



Regional Development Plan

Norwich GSP (EPN)

Planner	Peter Rye
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Date	13/03/2014

Norwich GSP (EPN)

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

Document History

Version	Date	Revision Class	Originator	Section Update	Details
1.3	13/03/2014	Major	Peter Rye	1.2, Appendix D	Expenditure aligned to the 19th February 2014 NAMP version J less indirect costs.
1.3	13/03/2014	Major	Peter Rye	1,2,3,4,5	RDP narrative updated to reflect latest position
1.3	13/03/2014	Major	Peter Rye	1.2, Appendix E, Appendix F	LI and HI output measures updated in line with current NAMP plan and RIG tables
1.3	13/03/2014	Minor	Peter Rye	2.2	Network changes in progress updated to reflect interventions to date
1.3	13/03/2014	Major	Peter Rye	4	Recommended strategy reflects latest position
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1 Executive Summary

This Regional Development Plan (RDP) reviews sections of UK Power Networks (UKPN) EPN HV and EHV network supplied from Norwich Main Grid Supply Point (GSP), comprising the northern and eastern part of the county of Norfolk, including the city of Norwich. This area comprises Sall, Earham, Thorpe, Trowse, Gorleston, Lowestoft and Gt Yarmouth Grid substations and the associated 132kV and 33kV network. Norwich Main 132 also supplies a wider geographic area via the 132kV interconnection to Bramford GSP that is outside the scope of this document, but is captured in RDP 12.

The network in this area also has significant embedded generation in the form of Great Yarmouth Power Station (400MW CCGT) and Sherringham Shoal (315MW Offshore Wind) both of which connect at 132kV. The network also provides electrical supplies to the Bacton Gas Terminal which is one of the main gas import terminals for the UK.

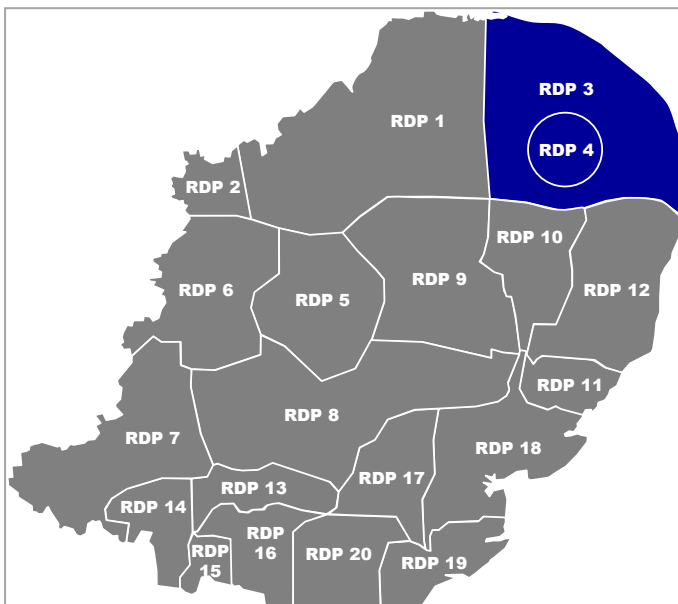


Figure 1 – Area covered by the RDP

This Regional Development Plan encompasses both the RDP03 and RDP04 areas marked on the adjacent map.

1.1 Summary of issues addressed

The main issues addressed by this Regional Development Plan are as follows:

- The main load development areas – Norwich Research Park & Northern / Eastern ‘fringe’
- Generation connections
- Plant condition and Asset Replacement issues
- Security of supply for the rural area
- Grid Substation capacity in the Thorpe / Trowse and Great Yarmouth areas
- Fault level issues
- Load balance issues arising from network configuration and generation effects

Investment Profile

The Figure below provides the projected expenditure profile for reinforcement and asset replacement projects (LRE and NLRE) in this RDP for both DPCR5 and ED1. This information is taken from the NAMP version 19th February 2014.

