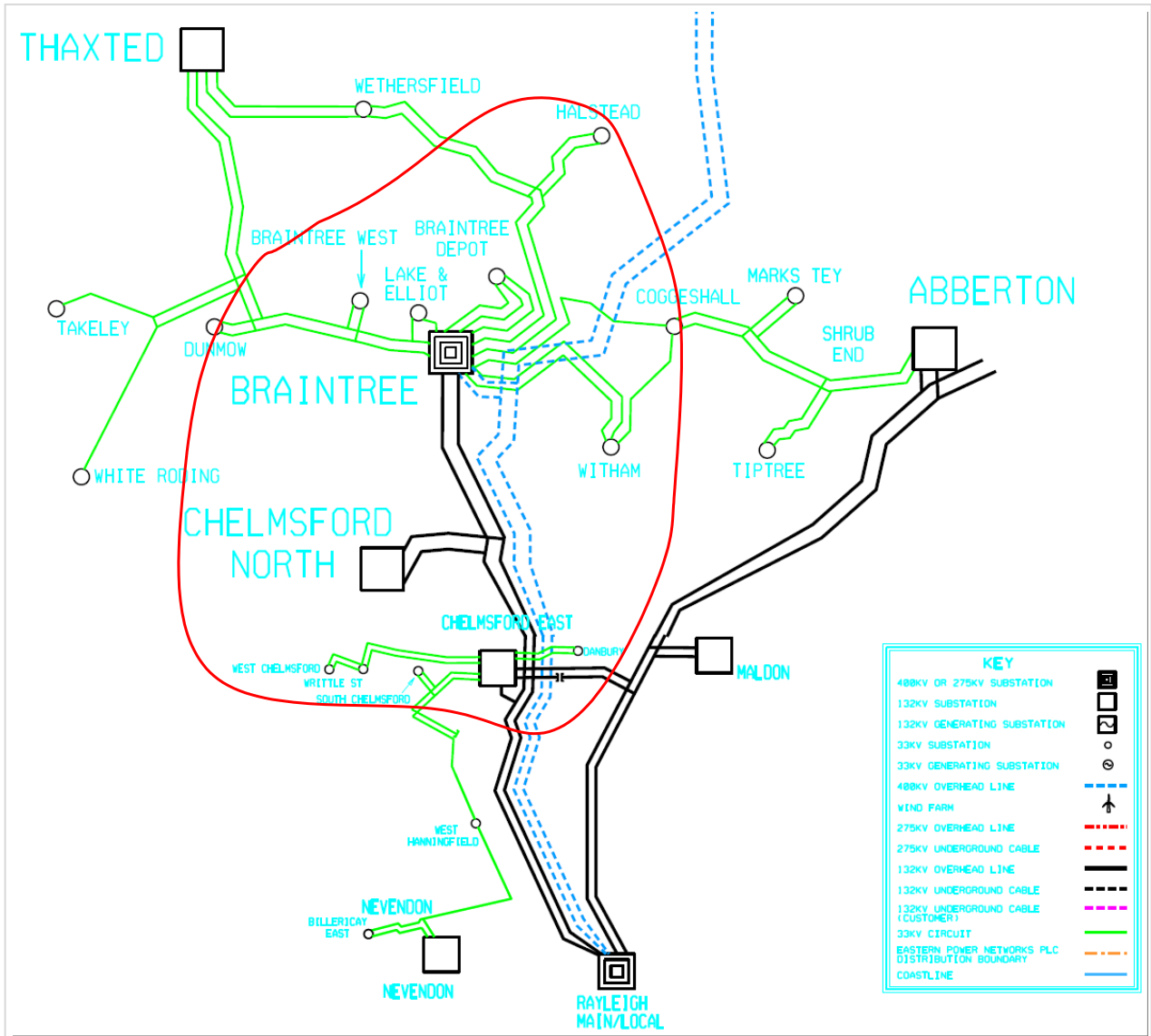
**Approval by:**

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

**Braintree – Rayleigh (EPN)**

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

