



Regional Development Plan

Bramford – Rayleigh 132kV Group Network (EPN)

Planner	Howard Green
Version	2.0
Date	20/03/2014

Contents

1	EXECUTIVE SUMMARY	3
1.1	SUMMARY OF ISSUES ADDRESSED	3
1.2	RECOMMENDED STRATEGY	4
	INVESTMENT PROFILE	4
2	NETWORK CONFIGURATION	6
2.1	EXISTING NETWORK	6
2.2	NETWORK CHANGES IN PROGRESS	7
3	SUMMARY OF ISSUES	7
3.1	DEVELOPMENT AREAS	7
3.2	ASSET REPLACEMENT	8
3.3	SECURITY OF SUPPLY ANALYSIS	9
3.4	OPERATIONAL AND TECHNICAL CONSTRAINTS	10
3.5	NATIONAL GRID	10
4	RECOMMENDED STRATEGY	10
4.1	DESCRIPTION	10
5	REJECTED OPTIONS	13
5.1	NEW NATIONAL GRID BULK SUPPLY POINT	13
5.2	NEW 132kV INTERCONNECTION FROM BRAINTREE BSP	13
6	REFERENCES	13
6.1	APPENDICES	13
6.2	DOCUMENT HISTORY	14
7	DOCUMENT SIGN OFF	14

1 Executive Summary

This Regional Development Plan (RDP) reviews UK Power Networks (UKPN) EPN HV and EHV network between Bramford and Rayleigh Grid Supply Points (GSP).

These GSP'S supply a large proportion of the Essex coastline between Harwich in the north and Maldon to the south, including the towns of Colchester and Clacton. There are approximately 184,000 customers with a combined winter maximum demand of 334MVA. This area was traditionally known as part of the Five Rivers Area. The 132kV network between the two GSP's operates a split at Colchester and relies heavily on the ability to transfer demands between the Rayleigh and Bramford groups during planned outages and faults, in either group to maintain P2/6 compliance (Standard of Security of Supply) and operational security requirements as defined by Network Control. The circuits are also required to support National Grid outages at both GSP's

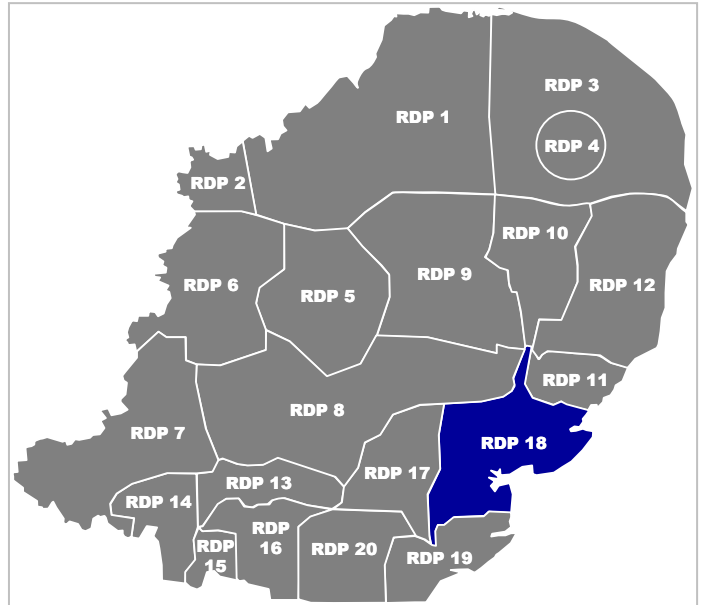


Figure 2. Area covered by RDP

This area of Essex includes key infrastructure such as the Harwich International Port and forms part of the Haven Gateway Development Area. The Dedham Vale and Stour Valley on the Essex Suffolk border is a large Area of Outstanding Natural Beauty in the region along with Conservation and Ramsar areas to the south along the river estuaries that exist along the extensive coastal regions.

There is generation support from the offshore wind farm Gunfleet Sands with 165MW connected via a single circuit to the 132kV compound at Clacton Grid. 33kV connections have also been provided to facilitate off shore trials for new larger turbines and a small on shore wind farm at Earls Hall near Clacton.

1.1 Summary of issues addressed

As demand increases across the Bramford supplied 132kV section of the network (Lawford, Clacton & Colchester 33kV Grids) up to 2023, the ability to transfer demands will reach the circuit/network capacity under various outage scenarios. These circuits will require reinforcement in order to maintain compliance of the two groups particularly under winter outage conditions affecting the PJ and PEC 132kV circuits. The reinforcement of the 3 x 132kV circuits between Bramford and Lawford will be required if demand increases as predicted. This can be achieved by reconductoring of the existing PJ (single circuit) and PEC (dual circuit) tower lines between Lawford and Bramford and Lawford and Cliff Quay respectively. These measures will provide sufficient capacity for demand to increase a further 20% above those predicted for 2023. The estimated cost of the two 132kV reinforcement schemes is approximately £6m.

The Rayleigh supplied 132kV network (Maldon, Abberton & Colchester 11kV Grids) will remain within its capacity for the review period, however it will be operating at approximately 90% of its post fault rating by the end of the period. Regular analysis will be necessary to ensure that measures are put in place to maintain compliance beyond the review period as solutions are likely to be protracted and costly.

The 33kV network to Wix and Dovercourt primary substations is a radial fed wood pole dual circuit 33kV overhead line. The line is developing problems with the wood pole supports that require dual circuit outages in order to replace the poles, this is not possible with the current network arrangements. A proposal in RDP 11

Bramford – Rayleigh 132kV Network Group

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

(Bramford GSP – Ipswich –Cliff Quay is to establish a new 132/33kV Grid substation at Felixstowe and provide 33kV interconnection to the Wix/Dovercourt circuits.

1.2 Recommended strategy

Within this group network are 5 x 132/33kV Grid Substations supplying approximately 184,000 customers. A reasonable level of 33kV interconnection exists with some dual and single circuit transfers available. The only Grid Substation that currently requires reinforcement is Clacton Grid. A 132/33kV transformer reinforcement project is the preferred solution as this should resolve reinforcement issues through the 2015-23 period. The reinforcement cost of Clacton Grid is an estimated £3.25m and defers early reinforcement of the 33kV switchgear at Colchester.

The reinforcement of Felixstowe in RDP11 will provide vital 33kV interconnection to the Lawford group improving summer outage conditions and resilience of both networks.

There are a range of projects primarily at 33kV within the group to maintain P2/6, asset health and ESQC compliance at specific sites and these and the other projects are summarised within Appendix E.

Summary of issues addressed

- Development of the 132kV interconnecting Network between Bramford and Rayleigh.
- Development of the 33kV interconnecting Networks.
- 132/33kV Substation Reinforcement.
- 33/11kV Substation Reinforcement.
- Major Plant Asset Replacement

Investment Profile

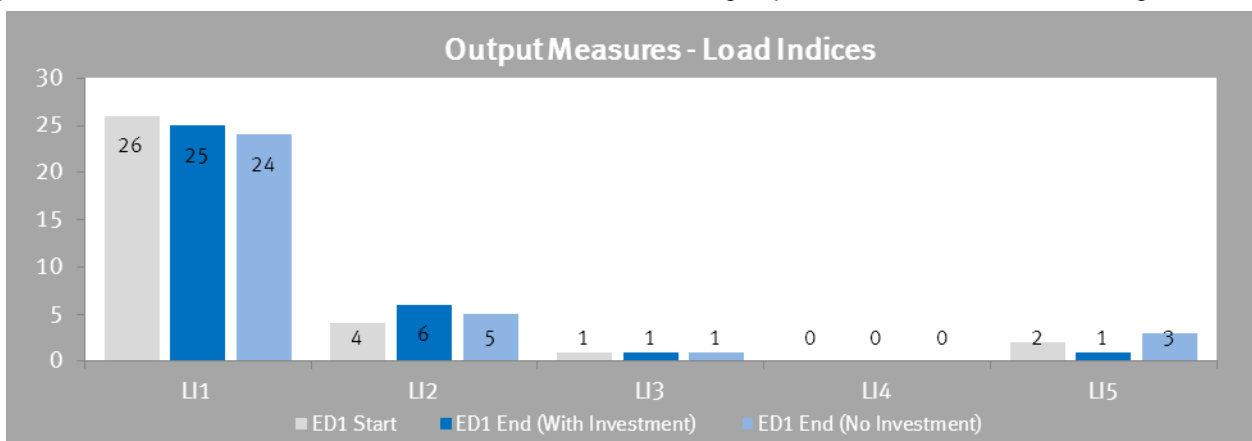
Table 1 provides the projected expenditure profile for reinforcement and asset replacement projects (LRE and NLRE) in this RDP for the ED1 period. This information is taken from the NAMP version 19-02-2014.

RDP	Type	DPCR5 2013-15	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	2020 /2021	2021 /2022	2022 /2023	RIIO-ED1 Total
RDP18	LRE	£5.5m	£1.6m	£0.0m	£0.0m	£0.3m	£0.1m	£3.5m	£1.2m	£4.3m	£11.0m
	NLRE	£2.9m	£0.0m	£0.0m	£0.2m	£1.0m	£2.2m	£1.5m	£0.5m	£1.4m	£6.8m
	TOTAL	£8.4m	£1.6m	£0.0m	£0.3m	£1.3m	£2.3m	£5.0m	£1.7m	£5.6m	£17.9m

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 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.

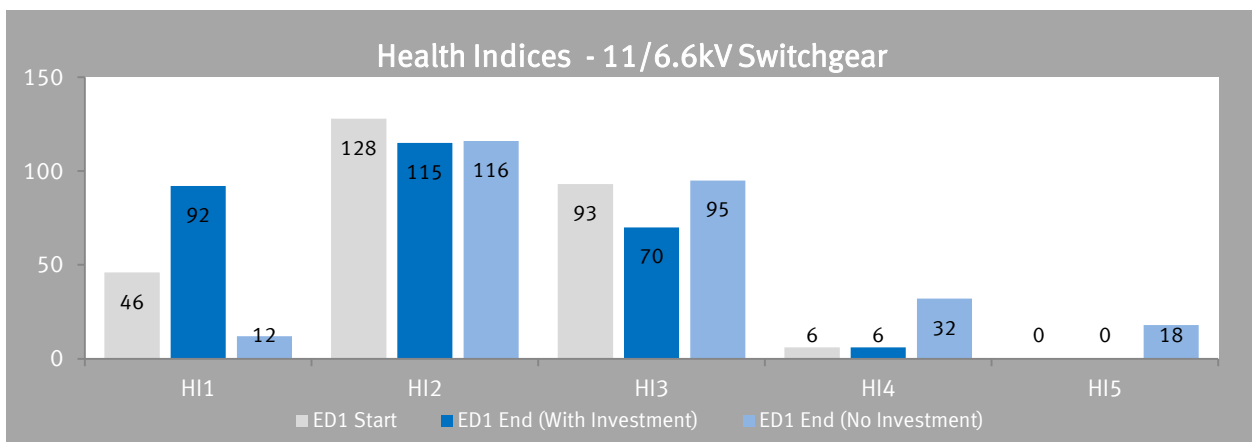
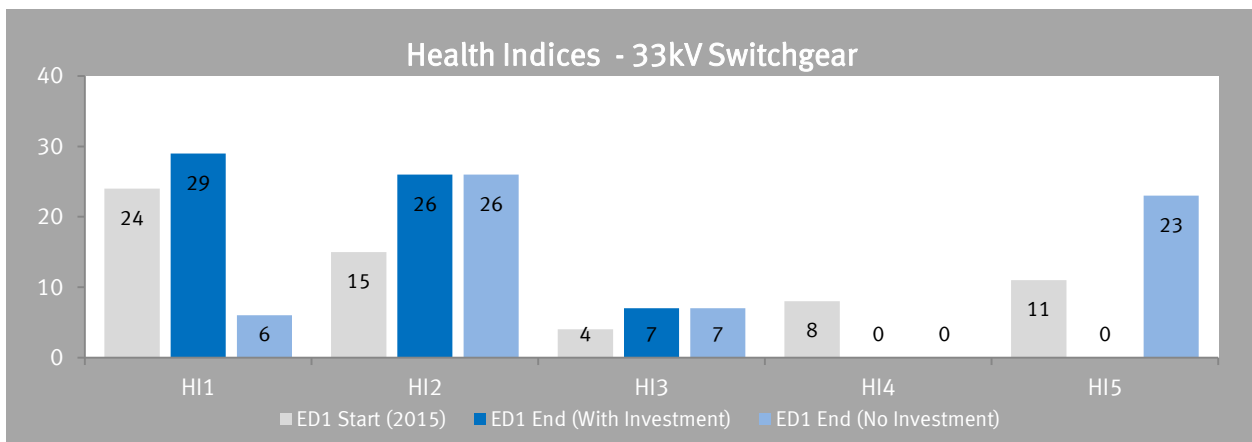
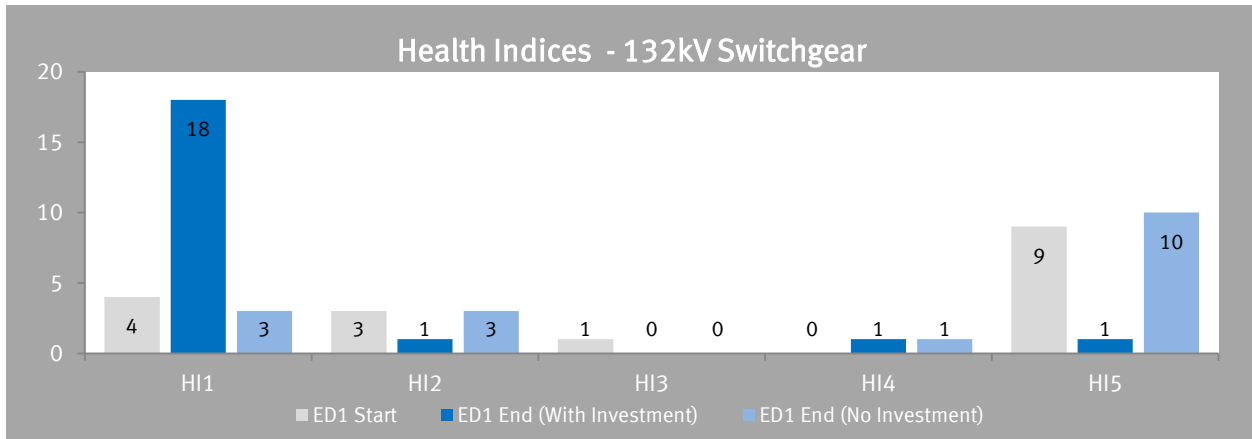


Bramford – Rayleigh 132kV Network Group

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

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.