Type	DPCR5 2013-15	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	2020 /2021	2021 /2022	2022 /2023	RIIO-ED1 Total
LRE	£3.6m	£2.8m	£3.7m	£0.1m	£0.6m	£2.6m	£2.7m	£0.0m	£0.0m	£12.5m
NLRE	£3.9m	£0.0m	£0.2m	£1.2m	£0.5m	£2.2m	£0.6m	£0.9m	£2.0m	£7.6m
TOTAL	£7.5m	£2.8m	£3.9m	£1.2m	£1.1m	£4.7m	£3.4m	£0.9m	£2.0m	£20.1m

Table 1. LRE and NLRE expenditure profile

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Output Measures

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

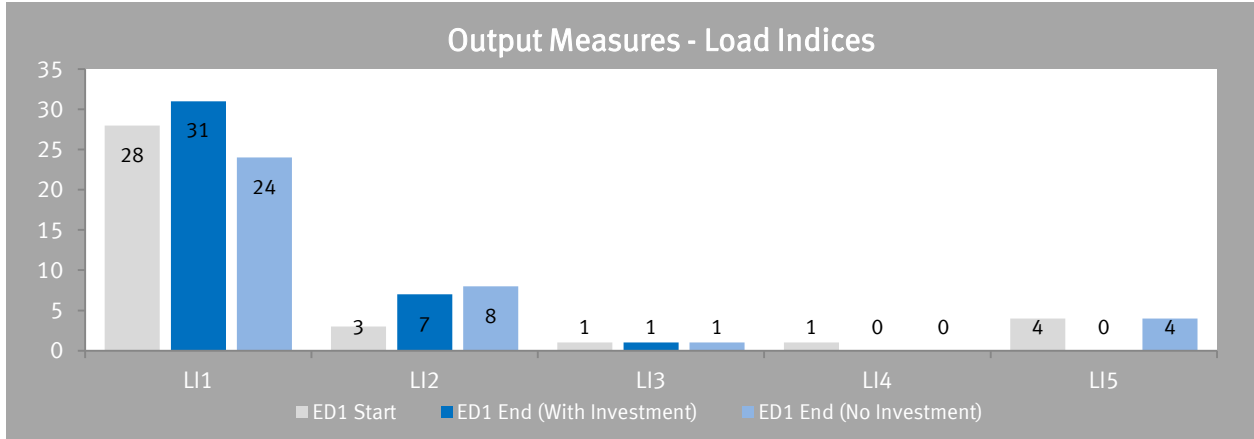
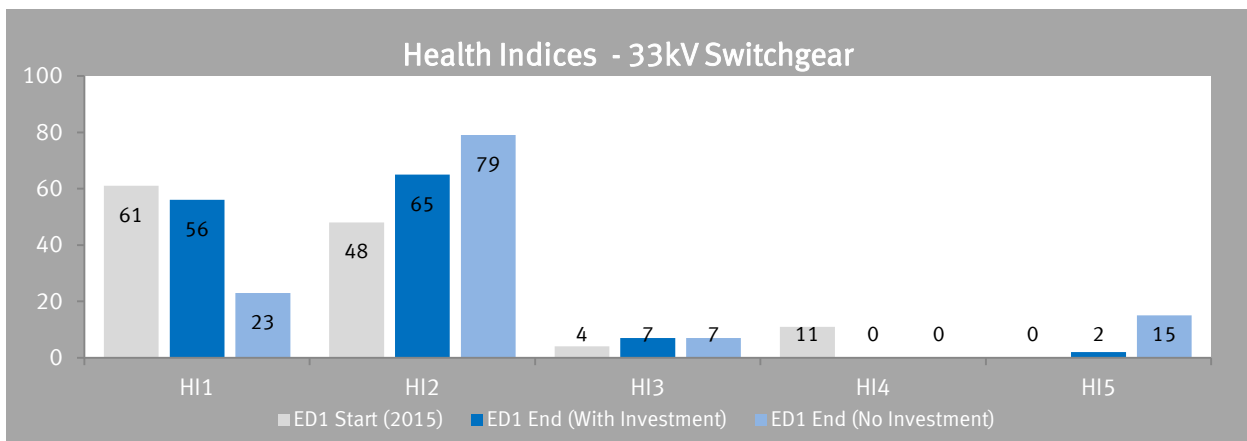
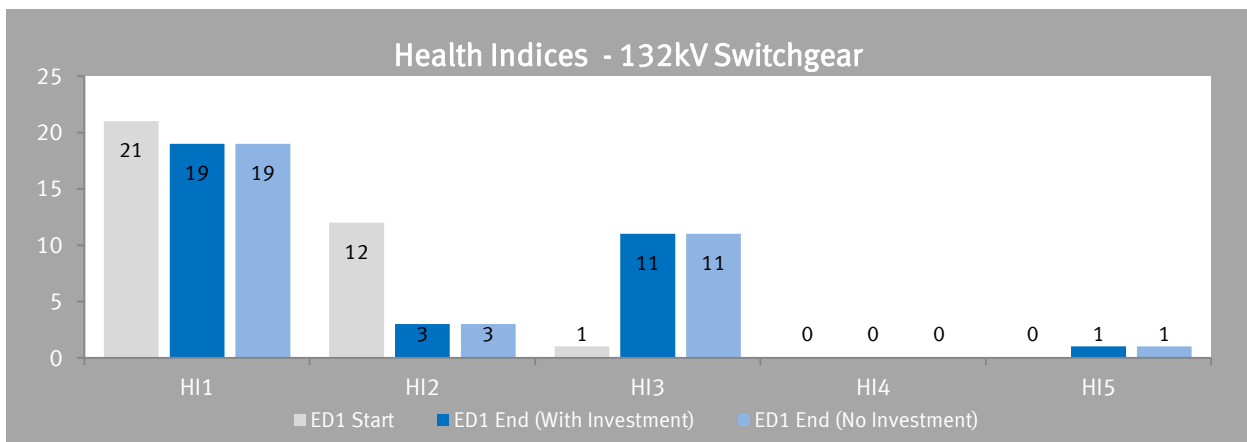