**APPENDIX A: GEOGRAPHICAL DIAGRAM**

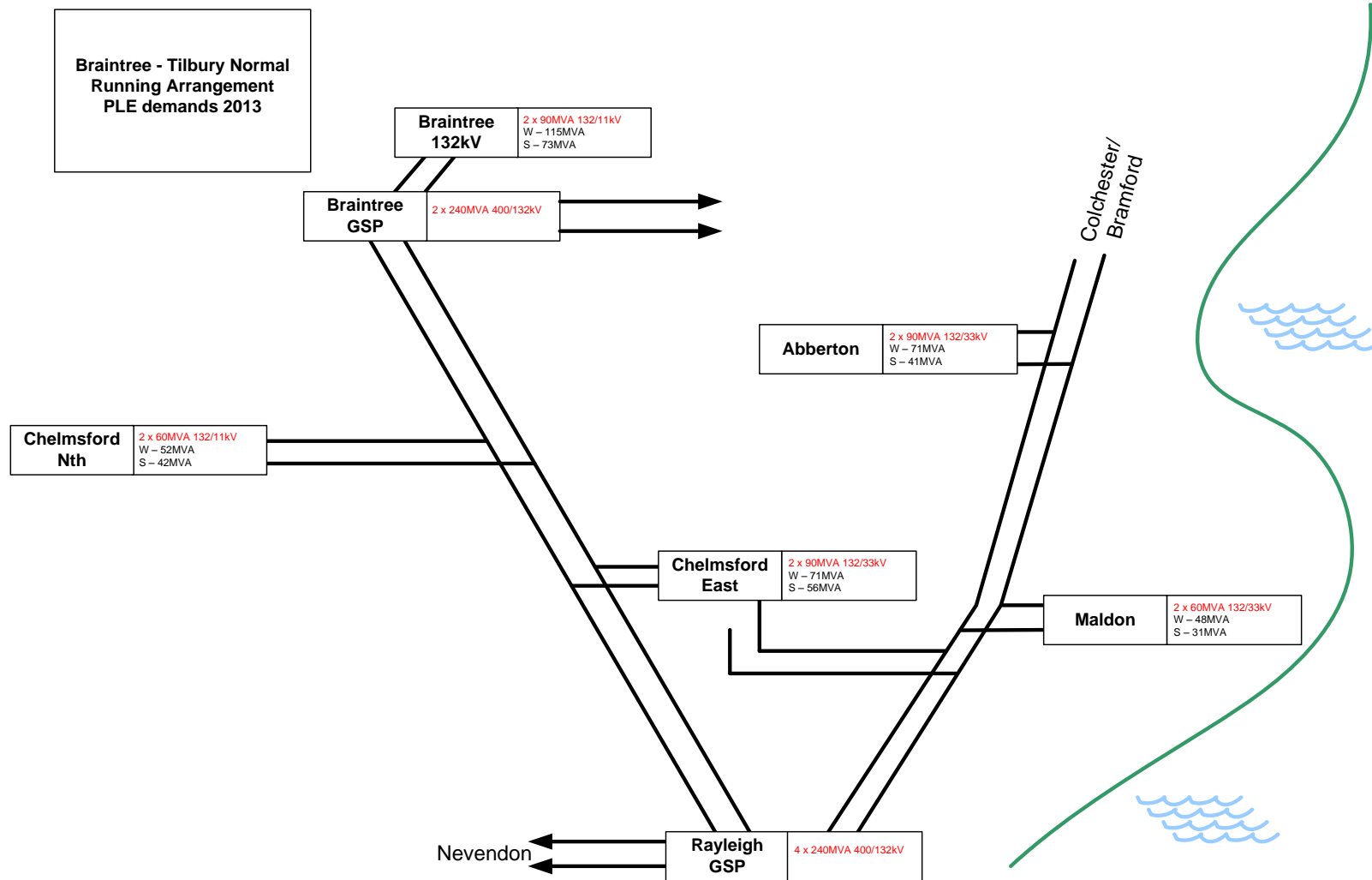


# Regional Development Plan

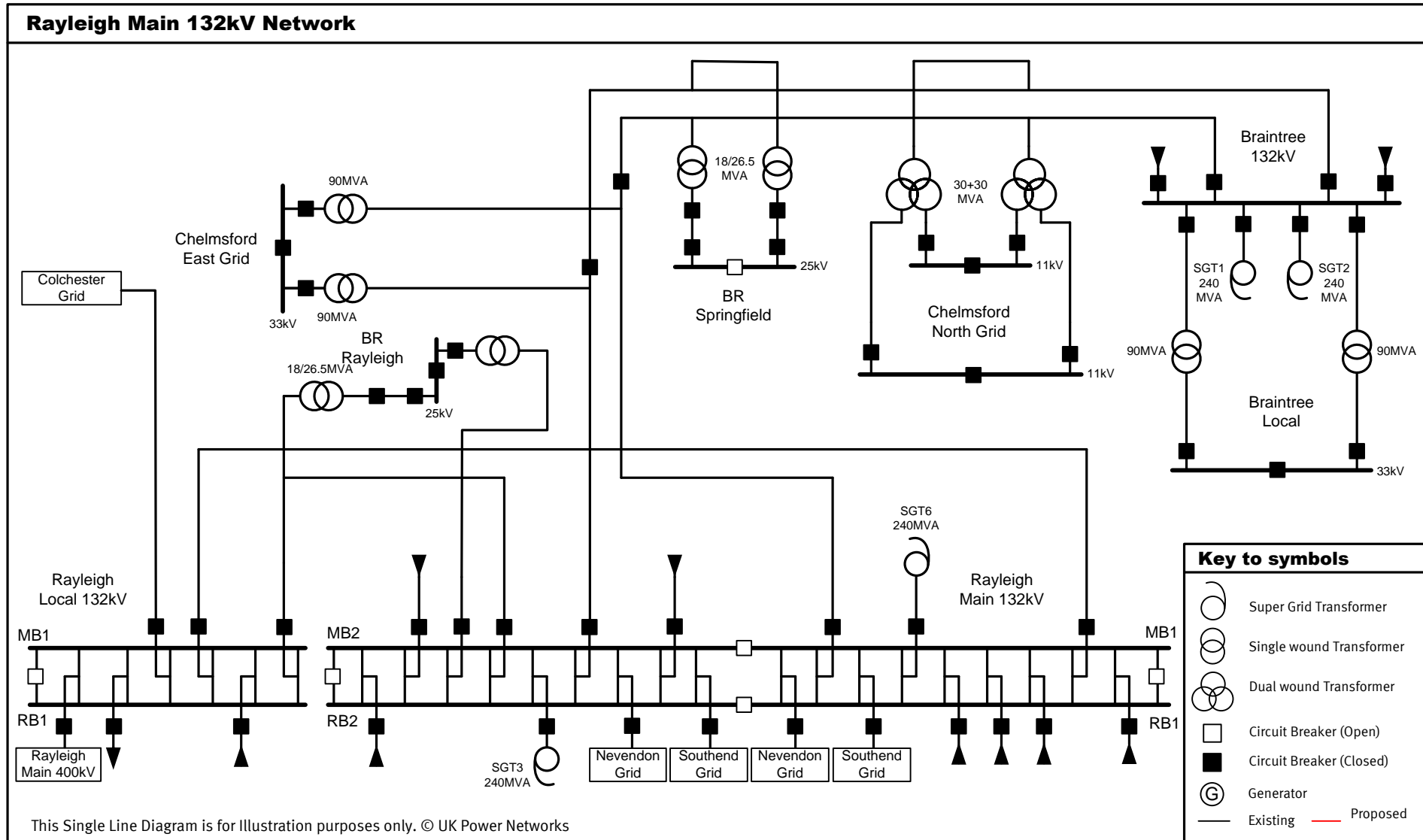