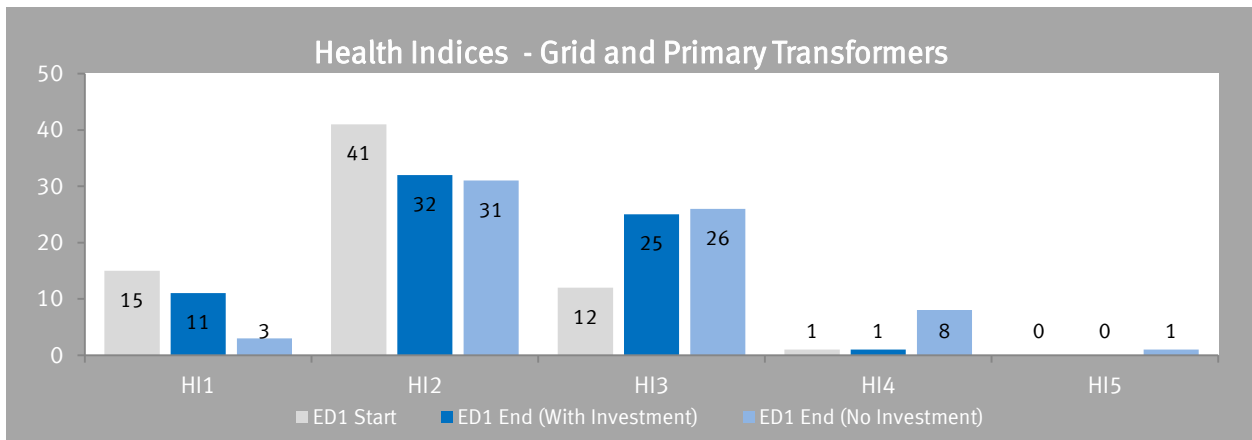


Figure 3. Health Indices by asset category

Scenarios Considered

- Demand growth from Planning Load Estimates (PLE's) up to 2023.
- Major Generation sites disconnected (Gunfleet Sands).
- Compliance with P2/6 Standard for Security of Supply and operational flexibility of the 132kV network.

RDP Dependencies and Interactions

- Reconductoring the 132kV OHL's through the Dedham Vale SSSI is possible.
- Replacement towers or tower enhancements can be achieved to accept 300mm UPAS conductors.
- Reinforcement of the 132kV routes can be delivered by 2018.
- Demand increase occurs at predicted rate.
- Obtaining new terminal tower and cable routes at East Bergholt.
- Interaction with RDP 11 Bramford GSP – Ipswich and Cliff Quay, RDP 12 Twinstead GSP and RDP 17: Rayleigh – Braintree GSP.

2 Network configuration

2.1 Existing Network

The 132kV interconnecting network between Bramford and Rayleigh National Grid Supply Points (GSP) supplies approximately 184,000 customers, a combined winter maximum demand of 334MVA. However this demand is split between the two exits points (GSP's) at Bramford and Rayleigh and therefore both these 132kV network groups are only class D network as defined within Table 1 of the Energy Networks Association Engineering Recommendation P2/6 Security of Supply.

The 132kV dual circuit network from Rayleigh GSP is routed through Maldon Grid, Abberton Grid and Colchester 132/11kV substations. These three substations whilst compliant are at risk of a single dual circuit tower fault that would result in a loss of supplies for the duration of any repair time, as there is no 132kV sectionalisation available. At Colchester there are 132kV normal open points (provided by 132kV CB's) where there are tee's on the Bramford side to Colchester Grid 33kV and the Hythe Network Rail Supply point at 132/25kV. The dual circuits continue to the 132kV switching substation at Lawford Grid where there is a tee via 132kV circuit breakers to Clacton Grid. Three 132kV circuits, a single circuit (PJ route) and a dual circuit (PEC route) then continue on to Bramford GSP. The PJ route is direct to Bramford whilst the PEC route has a single teed connection to the Network Rail Manningtree 132/25kV supply point and Ipswich Grid en-route to Bramford. At Clacton Grid there is a single circuit 132kV metered connection to the Gunfleet Wind Farm is provided.

Bramford – Rayleigh 132kV Network Group

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

The 33kV network supplies 25 primary substations within the group and runs predominately with dual circuits to each primary substation. The 33kV also provides some interconnection available between Grid substations. The 33kV network is a relatively equal combination between cabled and overhead line circuits. Some of the 33kV circuits are teed and demand needs to be monitored for potential overloading under fault and maintenance outages. There are 3 windfarms connected within this RDP area, details are contained in the table 2 below. There is approximately 11km of 33kV FFC and 4.5km of 132kV FFC within this area.

Table 2 - Output of generating plants not used in the analysis

Generation Plants	Type	DNC (MVA)	F (%)	pf	DG Output = F*DNC		
					MVA	MW	MVA _r
Gunfleet Sands	Off Shore Wind	165.0	0	1	0	0	0
Gunfleet Sands 3	Off Shore Wind	12.0	0	1	0	0	0
Earls Farm	On Shore Wind	14.0	0	1	0	0	0

2.2 Network changes in progress

Lawford Grid 132kV ABCB Replacement – The existing GA6 air blast circuit breakers have a known failure mechanism resulting in their catastrophic failure. The circuit breakers and associated equipment at Lawford 132kV compound are due for replacement in 2013/14. The operating arrangement is also to be revised to allow balancing of demands and circuits on the 132kV bus-bar.

Braintree Grid & Witham Reinforcement - A new primary substation known as Witham South is to be established at Witham fed from Maldon grid to provide reinforcement to Witham Primary and the 33kV bus bar at Braintree Grid by transferring demand on to Maldon Grid. This is expected to be completed by 2015. This will transfer 15MVA on to the Rayleigh – Colchester 132kV circuits once commissioned.

3 Summary of Issues

3.1 Development areas

The Sub Regional Growth Area known as the Haven Gateway (formally part of Essex Development & Regeneration Area) is partially included within the area under review. This includes the Harwich International Port, Colchester and the Tendring peninsula. There are also Local Development Plans for Colchester, Tendring and the Heart of Essex (Maldon/Chelmsford & Brentwood), showing growth over the next 25 years.

The Local Development Plans for Tendring DC, Colchester BC and Heart of Essex (Maldon, Chelmsford & Brentwood) Local Authorities are not finalised and unable to provide any real information regarding predicted housing and job creation. However previous plans provide an indication to levels of development expected.

The East of England Regional Spatial Strategy issued in March 2012 for the 2011-2031 period provided figures for job growth and new housing for these local Authorities.

	Job Growth	New Housing	
		Total	per annum
Colchester	18000	16800	840
Maldon	4000	2300	120
Tendring	7000	8600	430

(Extracts from East of England Regional Spatial Strategy)

These figures are expected to be revised once the Local Authorities revise their Local Plans in line with the National Planning Policy Framework, available through the Government Planning Portal:

www.planningportal.gov.uk/planning/planningsystem/localplans

Bramford – Rayleigh 132kV Network Group

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

Colchester Town Centre has been identified for several years for a new shopping and retail area known as Vineyard Street. The additional demand for this development has been speculated between 10 – 18MVA. Should this development go ahead it is likely that the reserve primary substation at Osborne Street would be equipped as a new 33/11kV town centre primary substation. In addition to meeting the new demand it could also facilitate demand transfers from other primary substations on to the new site providing spare capacity to the out of town areas. The new Osborne Street primary would be fed from Colchester Grid 33kV bus-bar some 2-3 km away at the Hythe Quay.

Harwich International Port has for several years indicated their intention to expand the port and with Felixstowe and Tilbury is part of the Hutchison Group. The Bathside development at Harwich as it is known received outline planning back in 2005 and would require approximately an additional 10-18MVA at the extremity of the 33kV network.

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). Much of the infrastructure was installed in the 1950's & 1960's under the electrification of the UK and is now approaching 50 to 60 years old.

A summary of Asset replacement projects currently expected to be required by 2023 are included in Appendix E Detailed Cost Phasing for recommended Strategy.

Rayleigh/Woodham Mort/Maldon (PAE/PBF) Refurbishment

The PAE and PBF routes are double circuit, 132 kV tower lines, running for 26.2 km between Rayleigh, Maldon and Maldon Tee. The PAE route consists of 50 towers built in 1968 and the PBF of 47 towers built in 1967. Both circuits were built to the PL16 design and have Zebra phase conductors (400mm² ACSR) and Lynx earth wire (175mm² ACSR), with no record of reconductoring. During a line patrol, it was recorded that the fittings and insulators were in poor condition on the entire route. A scheme was raised to replace the fittings and insulators on the entire route. It was decided that instead of this, only 10% of the fittings and insulators would be replaced and these would be sent to EA Technology for testing. A Cormon test carried out in 2011 showed the phase conductors to be condition 1 and the earth conductor condition 2. There is, therefore, no need to reconduct this route.

The scope of the project is to replace all phase and earth fittings and insulators on 97 towers (52.4 circuit km), rectify ACD defects on PAE route and rectify any other defects in Ellipse, or found while on site. The PBF route is a planned link for BT21.

Colchester/Mersea 132kV Tower Line (PYF) - 132kV Insulator & Fitting Replacement

The condition assessment of the Colchester/Mersea 132kV Tower Line (PYF) has shown that the probability of failure due to degradation will become unacceptable. This project recommends the replacement of the 132kV insulators and fittings (earth, cct2).

Abberton 132/33kV Grid Substation - Replace 33kV Switchgear

The condition assessment of the 1967 EEC OKM4 outdoor oil insulated switchgear installed at Abberton 132/33kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 6 circuit breakers replaced with 6 new circuit breakers.

Lawford 132/33kV Grid Substation - Replace 33kV Switchgear

The condition assessment of the 1963 EEC OKM4 outdoor oil insulated switchgear installed at Lawford 132/33kV Grid 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.

Braiswick 33/11kV Primary Substation - Replace 11kV Switchgear

Bramford – Rayleigh 132kV Network Group

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 1961 SWS C8X indoor oil insulated switchgear installed at Braiswick 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 7 circuit breakers replaced.

Old Rd 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1987 GEC VMXS indoor resin insulated switchgear installed at Old Rd 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 15 circuit breakers replaced with 15 new circuit breakers.

Brantham 33/11kV Primary Substation - Retrofit 11kV Switchgear

The condition assessment of the 1964 SWS C4X/D8-12X indoor oil insulated switchgear installed at Brantham 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 retrofitted.

East Bay 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1961-64 SWS C4X/D8-12X indoor oil insulated switchgear installed at East Bay 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.

Marks Tey 33/11kV Primary Substation - Retrofit 11kV Switchgear

The condition assessment of the 1967 SWS D8-12X indoor oil insulated switchgear installed at Marks Tey 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 3 circuit breakers retrofitted.

Peldon 33/11kV Primary Substation - Retrofit 11kV circuit breakers

The 11kV switchboard at Peldon Primary is primarily made up of SWS type C4X/C8X. The highest health index at this site is HI4. As part of the asset replacement strategy it is proposed to retrofit 7 circuit breakers.

Wix 33/11kV Primary Substation - Retrofit 11kV circuit breakers

The 11kV switchboard at Wix Primary is primarily made up of SWS type C8X/C4X. The highest health index at this site is HI4. As part of the asset replacement strategy it is proposed to retrofit 8 circuit breakers.

Braiswick 33/11kV Primary Substation - Replace Primary Transformers (T1, T2)

The condition assessment of the 1961 BRU Primary Transformer installed at Braiswick 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 2 Primary Transformers replaced with 2 new Primary Transformers.

Chisbon Heath 33/11kV Primary Substation - Replace Primary Transformers (T1, T2)

The condition assessment of the 1955 BRU Primary Transformer installed at Chisbon Heath 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 2 Primary Transformers replaced with 2 new Primary Transformers.