Figure 2. 2022/23 Load Indices with and without interventions

The 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.



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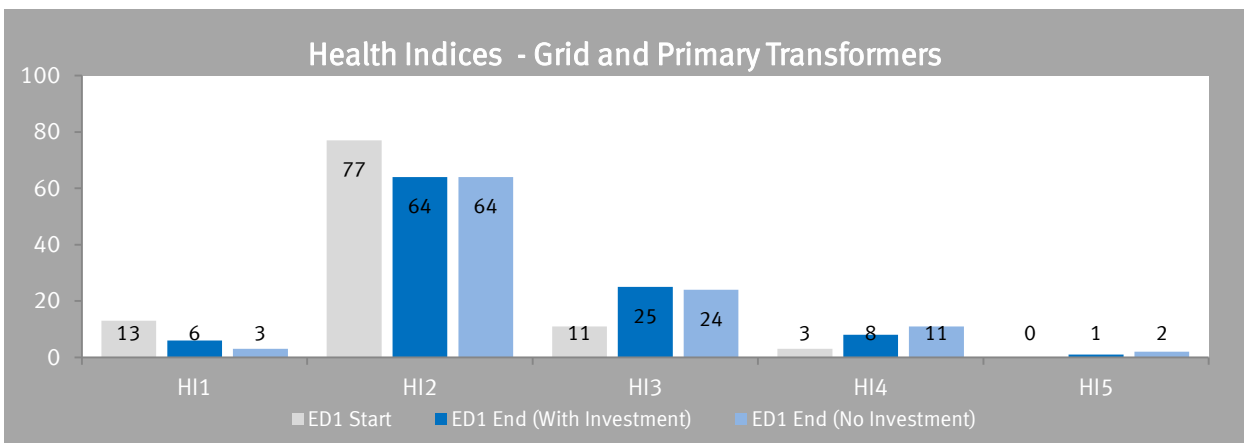
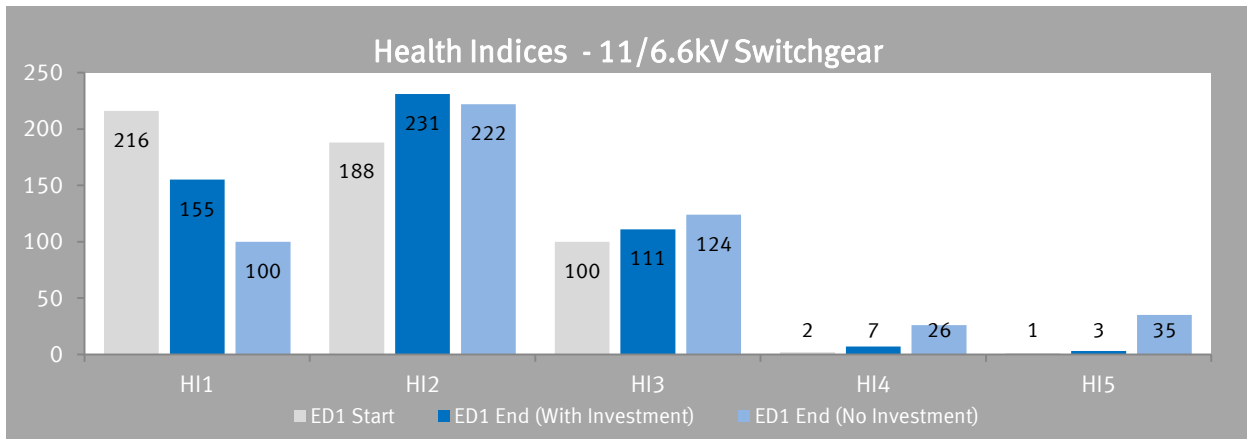


Figure 3. Health Indices by asset category

RDP Dependencies and Interactions

The 132kV network between Trowse 132kV and Lowestoft also interconnects with the 132kV network from the Bramford GSP near Ipswich, and there will therefore be a degree of interaction between this RDP and RDP12. These effects are primarily documented with the RDP12 document.