## Braintree – Rayleigh (EPN)

### APPENDIX B: 132KV SINGLE LINE DIAGRAM – EXISTING NETWORK



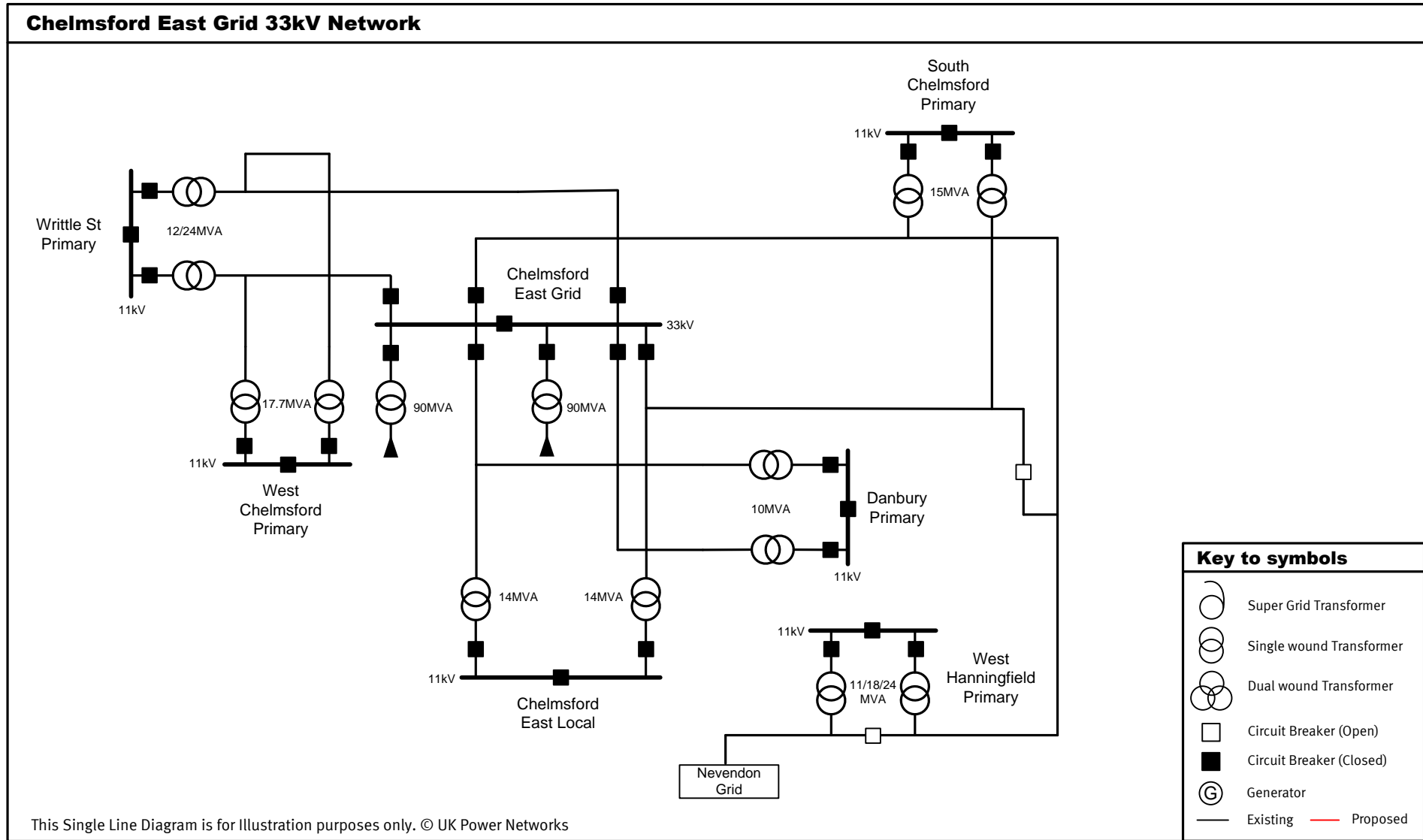
## Braintree – Rayleigh (EPN)