Dovercourt 33/11kV Primary Substation - Refurbish Primary Transformers (T1, T2)

The condition assessment of the 1965 FER Primary Transformer installed at Dovercourt 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 2 Primary Transformers refurbished.

3.3 Security of supply analysis

See Appendix E for details of Grid and Primary sites considered within this RDP area.

Bramford – Rayleigh 132kV Network Group

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 constraints

- With the 132/11kV and 132/33kV substations in Colchester fed from different Super Grid sources there are known problems with parallels at 33kV, 11kV and low voltage. The hazards created from this running arrangement have to be managed in order to avoid incidents.
- The 132kV network between Rayleigh and Bramford when operating in parallel can also provide a parallel path to the National Grid 400kV network between the two sites. Consideration is given by National Grid to avoid the 132kV system providing a bypass to the 400kV network during abnormalities on their system.
- The Gunfleet OffShore Wind Farm can generate 165MVA and through their single 132kV connection cause power flows to reverse. This generation cannot be used to secure network security due to the nature and connection arrangement of the windfarm.

The 132kV network is principally of dual circuit overhead construction (some single circuit 132kV circuit is in service). There are several 132kV crossings over Network Rail lines and a diamond crossing beneath a redundant 132kV National Grid line (constructed to 275kV) between Rayleigh and the decommissioned Bradwell Nuclear Power Station on the Essex coast.

The 33kV overhead line networks are predominately radial dual circuit lines with inherent problems when work on wood pole supports is necessary. As both circuits are required to be made dead in order to replace one leg of the H pole construction.

Connection of Generation - Heat Map

It is generally possible to connect generation equipment to the electricity network at all voltages, but this capability can be restricted by a number of elements which may be:

- a) The amount of new generation that can be connected relative to the existing load/demand on the system;
- b) The proposed location and size of the generator;
- c) The nature of the existing equipment;
- d) The amount of generation connected or committed to connect

The heat map presented in the Appendices is indicative of the capability of the high voltage electrical network to accept connection of new generation equipment.

3.5 National Grid

Bramford Supergrid is currently undergoing reinforcement works to replace the 132kV switchgear to allow the five 400/132kV transformers to be connected simultaneously thus avoiding the need for complicated operating arrangements.

Rayleigh Supergrid is currently undergoing asset replacement of the 400/132kV transformers and transfer of 132kV circuits between the ABCB substation at Rayleigh Local and the new GIS 132kV substation at Rayleigh Main. These works are expected to continue through to 2014.

4 Recommended strategy

4.1 Description

132kV Network Development

The recommended strategy to maintain P2/6 compliance and operational flexibility particularly during planned outages requires the re-conductoring of the PJ and PEC 132kV overhead lines between Lawford and Bramford/Cliff Quay with 300UPAS to replace the existing 175mm (Lynx) conductors. The towers have recently had the foundations reinforced as part of a refurbishment program but the route would need profiling to identify where clearance or tower alterations would be required. A section of 132kV cable will also be required through the village of East Bergholt where there are insufficient clearances over existing properties to accommodate the

Bramford – Rayleigh 132kV Network Group

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

new conductors. This will need to take place before 2018 when it is expected the existing capacities will be exceeded. This approach will secure the Lawford/Bramford network for a further 10-15 years with the creation of an additional 20% of circuit headroom.

Alternative consideration has been given to additional 132KV interconnection to the neighbouring Braintree Grid Supply Point or the proposed new Twinstead Grid Supply Point planned to replace the 132kV interconnection to Bramford from Pelham. Either scenario involves establishment of lengthy 132kV circuits, new 132/33kV substations and 33kV interconnection and is estimated to be in the range of £20m - £30M.

It is important to continue regular reviews of the 132kV network as network growth may exceed expectations or alternatively demands may develop at a slower rate.

The diagrams in Appendix B show the loading for the projected demands in 2023 and how they are shared under various outage scenarios. Consideration should be given to additional sectionalisation being made available at Abberton Grid substation with new 132kV CBs.

The scenario considered is derived from growth predicted from the PLE data. Clearly should network demand increase above the predicted rate the reinforcement referred to in this document will need to be reconsidered and probably accelerated. Appendix D details the estimated cost and year of incidence.

Substation (Grid and Primary) and 33kV circuit reinforcement

33kV teed Circuits	Winter Firm Capacity (MVA)	2011	2023	Action
Abberton - Shrub End - Lexden	32.8	30.5	36.7	Reinf
Colchester - East Bay - Braiswick	36.6	25	29.3	OK
Clacton - Old Rd - Chisbon Heath	32.6	31.1	35.3	Reinf
Lawford - Wix - Dovercourt	28	24.1	27	OK
Lawford - Foxash - Brantham	28	13.8	15.9	OK
Lawford - Langham - Severalls	28	21	24.8	OK
Maldon - Tillingham - Burnham	21.7	12.6	13.5	OK
Maldon - Sth woodham - Rayleigh	22.3	21.6	24.3	Reinf

Lawford - Cliff Quay 3 & Ipswich 1 PEC Route reinforcement

The Rayleigh – Bramford (both supergrids) 132kV interconnectors supports 9 x 132/33, 132/25kV and 132/11kV substations providing supplies to Maldon, Colchester, Clacton and parts of Ipswich. The combined demand is in excess of 300MW and often operates interconnected between the two National Grid supply points. With 5 SGT's at Bramford, 4 at Rayleigh and 5 x 132kV circuits, network outages occur on an annual basis.

In order to ensure capacity into the group beyond 2020 the 132kV dual circuit the section Cliff Quay to Lawford 132kV switching substation (towers 7 – 60 PEC route) is to be reconducted with 300mm UPAS conductors, approximately 15km. The Bramford – Cliff Quay section is already 300mm UPAS.

Tiptree 33/11kV Primary Substation - ITC (2x11/18/23MVA)

The predicted load at Tiptree Primary Substation will exceed the existing firm capacity of the 10MVA ONAN 33/11kV transformers, including the transfer capacity to Witham and Marks Tey Primary Substations early in the ED1 period.

It is proposed to install 2 x 12/24MVA 33/11kV transformers to utilise the capacity of the 1200amp 11kV switchgear. Completion of this project will see the 2 existing transformers replaced with 2 new transformers.

Bramford – Rayleigh 132kV Network Group

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

Maldon/South Woodham - Proposed new Primary Substation

The predicted load on the South Woodham Primary substation 11kV switchgear and the 33kV circuits will exceed their existing rating capacity towards the end of the ED1 period. It is therefore proposed to create a new primary substation in the South Woodham area to provide demand transfer and improved 11kV resilience.

Completion of this project in the ED2 period will see a new Primary Substation comprising 2x 11/18/24MVA transformers, a 13 panel 11kV switchboard and approximately 5 km of new underground circuit installed, fed from the Rayleigh 33kV network.

Clacton 132/33kV Grid Substation - ITC (2 x 90MVA units)

The predicted load at Clacton Grid Substation will exceed the existing firm capacity, including the transfer capacity to Colchester Grid Substation. It is therefore proposed to replace the existing transformers with larger units. The existing switchgear is fully rated for this increased load and the existing circuits supplying the transformers are fully rated for the larger units. Completion of this project will see the 2 existing transformers replaced with 2 new transformers.

Clacton Grid /Old Road Tee - Reinforce 33kV Circuit

The 33kV dual circuit from Clacton Grid to the Old Rd Primary tee point is a combination of OHL for the first 16 spans and underground cable for the remainder. The circuit supports the combined loads of Old Road and Chisbon Heath Primary substations and provides 33kV interconnection to Colchester Grid. Reinforcement of the circuits is required and it is planned to replace the OHL section with an extension of the underground cables from Clacton Grid through to pole 17 E/W near the tee point.

Abberton Grid 132kV Sectionalisation

In order to improve 132kV operation and security between Rayleigh and Bramford National Grid Supply Points it is proposed to install new 132kV sectionalisation points at Abberton Grid on the Rayleigh side in the PDE route. This will improve network flexibility and resilience of these important interconnectors supporting nine 132/33kV, 132/11kV & 132/25kV substations and the 132kV connected wind farm at Gunfleet Sands.

Clacton 132/33kV Grid Substation - increase switchgear rating

The predicted load at Clacton Grid Substation will exceed the rating of the existing switchgear. It is not possible to lower the load without compromising operational and planning requirements. Completion of this project will see 3 circuit breakers replaced with 3 new circuit breakers.

Hadleigh Rd/Lawford 132 kV Tower Line (PJ) Circuit - reinforce (300mm)

The predicted load on the Hadleigh Rd/Lawford (PJ) circuit will exceed the existing rating during certain fault and outage conditions affecting the three Lawford 132kV circuits. It is not possible to lower the load without compromising operational and planning requirements. Completion of this project will see a 14km overhead replacement conductor installed and tower foundations reinforced.

Abberton/Peldon 33kV OHL Circuit - reinforce OHLs (570A)

The predicted load on the Abberton/Peldon circuit will exceed the existing rating of the 33kV overhead line. It is not possible to lower the load without compromising operational and planning requirements. Completion of this project will see 2 x 2.5km overhead replacement circuits installed. The demand on Peldon Primary is predicted to exceed the line rating within the ED1 period and will require reinforcement.

Abberton Tee/Tiptree 33kV OHL Circuit - reinforce OHL (570A)

The predicted load on the Abberton Tee/Tiptree circuit will exceed the existing rating. It is not possible to lower the load without compromising operational and planning requirements. Completion of this project will see a 9km overhead replacement circuit installed.

Abberton/Shrub End 33kV Circuits - reinforce 33kV circuits (2 x 730A)

The predicted load on the Abberton - Shrub End/Lexden Primary 33kV Substation circuits will exceed the existing rating and network security supply arrangements of the 33kV dual circuit overhead lines. It is not possible to lower the load without compromising operational and planning requirements.

Bramford – Rayleigh 132kV Network Group

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

Completion of this project will see the dual circuit 33kV overhead line altered to enable higher operating temperatures and therefore a greater rating.

(RDP - Braintree) Lawford/Rayleigh 132kV Circuits (PNB, PUD, PAE) – reinforce

The predicted load on the Lawford/Rayleigh 132kV (PNB, PUD, PAE) circuits will exceed the existing security of supply arrangements under certain fault and outage conditions (N-2) when operating interconnected with the Bramford – Lawford 132kV network. It is not possible to lower the load without compromising operational and planning requirements. Completion of this project will see 2 x 20km underground/overhead circuits reinforced and associated switchgear installed.

This project is due for completion in the ED2 period.

5 Rejected Options

5.1 New National Grid Bulk Supply point

With National Grid supply points already at Braintree, Bramford and Rayleigh all with capacity available a new BSP is not a logical requirement and has therefore not been fully costed. Though exit charges would be expected to be over £1m per annum, in addition to any capital works in the region of £7-£10m.

5.2 New 132kV Interconnection from Braintree BSP

There is insufficient growth in demand through the ED1 period to justify provision of additional 132kV interconnection or demand transfer from the Rayleigh – Bramford 132kV network. There are incremental stages available to reinforce the 132kV network for the current period. Should growth prompt additional reinforcement the option of a 132kV demand transfer would be reviewed. The are stages of reinforcement available from installation of a new 132/33kV substation fed from Braintree and providing 33kV transfer capacity for approximately £15-£20m to a 132kV demand transfer enabling Braintree to permanently supply part of the group load. This would be expected to be over £20m depending largely on availability of 132kV overhead or underground circuits.