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2 Network configuration

2.1 Existing Network

This Regional Development Plan covers the network supplied from the Norwich Main Grid Supply Point (GSP), comprising the northern and eastern part of the county of Norfolk, including the city of Norwich.

Norwich Main is located just outside the city of Norwich and is presently equipped with five SGTs, which are connected to two 132kV switchboards located at Trowse (approximately 4 km) and Earlham (approximately 7 km). Two SGTs connect directly to Trowse via 132kV overhead line circuits, one SGT connects directly to Earlham via 132kV underground cable and the remaining two SGTs connect to both Trowse and Earlham via 132kV overhead line circuits.

From the Trowse switchboard there are a further four dual circuit 132kV overhead lines, two of these feed eastwards to Great Yarmouth and Lowestoft and the other two feed Thorpe Grid Substation in Norwich, which supplies part of the city and the North Norfolk area via 33kV and 11kV networks. Trowse Grid also feeds parts of the city and surrounding area at 33kV.

From the Earlham switchboard there is a dual circuit 132kV overhead line which feeds a Grid Substation at Sall and the connection for the 'Sherringham Shoal' offshore windfarm. Earlham Grid also feeds parts of the city and surrounding area at 33kV and 11kV.

A Geographic diagram of the existing network is in Appendix A and SLD in Appendix B

Embedded Generation

The existing significant embedded generators in this network are :

- Gt Yarmouth CCGT Power Station (132kV 400MW)
- Scroby Sands offshore windfarm (33kV, 60MW)
- Sherringham Shoal offshore windfarm (132kV, 315MW)

There are also 27 other existing embedded generators, primarily connected at 11kV, which have a total combined capacity of 47MW and 19 further sites with 'accepted' connection offers with a combined capacity of 170MW.

The ability to offer further connections is now very limited, largely because the 'Sherringham Shoal' offshore windfarm utilises the majority of the capacity of the 132kV lines between Sall and Earlham.

2.2 Projects in progress

The schemes below are either in progress or due to be completed prior to 2015. The expenditure profile for these schemes can be found in Appendix D.

Scottow Primary - replacement of 33/11kV transformers

The 33/11kV transformers at Scottow Primary are approaching the end of their anticipated service life and have been assessed as having an unacceptable risk of failure. It is therefore proposed to replace the transformers with new units. Completion of this project will see two new transformers installed.

Cringleford 33/11kV Primary S/S - replace 33kV Bus Section OCB (1200A)

The 33kV bus section CB is Crompton and Parkinson OE5 manufactured in 1964. This type of switchgear is no longer supported by the OEM so spare parts are not available should they be required at maintenance or following a failure of the breaker and it is therefore proposed to replace the CB.

Stalham 33/11kV Primary Substation - Replace 33kV Bus Section CB

The bus section CB is a SWS EO1 OCB manufactured in 1965. This type of switchgear is no longer supported by the OEM so spare parts are not available should they be required at maintenance or following a failure of the breaker and it is therefore proposed to replace the CB.

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

The condition assessment of the 1959 SWS C4X indoor oil insulated switchgear installed at Hapton 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements therefore this project recommends its replacement. Completion of the project will see 7 circuit breakers replaced with 7 new circuit breakers.

This project has been brought forward following a fault on the two 11kV incoming circuit breakers.

Earlham Grid/Wymondham 33kV Circuit - reinforce (575A(W))

The predicted load at Wymondham Primary Substation will exceed the existing rating of the associated circuit. It is not possible to lower the load without compromising operational and planning requirements. It is therefore proposed to replace the under-rated sections of this circuit. Completion of this project will see 3.2km overhead line rebuilt and 800m underground circuit replaced.

Knapton Primary – Install 3rd Transformer

In order to cater for additional load requirements at the Bacton Gas Terminal it is necessary to reinforce Knapton Primary by installing a 3rd 33/11kV transformer and new 11kV switchboard.

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3 Summary of Issues

3.1 Development Areas

Load

The main areas for projected growth are in and around the city of Norwich, which are primarily being led by the 'Greater Norwich Development Partnership' (GNDP), which is a partnership between Norfolk County Council, Norwich City Council, South Norfolk Council and Broadland District Council.