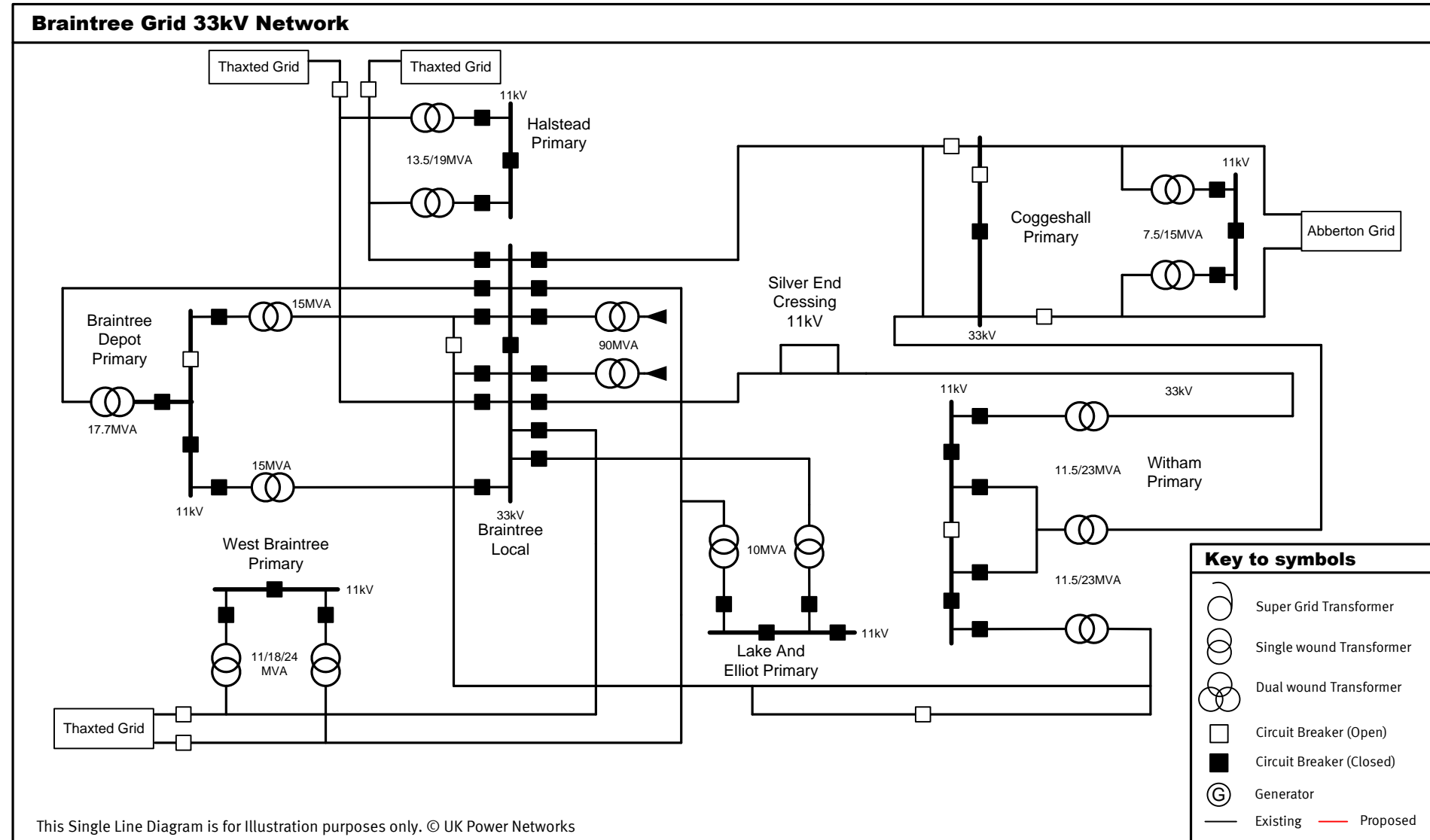
## Braintree – Rayleigh (EPN)