6 References

References	Description
Reference 1	Planning Load Estimates EPN Area 2011 - 2023
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, East of England Plan >2031,

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
1.3	24/06/2013	Howard Green	Final version
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		20/03/14
Nuno Da Fonseca	Infrastructure Planning Manager (EPN)		

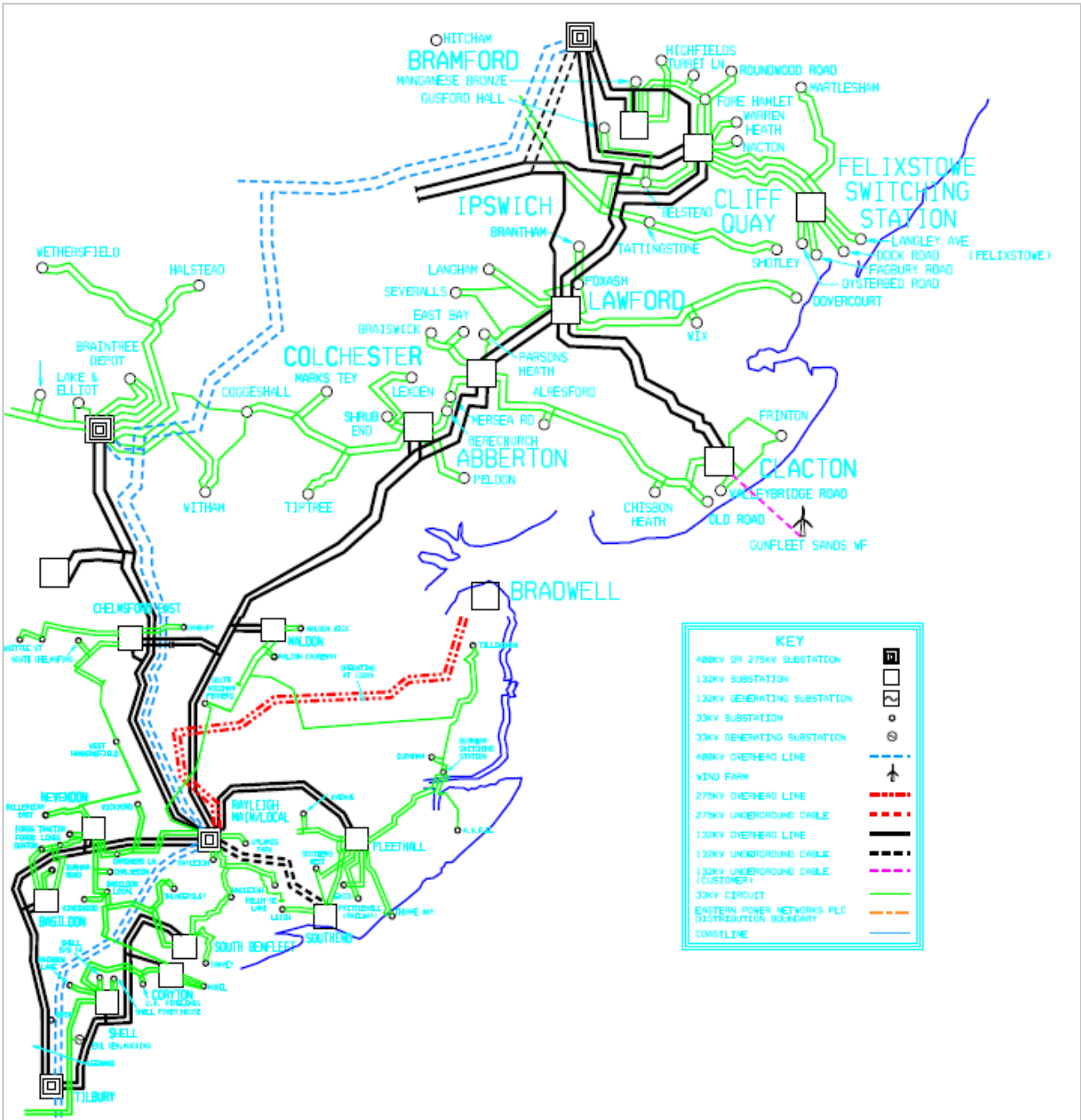
Approval by:

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

Bramford – Rayleigh 132kV Network Group

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

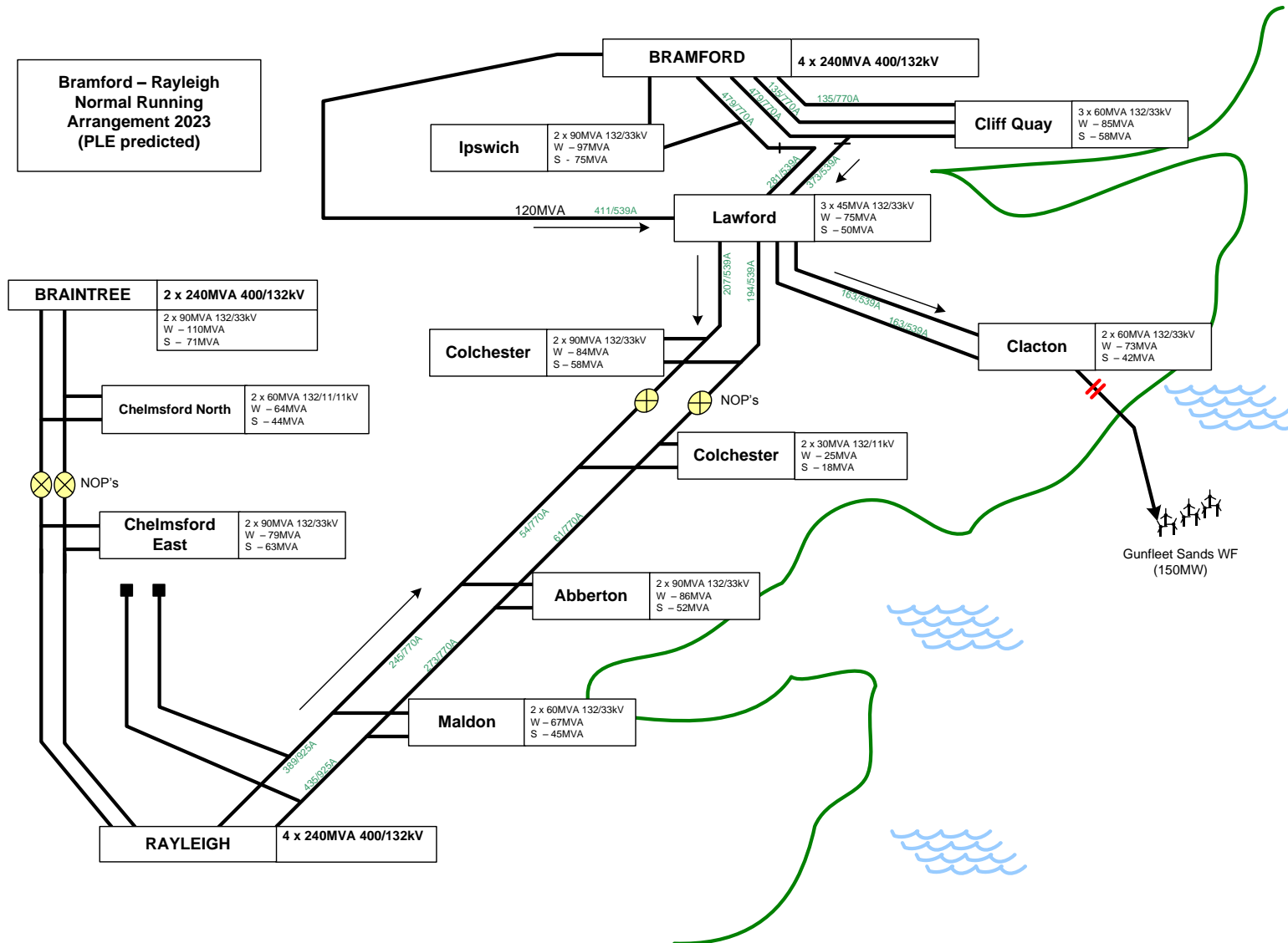


Regional Development Plan



Bramford – Rayleigh 132kV Network Group

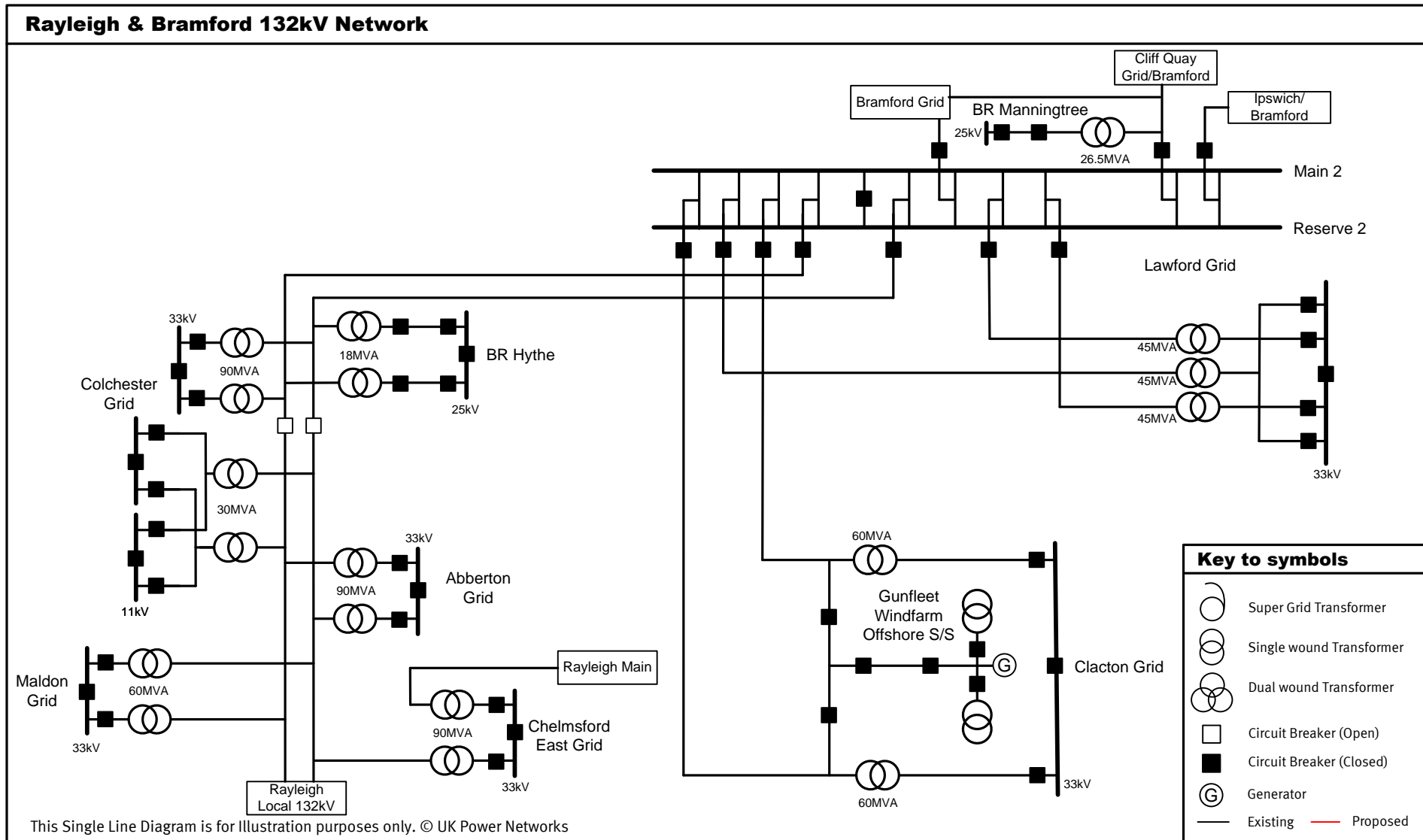
APPENDIX B: SINGLE LINE DIAGRAM – EXISTING NETWORK 2023 DEMANDS



Regional Development Plan



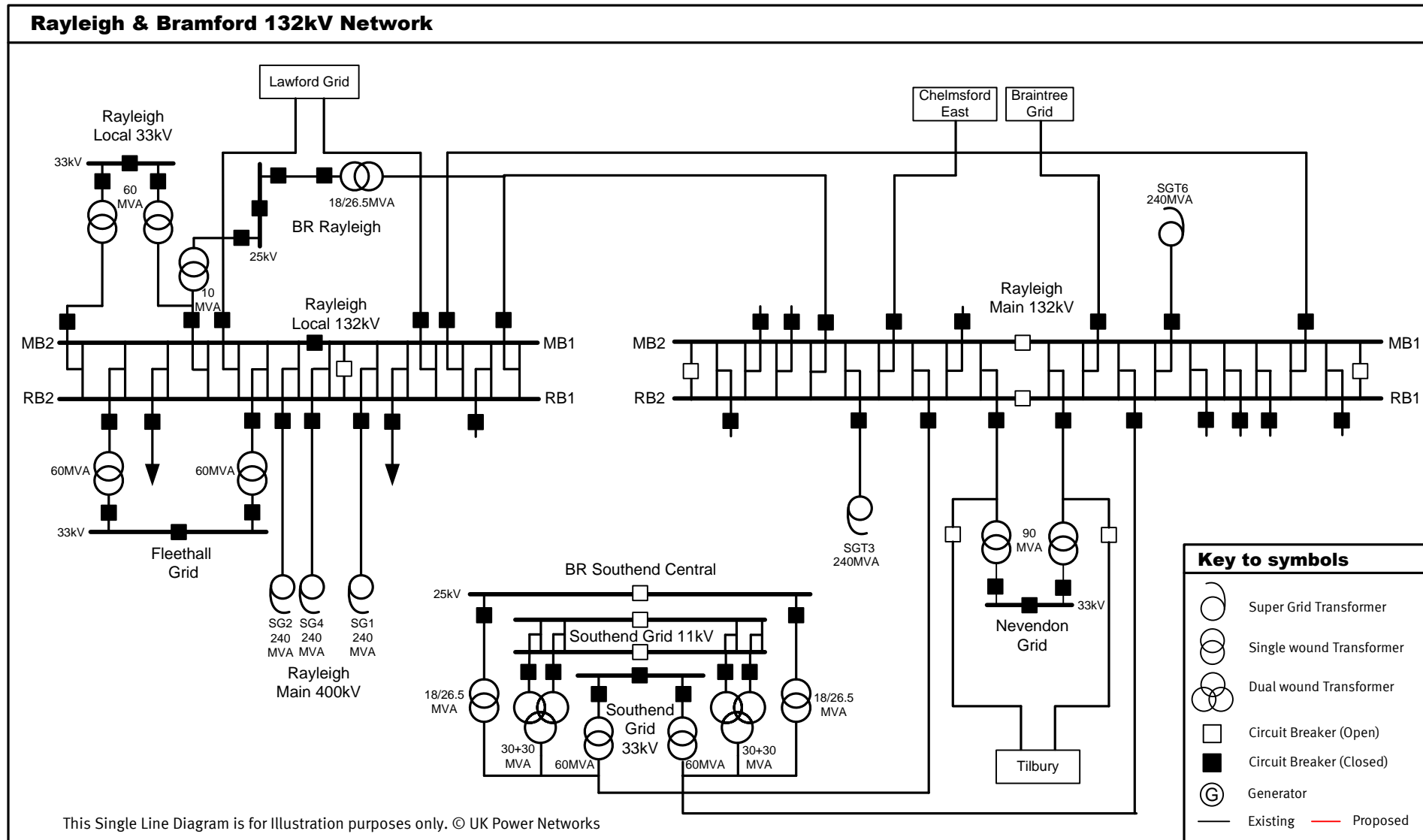
Bramford – Rayleigh 132kV Network Group



Regional Development Plan



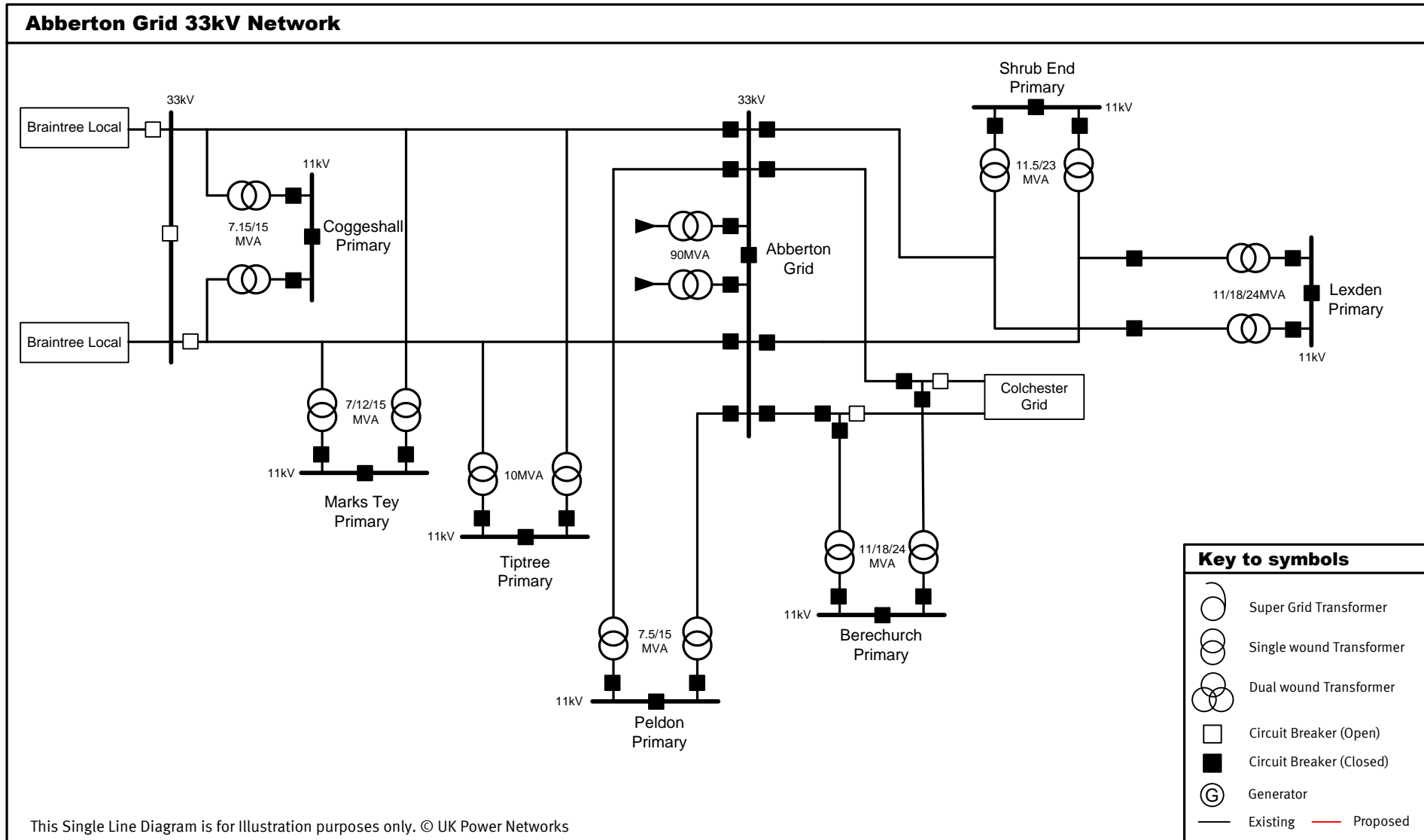
Bramford – Rayleigh 132kV Network Group



Regional Development Plan



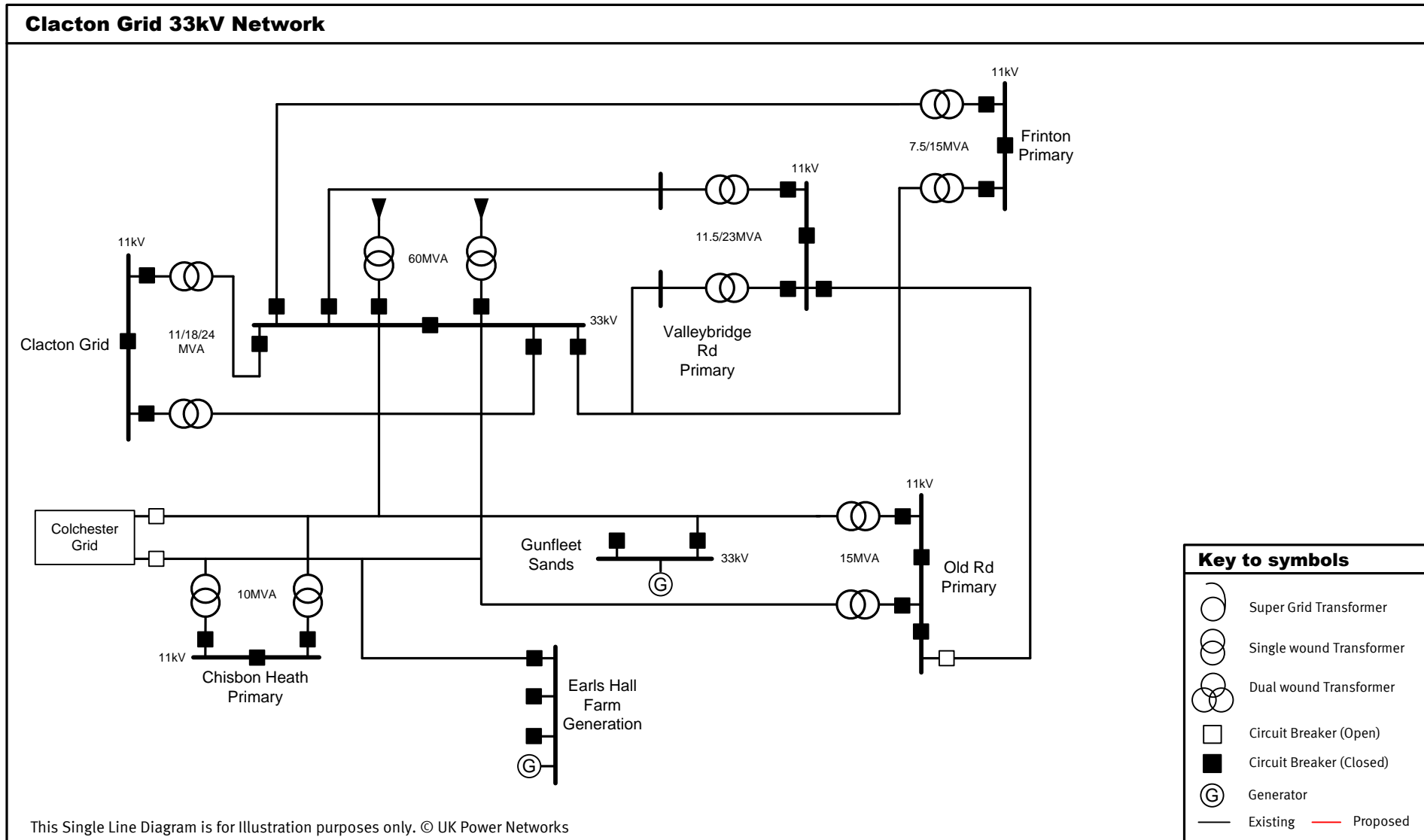
Bramford – Rayleigh 132kV Network Group



Regional Development Plan



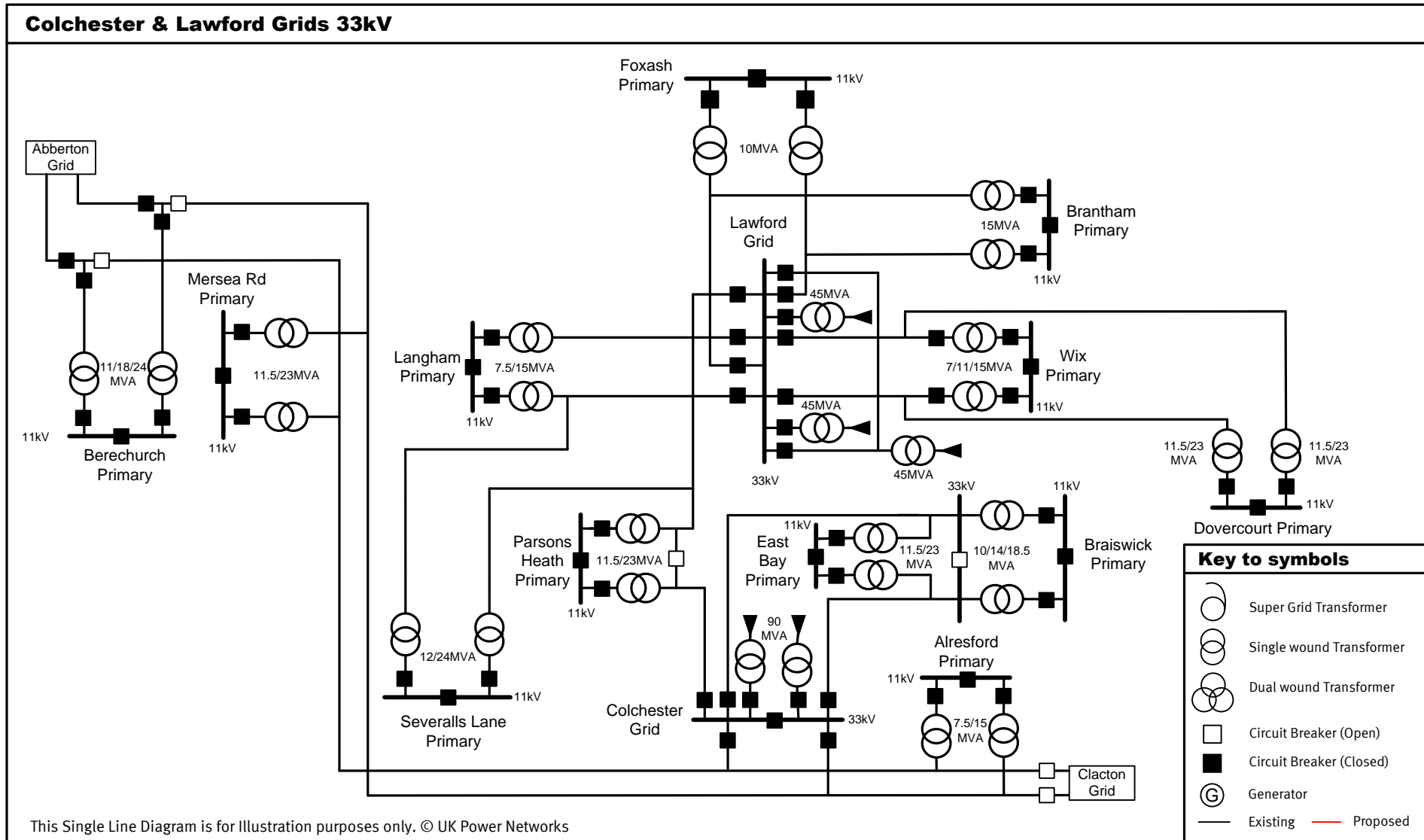
Bramford – Rayleigh 132kV Network Group



Regional Development Plan



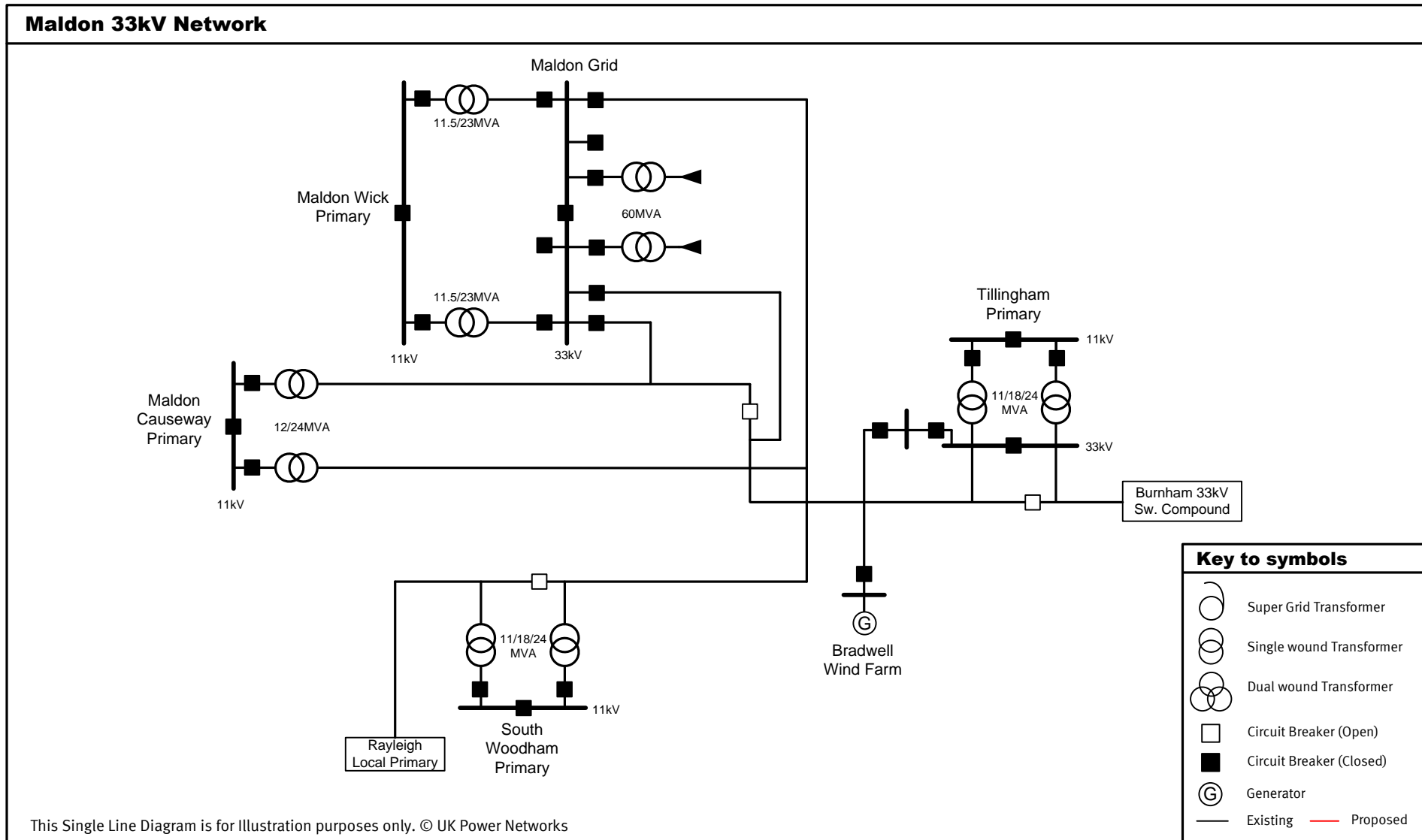
Bramford – Rayleigh 132kV Network Group



Regional Development Plan



Bramford – Rayleigh 132kV Network Group

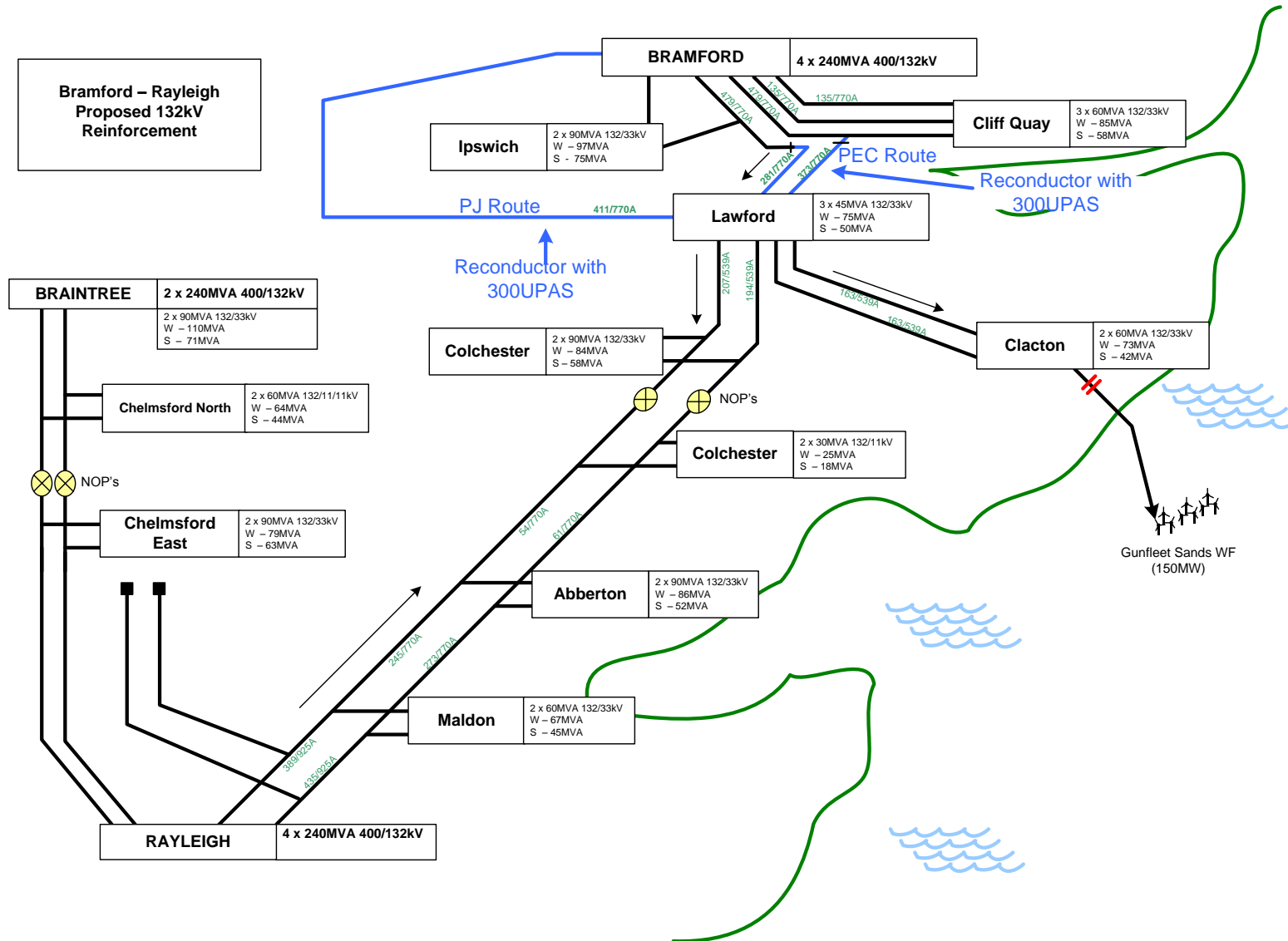


Regional Development Plan



Bramford – Rayleigh 132kV Network Group

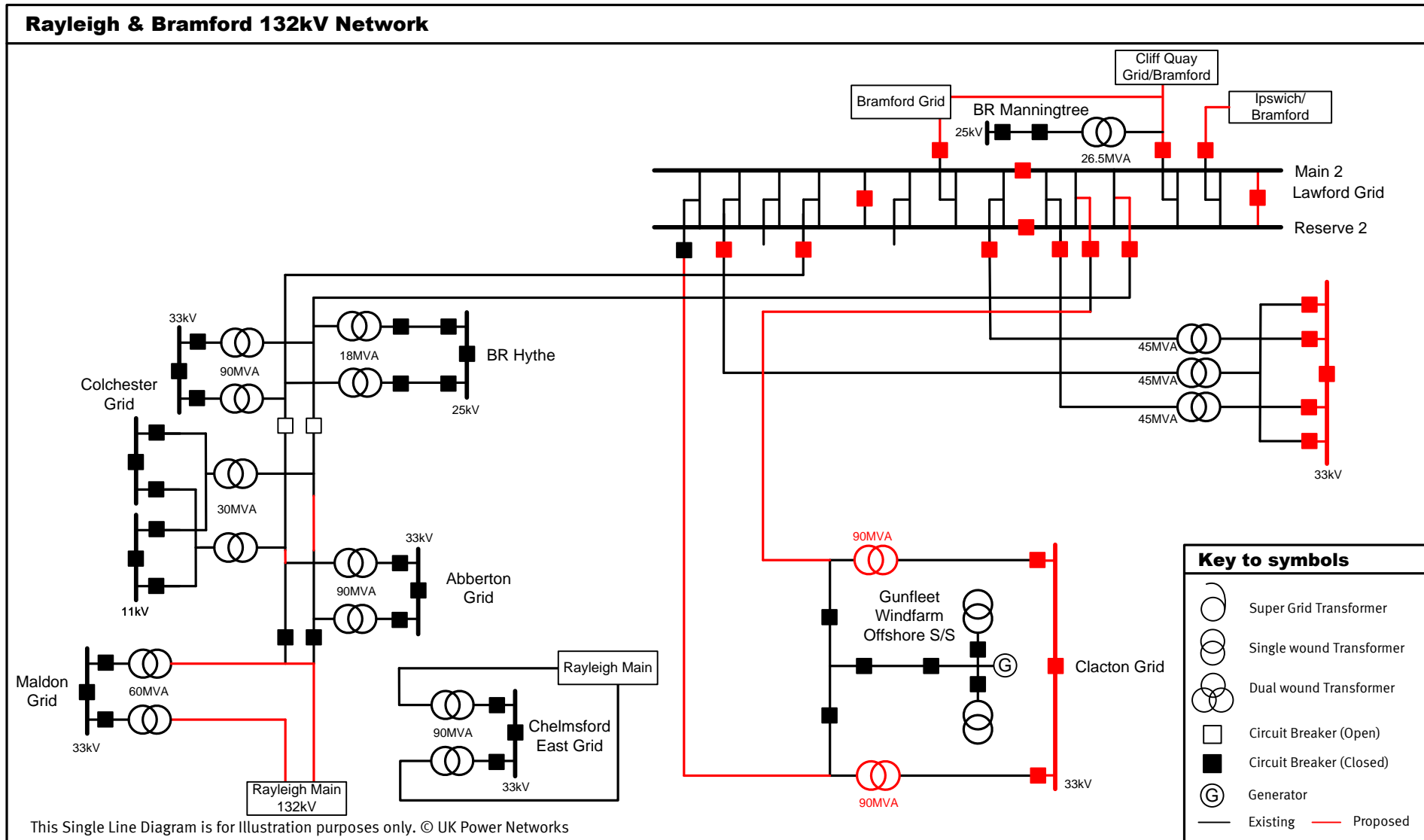
APPENDIX C: SINGLE LINE DIAGRAM – RECOMMENDED STRATEGY