### Chelmsford East Grid 33kV Network



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

## Braintree – Rayleigh (EPN)

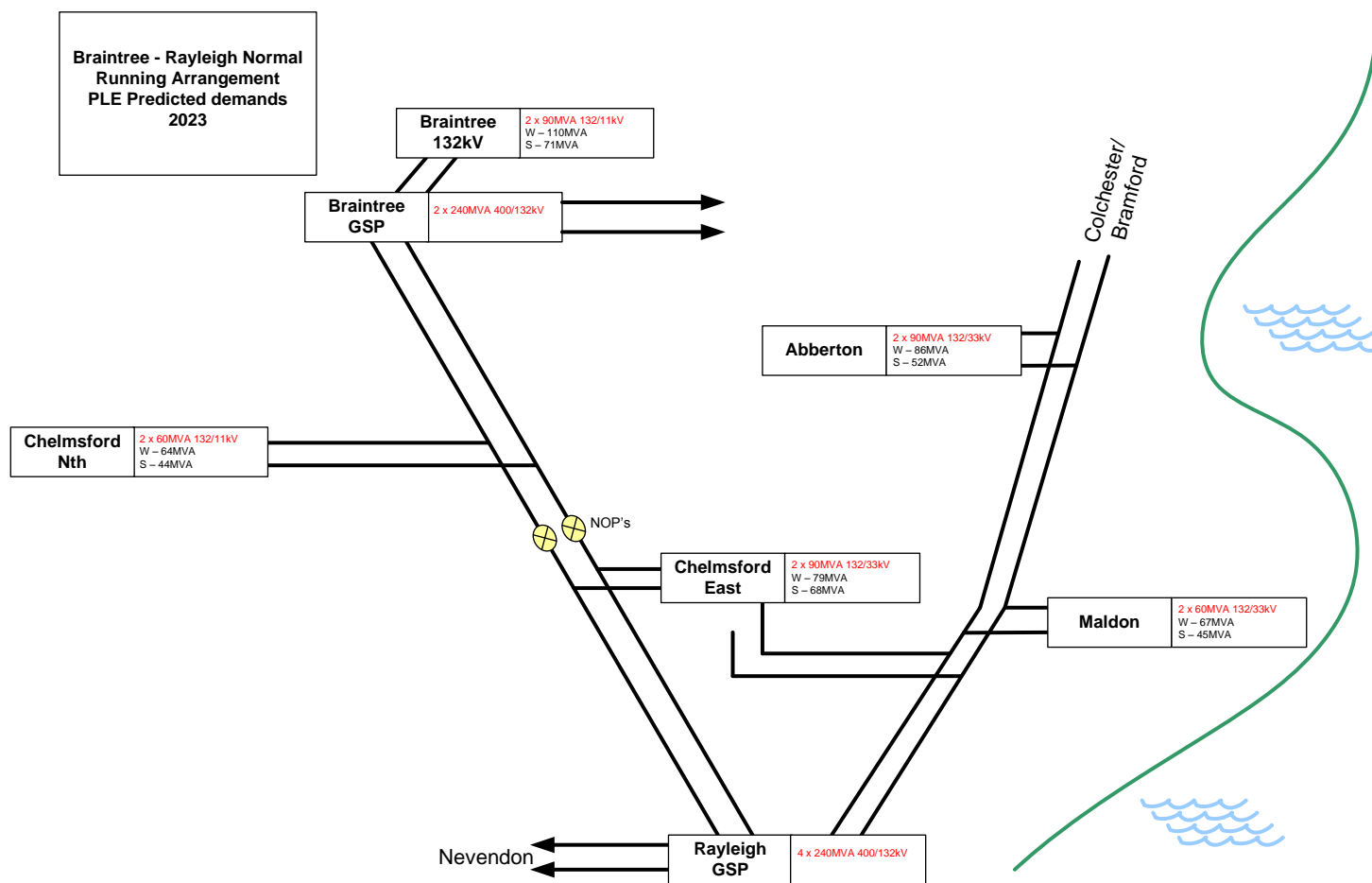


# Regional Development Plan

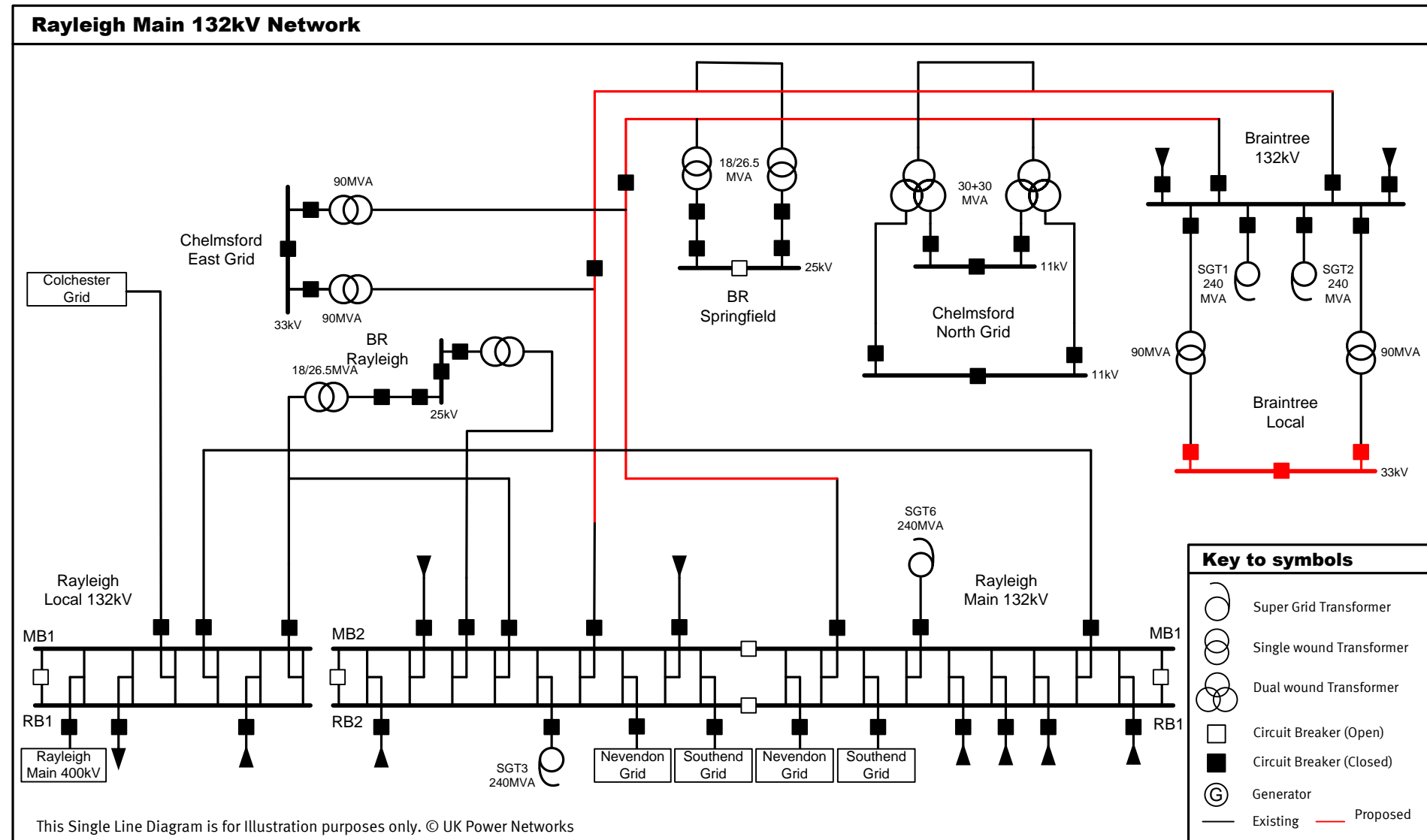


## Braintree – Rayleigh (EPN)

### APPENDIX C: 132KV SINGLE LINE DIAGRAM – PROPOSED NETWORK

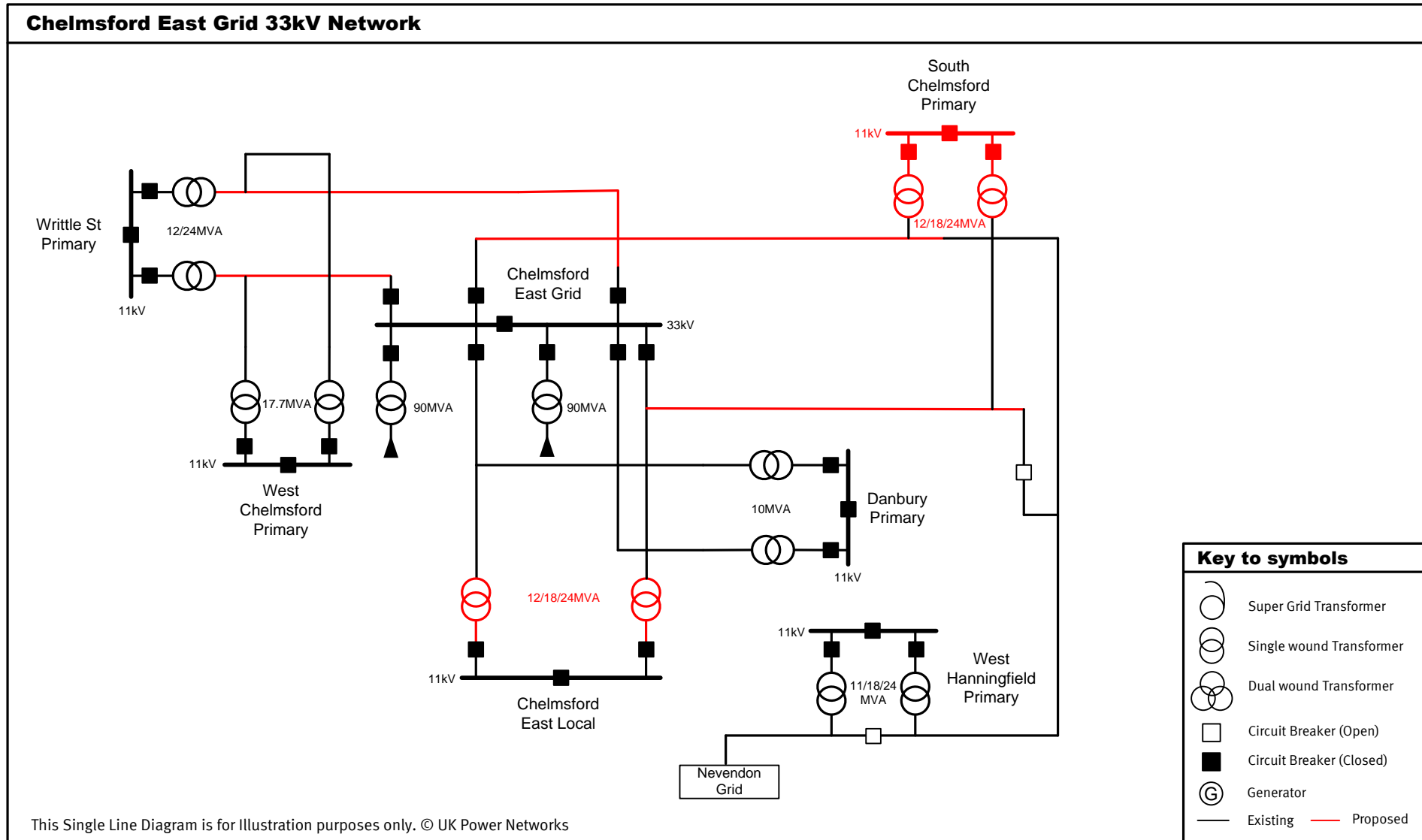


## Braintree – Rayleigh (EPN)

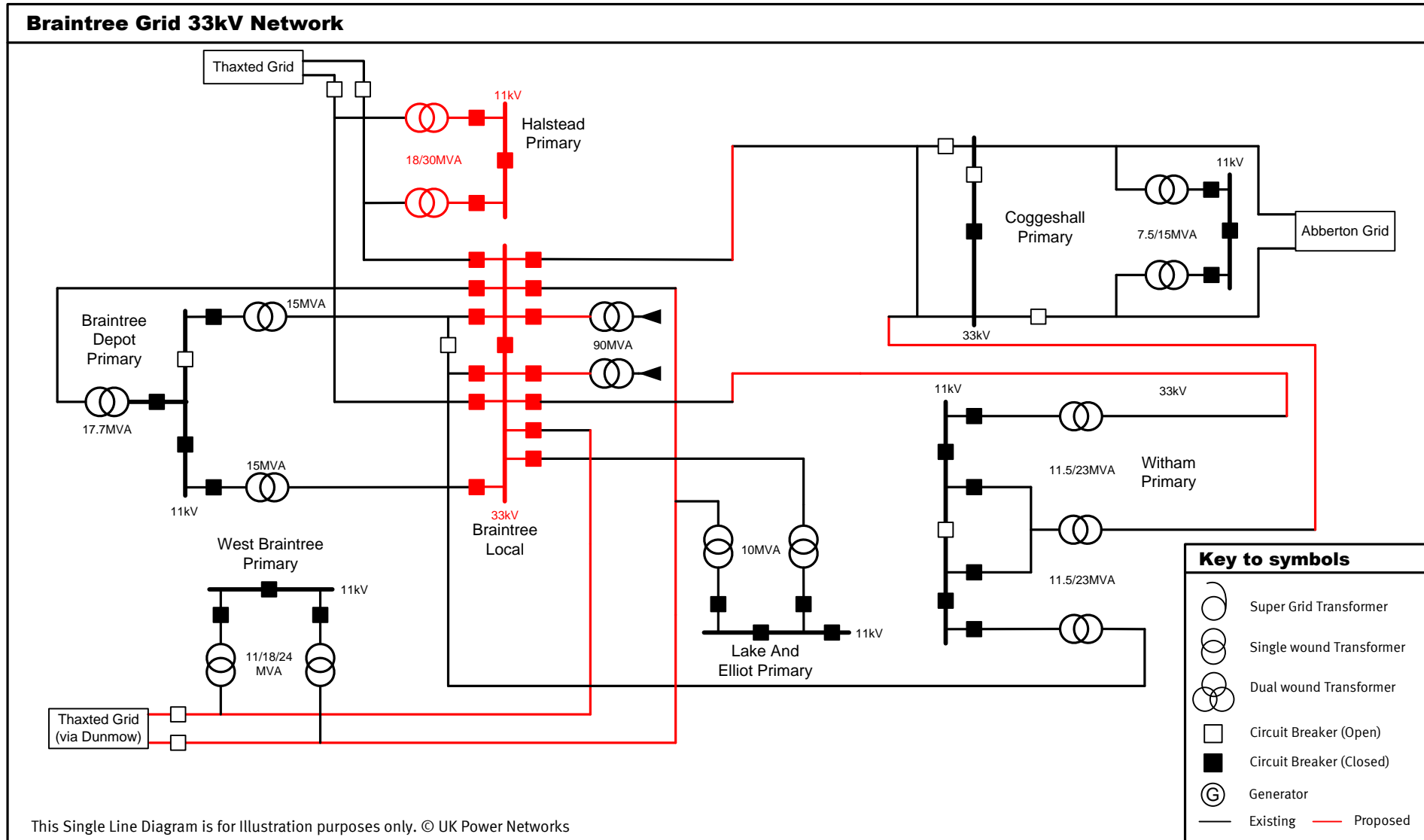


## Braintree – Rayleigh (EPN)

### Chelmsford East Grid 33kV Network



## Braintree – Rayleigh (EPN)



# Regional Development Plan



## Braintree – Rayleigh (EPN)

### APPENDIX D: DETAILED COSTS FOR RECOMMENDED STRATEGY

NAMP version: Table J Less Ind Baseline 19th February 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	2080	PSA - Rayleigh - Chelmsford East - Conductor Replacement				510,200	1,220,617					
A	1.02.03	2115	PSB - Braintree - Chelmsford East - Conductor Replacement						510,200	1,406,063			
A	1.02.03	7553	PCF - South Chelmsford - East Chelmsford - Conductor Replacement					61,815	185,445				
A	1.09.01	2125	(RDP - Braintree) Braintree Grid/Coggeshall 33kV OHL Circuits - Rebuild (575A(W))	53,000									
A	1.09.01	2126	Braintree Grid/Witham 33kV OHL Circuit - 33kV Wood Pole OHL Replacement (575A(W))	873,405									
A	1.09.01	7575	3SQD South Chelmsford - 33kV Tower OHL Replacement							15,041	45,122		
A	1.09.01	7583	3A06B (P23-P149) and 3A11D (P10-P23) Braintree Local/Dunmow - 33kV Wood Pole OHL Rebuild						540,352	1,560,348			
A	1.09.01	7588	3A06B - Braintree Grid/Lake&Elliot - 33kV Wood Pole OHL Replacement				15,541	46,622					
A	1.50.01	5814	South Chelmsford 33/11kV Primary - Replace 11kV Switchboard	709,501	89,358								
A	1.51.01	2999	Chelmsford East 132/33kV Substation - Replace Transformer (1 x 90MVA)	48,501									
A	1.51.01	4198	Chelmsford North 132/11kV Grid Substation - Replace 132/11kV Transformer(s)	34,378									