Regional Development Plan



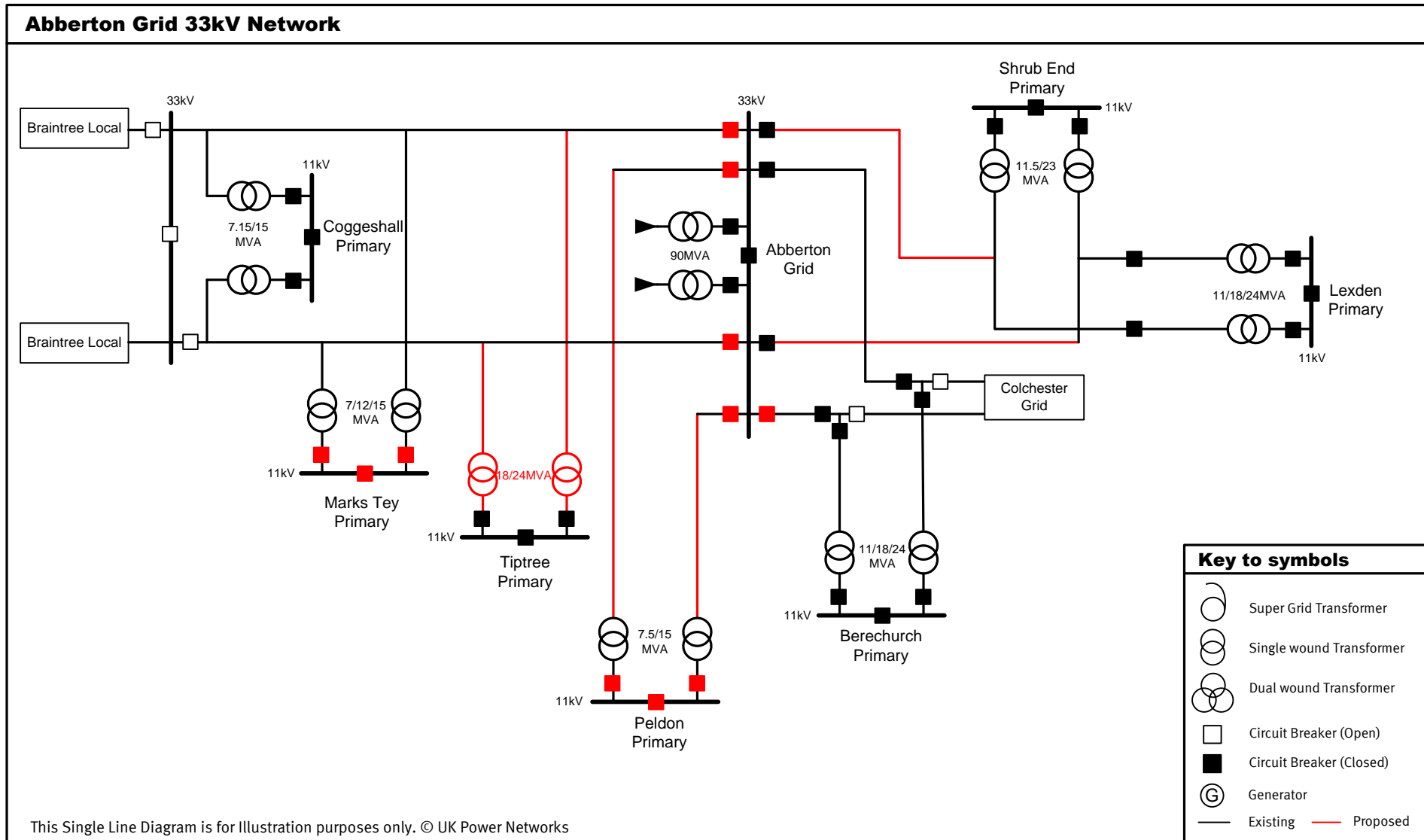
Bramford – Rayleigh 132kV Network Group



Regional Development Plan

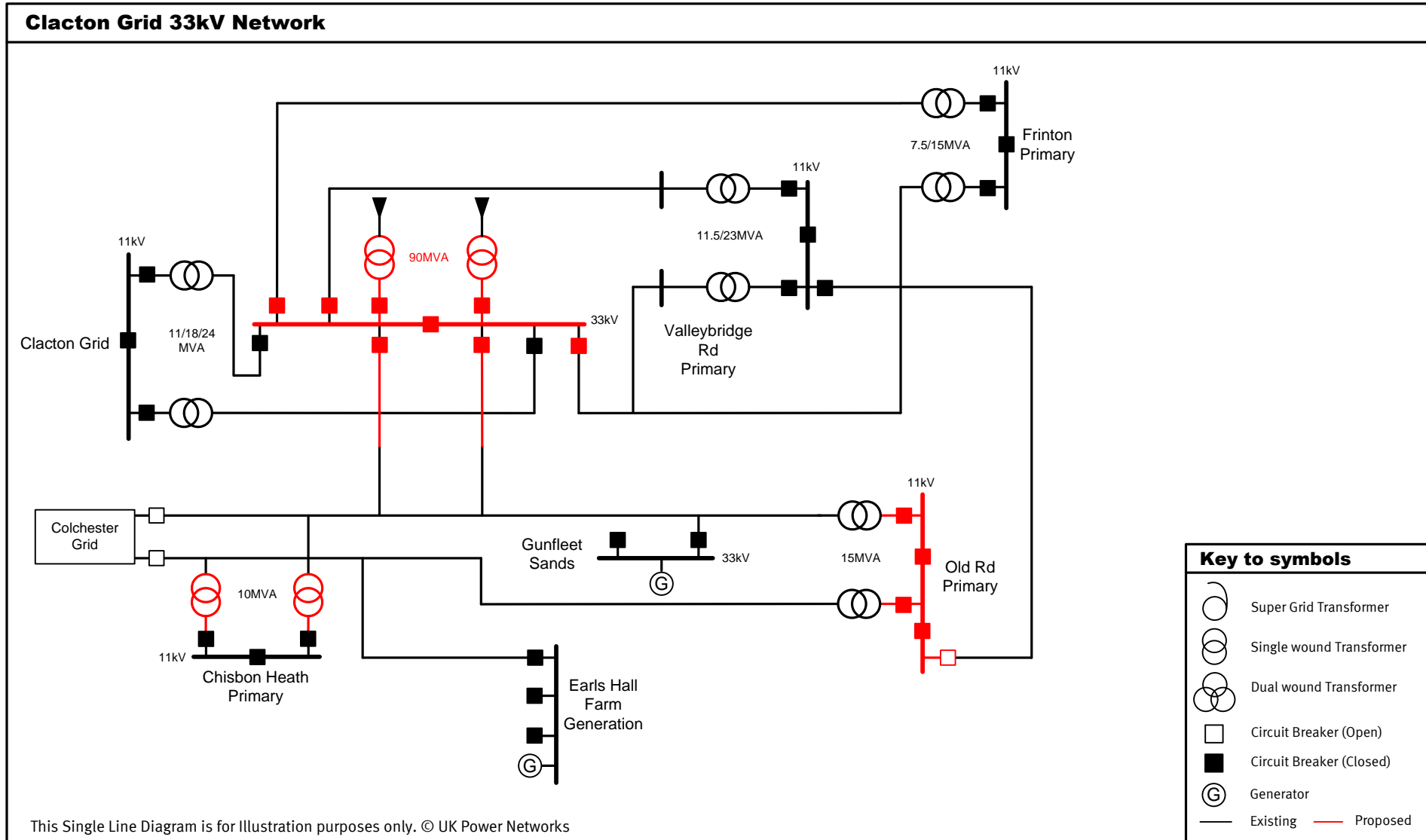


Bramford – Rayleigh 132kV Network Group



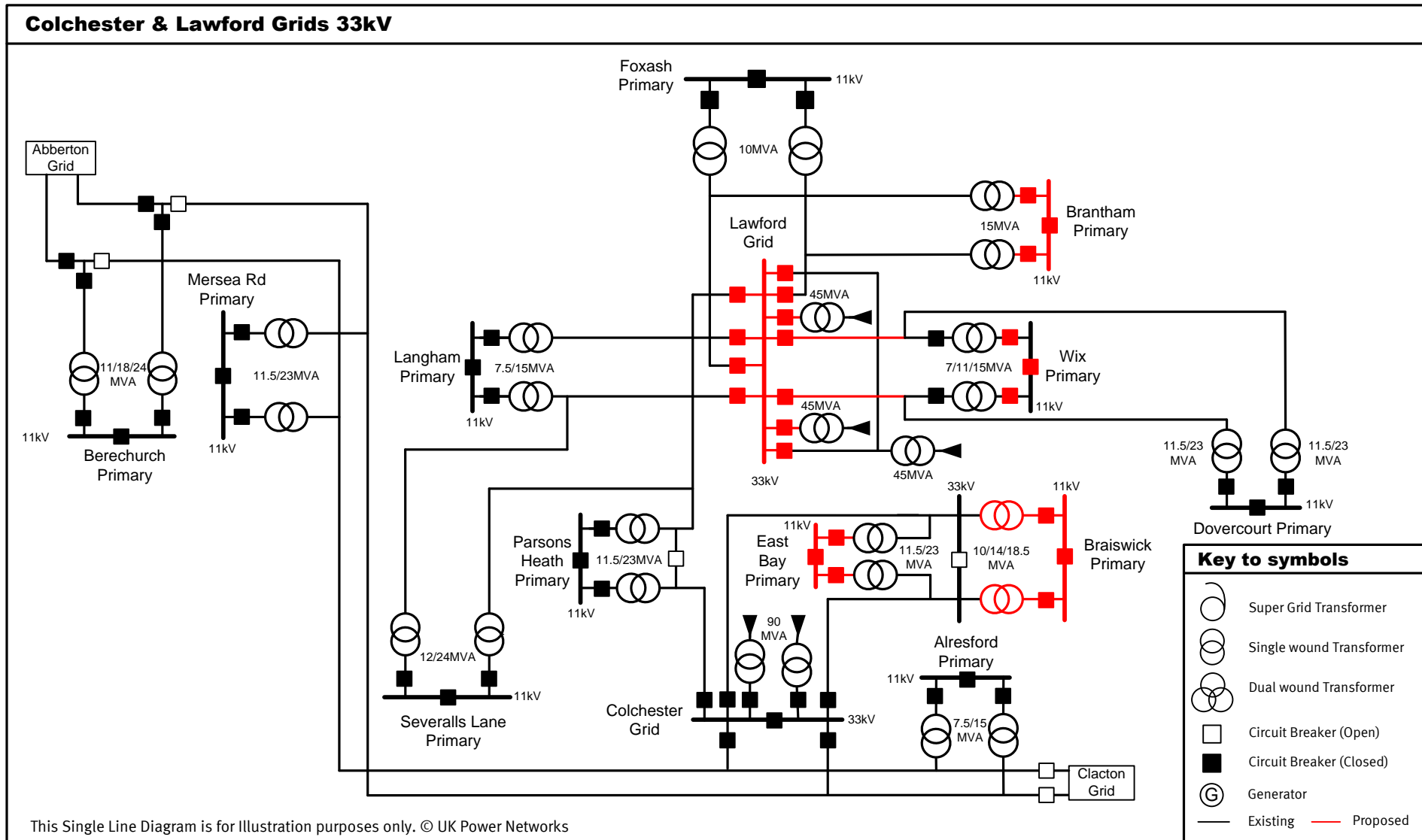
Regional Development Plan

Bramford – Rayleigh 132kV Network Group



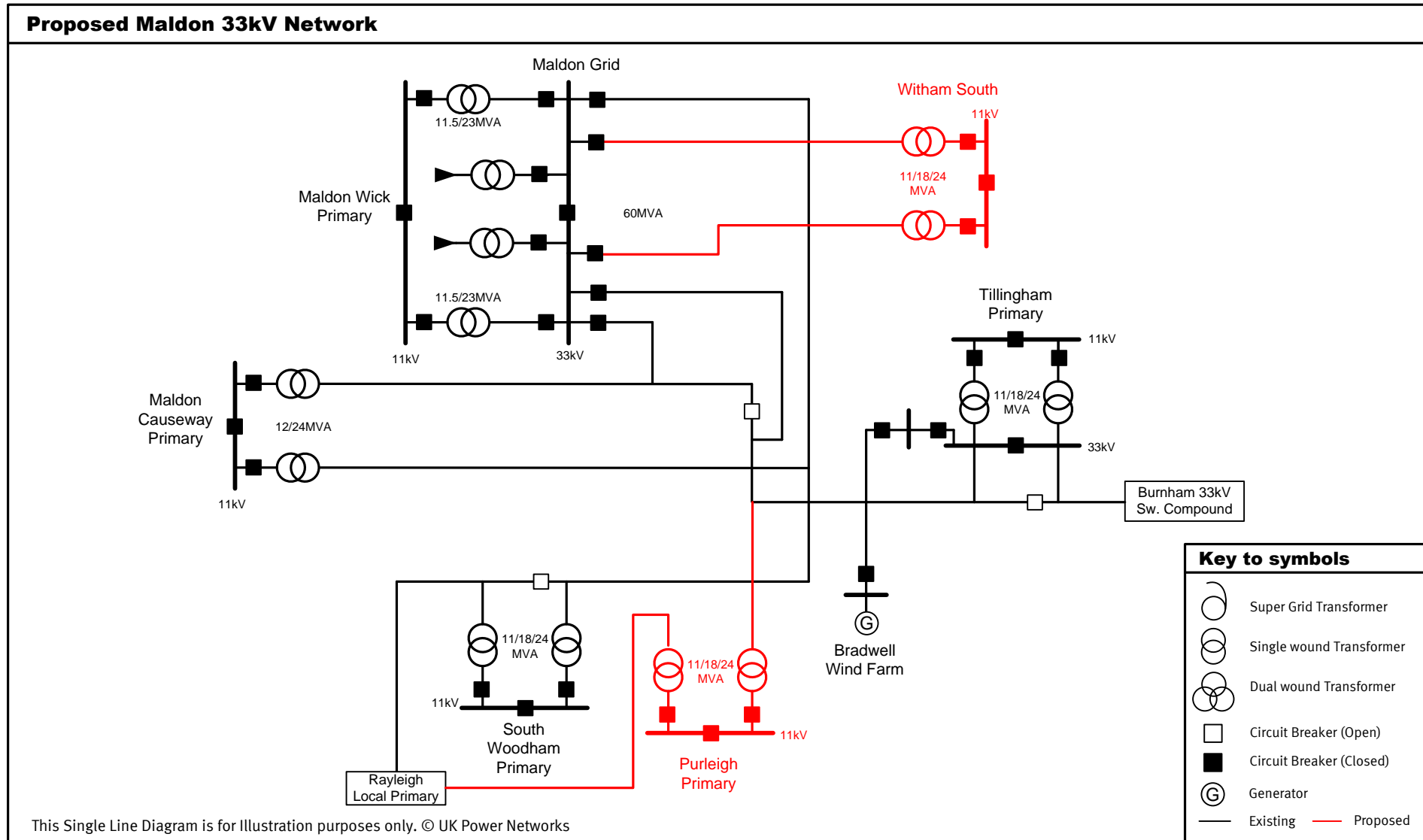
Regional Development Plan

Bramford – Rayleigh 132kV Network Group



Regional Development Plan

Bramford – Rayleigh 132kV Network Group



Regional Development Plan



Bramford – Rayleigh 132kV Network Group

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	5850	PAE/PBF - Rayleigh - Woodham Mort/Maldon - Insulator and Fittings Replacement	310,533									
A	1.02.03	7566	PYF - Colchester - Mersea - Insulator & Fitting Replacement					13,787	41,360				
A	1.48.01	2903	Lawford 132/33kV Grid Substation - Replace GA6 132kV CBs	1,086,015	505,716								
A	1.48.01	5384	Lawford Grid GA6 Associated Replacements	278,007	542,655								
A	1.48.02	2099	Abberton 132/33kV Grid Substation - Replace 33kV Switchgear									237,924	392,179
A	1.48.02	7617	Lawford 132/33kV Grid Substation - Replace 33kV Switchgear							237,713	707,460		