A	1.51.03	2066	South Chelmsford 33/11kV Primary Substation - ITC (2 x 18/30/40MVA)	1,139,729	206,063								
R	1.11.05	8540	Beaulieu Park / Boreham Interchange Development PGF Diversion						1,216,577	1,216,577	2,433,153	2,533,852	
R	1.33.01	4015	Halstead 33/11kV Primary Substation - ITC (2 x 18/30MVA) and 11kV switchgear	51,154	1,145,760	816,423							
R	1.33.01	6092	Chelmsford East Local 33/11kV Primary Substation - ITC (2x 11/18/24MVA)							16,630	66,521	1,059,252	
R	1.33.07	3640	(RDP - Braintree)Howbridge Hall (Witham South) Proposed 33/11kV Primary Substation - (2 x 12/24MVA)	3,014,584	2,932,439	442,017							
R	1.35.01	3780	(RDP - Braintree) Braintree 132/33kV Grid Substation - ITC (3 x 90MVA)										
R	1.35.05	3847	Writtle St & West Chelmsford FFC Circuits - Reinforce								63,151	1,488,406	
R	1.36.03	2065	Chelmsford East 132/33kV Grid Substation - Replace 33kV Transformer CBs (2000A)	74,334									
R	1.36.03	2818	Braintree GSP 132/33kV Exit Point - Replace 33kV Switchboard (Fault Level)		51,964	1,645,516							

# Regional Development Plan



## Braintree – Rayleigh (EPN)

### APPENDIX E: OUTPUT MEASURES – LOAD INDICES (LI)

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

Substation	Season	First Limitation	DPCR5 Intervention		RIIO-ED1 without intervention				RIIO-ED1 with Intervention		P2/6 at End of ED1		Comply	
			FC NOW (MVA)	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	FC ED1 end (MVA)	2022 (S) 22/23 (W)		P2/6 Class
Braintree Depot	W	Transformer	39.0		39.0	26.4	28.2	LI1	LI1		39.0	LI1	C	Yes
Braintree Grid 33	W	Switchgear	114.3		114.3	104.2	113.2	LI2	LI3	3640	114.3	LI3	D	Yes
Chelmsford East Grid 33	W	Switchgear	71.5	2065	114.3	70.0	74.7	LI1	LI1		114.3	LI1	D	Yes
Chelmsford East Local	W	Transformer	14.0		14.0	14.4	15.6	LI4	LI5	6092	24.0	LI1	C	Yes
Chelmsford North	W	Switchgear	76.3		76.3	51.3	54.6	LI1	LI1		76.3	LI1	C	Yes
Danbury	W	Transformer	13.0		13.0	8.3	9.1	LI1	LI1		13.0	LI1	B	Yes
Halstead	W	Transformer	19.0		19.1	19.6	22.4	LI5	LI5	4015	35.4	LI1	C	Yes
Lake & Elliot	W	Transformer	13.0		13.0	9.0	9.6	LI1	LI1		13.0	LI1	B	Yes
South Chelmsford	W	Transformer	19.5	2066	21.1	18.3	19.3	LI2	LI2		21.1	LI2	C	Yes
West Braintree	W	Transformer	24.0		24.0	13.5	15.3	LI1	LI1		24.0	LI1	C	Yes
West Chelmsford	W	Transformer	21.3		21.3	16.5	17.5	LI1	LI2		21.3	LI2	C	Yes
West Hanningfield total	W	Aux equipment	15.2		15.2	6.5	6.9	LI1	LI1		15.2	LI1	B	Yes
Witham	W	Circuit Rating	40.5		40.5	36.8	38.9	LI2	LI3		40.5	LI1	C	Yes
Writtle Street	S	Transformer	18.0		18.0	14.1	15.0	LI1	LI2		18.0	LI2	C	Yes
Witham South (New)	W	Transformer		3640	24.0	-	15.0	-	LI1		24.0	LI1	C	Yes



## Braintree – Rayleigh (EPN)

### APPENDIX F: OUTPUT MEASURES - HEALTH INDICES (HI)

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
BRAINTREE 132KV	5	2				5	2				5	2			
CHELMSFORD EAST GRID	2					2					2				
<b>TOTAL</b>	<b>7</b>	<b>2</b>				<b>7</b>	<b>2</b>				<b>7</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
BR SPRINGFIELD		2					2								
BRAINTREE LOCAL	5	2	6	1		1	5	1	6	1	14				
CHELMSFORD EAST GRID	3	6				3	2	4			3	2	4		
SOUTH CHELMSFORD PRIMARY	2					2					2				
WITHAM SOUTH	2					2					2				
<b>TOTAL</b>	<b>12</b>	<b>10</b>	<b>6</b>	<b>1</b>		<b>1</b>	<b>14</b>	<b>3</b>	<b>10</b>	<b>1</b>	<b>14</b>	<b>7</b>	<b>2</b>	<b>4</b>	

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
BRAINTREE DEPOT PRIMARY		14	2				14	2				14	2		
CHELMSFORD EAST LOCAL	9					9					9				
CHELMSFORD NORTH GRID	33					33					33				
DANBURY PRIMARY		6	1				7					7			
HALSTEAD PRIMARY		5	4				3	6				11			
LAKE & ELLIOT PRIMARY		8	3				10	1				10	1		
SOUTH CHELMSFORD PRIMARY			4	5	1					10		11			
WEST BRAINTREE PRIMARY	14					14					14				
WEST CHELMSFORD PRIMARY	14					14					14				
WEST HANNINGFIELD PRI		8					5	3				5	3		
WITHAM PRIMARY	23					23					23				
WITHAM SOUTH	9					9					9				
<b>TOTAL</b>	<b>102</b>	<b>41</b>	<b>14</b>	<b>5</b>	<b>1</b>	<b>42</b>	<b>68</b>	<b>40</b>	<b>3</b>	<b>10</b>	<b>64</b>	<b>65</b>	<b>34</b>	<b>3</b>	

## Braintree – Rayleigh (EPN)

### OUTPUT MEASURES - HEALTH INDICES (HI)

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
BR SPRINGFIELD	1	1				1	1				1	1			
BRAINTREE DEPOT PRIMARY		2	1					3					3		
BRAINTREE LOCAL		2						2					2		
CHELMSFORD EAST GRID	1	1					1	1				1	1		
CHELMSFORD EAST LOCAL		2						2			2				
CHELMSFORD NORTH GRID		2					2					2			
DANBURY PRIMARY		2						2					2		
HALSTEAD PRIMARY		2						2			2				
LAKE & ELLIOT PRIMARY		2					1	1				1	1		
SOUTH CHELMSFORD PRIMARY					2					2	2				
WEST BRAINTREE PRIMARY	1	1				1	1				1	1			
WEST CHELMSFORD PRIMARY		2					1	1				1	1		
WEST HANNINGFIELD PRI	2						2					2			
WITHAM PRIMARY		2	1					2	1				2	1	
WITHAM SOUTH	2						2				2				
<b>TOTAL</b>	<b>7</b>	<b>21</b>	<b>2</b>		<b>2</b>	<b>2</b>	<b>11</b>	<b>16</b>	<b>1</b>	<b>2</b>	<b>10</b>	<b>9</b>	<b>12</b>	<b>1</b>	

## Braintree – Rayleigh (EPN)

### 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 existing 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.