A	1.50.01	5846	Braistwick 33/11kV Primary Substation - Replace 11kV Switchgear									248,182	642,686
A	1.50.01	7658	Old Rd 33/11kV Primary Substation - Replace 11kV Switchgear										40,026
A	1.50.01	7673	Brantham 33/11kV Primary Substation - Replace 11kV Switchgear						39,111	823,146			
A	1.50.01	7681	East Bay 33/11kV Primary Substation - Replace 11kV Switchgear					234,836	555,099				
A	1.50.01	7697	Marks Tey 33/11kV Primary Substation - Retrofit 11kV Switchgear										48,979
A	1.50.07	5866	Peldon 33/11kV Primary Substation - Retrofit 11kV Circuit Breakers	107,850									
A	1.50.07	5868	Wix 33/11kV Primary Substation - Retrofit 11kV Circuit Breakers	105,600									
A	1.51.03	7745	Braistwick 33/11kV Primary Substation - Replace Primary Transformers (T1, T2)						394,039	748,364			
A	1.51.03	7750	Chisbon Heath 33/11kV Primary Substation - Replace Primary Transformers (T1, T2)							394,039	748,364		
A	1.51.11	7727	Dovercourt 33/11kV Primary Substation - Refurbish Primary Transformers (T1, T2)									51,020	250,814
R	1.11.04	3845	Wallasea Island Flooding - Protection of AWRE Cable	601,486	1,647,209								
R	1.33.01	2075	Tiptree 33/11kV Primary Substation - ITC (2x11/18/23MVA)		166,303	976,101							

Regional Development Plan



Bramford – Rayleigh 132kV Network Group

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
R	1.33.01	3852	Frinton 33/11kV Primary Substation - ITC (2 x 11/18/24MVA) & Switchboard (2000A)										
R	1.33.07	3684	Maldon/South Woodham - Proposed New Primary Substation (Temp Name - Purleigh Primary)								38,896	1,030,744	1,536,392
R	1.35.05	3950	Clacton Grid /Old Road Tee - Reinforce 33kV Circuit								17,566	52,699	1,080,331
R	1.36.01	5860	Abberton Grid 132kV Sectionalisation							69,281	559,437		
R	1.37.01	2221	Hadleigh Rd/Lawford 132 kV Tower Line (PJ) Circuit - Reinforce (300mm)	526,793	1,960,421	602,049							
R	1.37.01	5848	Lawford - Cliff Quay 3 & Ipswich 1 PEC Route Reinforcement							67,082	2,912,612		
R	1.37.05	2072	Abberton/Shrub End 33kV Circuits - Reinforce 33kV Circuits (2 x 730A)									18,853	288,434
R	1.37.05	3440	Abberton/Peldon 33kV OHL Circuit - Reinforce OHLs (570A)					26,446	282,232				
R	1.37.05	3441	Abberton Tee/Tiptree 33kV OHL Circuit - Reinforce OHL (570A)	34,625	539,660								
R	1.37.07	3010	Lawford/Dovercourt 33kV Circuits - Reinforce										
R	1.37.09	3986	(RDP - Braintree) Lawford/Rayleigh 132kV Circuits (PNB, PUD, PAE) - Reinforce									90,796	1,361,933

Regional Development Plan



Bramford – Rayleigh 132kV Network Group

APPENDIX E: OUTPUT MEASURES – LOAD INDICES (LI)

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 at 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	FC ED1 end (MVA)	2022 (S) 22/23 (W)	P2/6 Class	Comply
Abberton Grid 33	W	Switchgear	114.3		114.3	65.0	71.3	L11	L11		114.3	L11	D	Yes
Alresford	W	Transformer	15.0		15.0	10.7	11.8	L11	L11		15.0	L11	B	Yes
Berechurch	W	Circuit Rating	20.1		20.1	8.0	8.5	L11	L11		20.1	L11	B	Yes
Braiswick	W	Transformer	18.5		18.5	12.5	13.1	L11	L11		18.5	L11	C	Yes
Brantham	W	Transformer	18.0		18.0	5.2	5.7	L11	L11		18.0	L11	B	Yes
Chisbon Heath	W	Switchgear	12.0		12.0	10.3	11.3	L12	L12		12.0	L13	B	Yes
Clacton Grid	W	Transformer	24.0		24.0	14.9	16.1	L11	L11		24.0	L11	C	Yes
Clacton Grid 33	W	Switchgear	114.3		78.0	74.0	79.5	L13	L15	2861	114.3	L11	D	Yes
Coggeshall	W	Transformer	15.0		15.0	6.9	7.7	L11	L11		15.0	L11	B	Yes
Colchester Grid 11	W	Transformer	39.0		39.0	18.0	19.1	L11	L11		39.0	L11	C	Yes
Colchester Grid 33	W	Switchgear	71.5		71.5	51.4	54.8	L11	L11		71.5	L11	C	Yes
Dovercourt	W	Switchgear	22.8		22.8	15.7	16.6	L11	L11		22.8	L11	C	Yes
East Bay	W	Circuit Rating	19.8		19.8	12.2	12.9	L11	L11		19.8	L11	C	Yes
Foxash	W	Transformer	12.0		12.0	7.6	8.4	L11	L11		12.0	L11	B	Yes
Frinton	W	Transformer	15.0		15.0	12.2	13.4	L12	L12		15.0	L12	C	Yes
Langham	S	Transformer	11.5		11.5	4.3	4.6	L11	L11		11.5	L11	B	Yes
Lawford Grid 33	W	Transformer	117.0		117.0	57.0	61.1	L11	L11		117.0	L11	D	Yes
Lexden	W	Transformer	24.0		24.0	13.4	14.4	L11	L11		24.0	L11	C	Yes
Maldon Causway	S	Transformer	20.0		20.0	14.1	15.2	L11	L11		20.0	L11	C	Yes
Maldon Grid 33	W	Transformer	78.0		78.0	46.9	50.4	L11	L11		78.0	L12	C	Yes
Maldon Wick	W	Transformer	23.0		23.0	17.4	18.6	L11	L12		23.0	L12	C	Yes
Marks Tey	W	Transformer	15.0		15.0	6.5	7.2	L11	L11		15.0	L11	B	Yes
Mersea Road	S	Transformer	17.3		17.3	9.8	10.3	L11	L11		17.3	L11	B	Yes
Old Road	W	Circuit Rating	23.0		18.5	19.1	20.2	L12	L12		18.5	L12	C	Yes
Parsons Heath total	W	Transformer	23.0		23.0	12.3	13.2	L11	L11		23.0	L11	C	Yes
Peldon	W	Circuit Rating	11.3		11.3	10.8	12.1	L13	L15	3440	15.0	L12	C	Yes
Severalls	S	Transformer	18.0		18.0	11.9	12.3	L11	L11		18.0	L11	C	Yes
Shrub End	S	Transformer	17.3		17.3	13.2	13.8	L12	L12		17.3	L12	C	Yes
South Woodham total	W	Circuit Rating	22.3		22.3	20.5	22.4	L12	L14		22.3	L12	C	Yes
Tillingham total	S	Transformer	18.0		18.0	8.1	8.7	L11	L11		18.0	L11	B	Yes
Tiptree	W	Circuit Rating	12.8		13.0	13.9	14.7	L15	L15	2075	22.9	L11	C	Yes
Valleybridge Rd	W	Transformer	23.0		23.0	17.8	18.9	L11	L12		23.0	L12	C	Yes
Wix	W	Transformer	15.0		15.0	6.5	7.1	L11	L11		15.0	L11	B	Yes
Witham South (New)	W	Transformer			0.0	0.0	0.0			3640	24.0	L11	A	Yes

Bramford – Rayleigh 132kV Network Group

APPENDIX F: OUTPUT MEASURES - HEALTH INDICES (HI)

132kV Switchgear (2013 Information)

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
ABBERTON GRID											2				
CLACTON GRID	3					3					3				
COLCHESTER GRID		1	1						1	1				1	1
LAWFORD GRID	1	2			9		3			9	13	1			
TOTAL	4	3	1		9	3	3		1	10	18	1		1	1

OUTPUT MEASURES - HEALTH INDICES (HI)

33kV Switchgear (2013 Information)

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
ABBERTON GRID	3	2		5	1		5			6	6	5			
BERECHURCH PRIMARY	2					2					2				
CLACTON GRID	1	1			8		2			8	8	2			
COGGESHALL PRIMARY	1						1					1			
COLCHESTER GRID	1	9				1	2	7			1	2	7		
LAWFORD GRID	3		4	3	2		3			9	9	3			
MALDON GRID	10						10					10			
PARSONS HEATH PRIMARY		1					1					1			
SHRUB END PRIMARY		2					2					2			
TILLINGHAM PRIMARY	1					1					1				
WIX PRIMARY	2					2					2				
TOTAL	24	15	4	8	11	6	26	7		23	29	26	7		

Bramford – Rayleigh 132kV Network Group

OUTPUT MEASURES - HEALTH INDICES (HI)

11/6.6kV Switchgear (2013 Information)

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
ALRESFORD PRIMARY		2	7				1	8				1	8		
BERECHURCH PRIMARY	10					3	7				3	7			
BRAISWICK PRIMARY			11					6	1	4	11				
BRANTHAM PRIMARY		3	6	1			1	2	6	1	10				
CHISBON HEATH PRIMARY		7					3	4				3	4		
CLACTON GRID	9					9					9				
COGGESHALL PRIMARY		7					7					7			
COLCHESTER GRID		12					12					12			
DOVERCOURT PRIMARY		3	9					12					12		
EAST BAY PRIMARY			9					4		5	9				
FOXASH PRIMARY	8						8					8			
FRINTON PRIMARY		2	9				1	9	1			1	9	1	
LANGHAM PRIMARY	4	3					6	1				6	1		
LEXDEN PRIMARY		11					11					11			
MALDON CAUSEWAY PRIMARY	3	10					13					13			
MALDON WICK PRIMARY	2	5	1				6	2				6	2		
MARKS TEY PRIMARY		2	7					8	1		9				
MERSEA RD PRIMARY		6	4				4	6				4	6		
OLD RD PRIMARY		15							15		15				
PARSONS HEATH PRIMARY		5	6				4	6	1			4	6	1	
PELDON PRIMARY			4	4				1	3	4	8				
PURLEIGH PRIMARY											10				
SEVERALLS LN PRIMARY		9					9					9			
SHRUB END PRIMARY		10					10					10			
SOUTH WOODHAM PRIMARY		4	6				1	5	4			1	5	4	
TILLINGHAM PRIMARY	10						10					10			
TIPTREE PRIMARY		8					1	7				1	7		
VALLEYBRIDGE RD PRIMARY		4	7				1	10				1	10		
WIX PRIMARY			7	1				4		4	8				
TOTAL	46	128	93	6		12	116	95	32	18	92	115	70	6	

Bramford – Rayleigh 132kV Network Group

OUTPUT MEASURES - HEALTH INDICES (HI)

Grid and Primary Transformers (2013 Information)

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
ABBERTON GRID	1	1					1	1				1	1		
ALRESFORD PRIMARY		2						2					2		
BERECHURCH PRIMARY	2						2					2			
BRAISWICK PRIMARY			1	1					1	1	2				
BRANTHAM PRIMARY		1	1					2					2		
CHISBON HEATH PRIMARY			2						2		2				
CLACTON GRID	2		2				2		2		2	2			
COGGESHALL PRIMARY		2					2					2			
COLCHESTER GRID	3	3				2	3	1			2	3	1		
DOVERCOURT PRIMARY			2						2			2			
EAST BAY PRIMARY		2					1	1							
FOXASH PRIMARY		1	1					2					2		
FRINTON PRIMARY		2						2					2		
LANGHAM PRIMARY		2					2					2			
LAWFORD GRID		3						3					3		
LEXDEN PRIMARY	1	1					2					2			
MALDON CAUSEWAY PRIMARY		2					1	1				1	1		
MALDON GRID	2					1	1				1	1			
MALDON WICK PRIMARY		2						2					2		
MARKS TEY PRIMARY	2						2					2			
MERSEA RD PRIMARY		2					2					2			
OLD RD PRIMARY			2					2					2		
PARSONS HEATH PRIMARY		2					2					2			
PELDON PRIMARY		2						2					2		
PURLEIGH PRIMARY											2				
SEVERALLS LN PRIMARY		2					2					2			
SHRUB END PRIMARY		2					2					2			
SOUTH WOODHAM PRIMARY	1	1					2					2			
TILLINGHAM PRIMARY		2					1		1			1		1	
TIPTREE PRIMARY		2						2					2		
VALLEYBRIDGE RD PRIMARY		1	1					2					2		
WIX PRIMARY	1	1					1	1				1	1		
TOTAL	15	41	12	1		3	31	26	8	1	11	32	25	1	

Regional Development Plan

Bramford – Rayleigh 132kV Network Group

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.