The two main areas earmarked for growth are the 'Norwich Research Park', which is adjacent to the Norfolk & Norwich Hospital in the northwest of the city, and the northern / eastern fringe which includes the area around Norwich Airport. The main 'enabler' for this latter area is the 'Northern Distributor Road' for which the planning process was initiated in February 2014.

The original GNDP 'core strategy' contained some ambitious targets for growth in both housing and employment up to 2026, although little of this has so far come to fruition due to the economic downturn.

Norwich Research Park

This area is fed from Earlham Local 11kV, which is presently anticipated to have sufficient spare capacity to provide for the requirements of the area during the ED1 period, although reinforcement may have to be brought forward if development takes place more quickly than anticipated. When the existing capacity is exhausted it is planned to install 2 x 132/11kV 60MVA transformers at Earlham Grid to provide additional capacity, which will also release capacity on the 33kV network. A double-bus 11kV switchboard has already been installed to facilitate this development, and spare circuit breakers have also been included on the recently installed 132kV switchboard to feed these proposed transformers.

Northern / Eastern Fringe

This area is presently fed via four existing Primary Substations (Sprowston, George Hill, Horsford & Boundary Park), which are all approaching capacity.

When this capacity is exhausted, it is intended to establish a new Primary Substation on a reserved substation site near the Airport called Hurricane Way, which was sized to ultimately accommodate a new Grid Substation as well.

The 33kV network feeding this area was reinforced in the late 1990's from Thorpe Grid with the intention that the proposed primary, which was expected to be needed shortly thereafter, would also be fed by this network, as Thorpe Grid had capacity to spare at that time. This new Primary has not yet been required, but over the intervening years the load in the central area of Norwich has increased, which has brought the 33kV loading at both Thorpe Grid and Trowse Grid close to capacity. The available 33kV capacity at Thorpe Grid will therefore have to be enhanced before the new Primary could be established.

Alternatively, if 132/11kV transformation has been installed at Earlham this may release sufficient 33kV capacity that the proposed new Primary could be fed from Earlham. This would require a new dual circuit 33kV cable route of around 8km to be installed, but would also increase the 33kV interconnection between Thorpe and Earlham.

Generation

There have been a significant number of applications for the connection of new generation in the area, and to date there are 27 existing embedded generators, primarily connected at 11kV, which have a total combined capacity of 47MW and 19 further sites with 'accepted' connection offers with a combined capacity of 170MW. This is in addition to Great Yarmouth Power Station (400MW, 132kV), Sherringham Shoal Windfarm (315MW, 132kV) and Scroby Sands Windfarm (60MW, 33kV)

Distributed Generation is going to be one of the major challenges in the area into the future, as the rural area of the county is proving very popular with developers of solar generation stations, but the network now has very limited capacity to accommodate further generation.

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Network modelling of the increasing generation has also shown this to introduce issues with load balance on the network which is discussed in more detail in section 3.4.

The other generation related issue is that Sall Grid is the 132kV connection point for the 315MW 'Sherringham Shoal' offshore windfarm, which at full output utilises the full capacity of both 132kV circuits back to Earham Grid. As a result we have already reached the situation where no more generation can be connected to the network supplied from Sall Grid without risking overload of the 132kV line.

3.2 Asset Health

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).

Trowse/Thorpe 132kV Tower Line (PMB) - 132kV Tower Line Refurbishment

The condition assessment of the Trowse/Thorpe 132kV Tower Line (PMB) 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 3 km of 132kV Tower Line refurbished.

Norwich Main/Earham 132kV Tower Line (PO) - 132kV Tower Line Refurbishment

The condition assessment of the Norwich Main/Earham 132kV Tower Line (PO) 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 19 km of 132kV Tower Line refurbished.

Norwich/Trowse 132kV Tower Line (PHC) - 132kV Insulator & Fitting Replacement

The condition assessment of the Norwich/Trowse 132kV Tower Line (PHC) 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 of the 132kV insulators and fittings (earth).

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

The condition assessment of the 1973 SWS EO1 outdoor oil insulated switchgear installed at Stody 132/33kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements therefore this project recommends its replacement. Completion of the project will see 1 circuit breaker replaced with 1 new circuit breaker.

LS & E 33/11kV Primary Substation - Replace 33kV Switchgear

The condition assessment of the 1968 SWS EO1 outdoor oil insulated switchgear installed at LS & E 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements therefore this project recommends its replacement. Completion of the project will see 2 circuit breakers replaced with 2 new circuit breakers.

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

The condition assessment of the 1968 SWS ET indoor oil insulated switchgear installed at Lowestoft 132/33kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements therefore this project recommends its replacement. Completion of the project will see 8 circuit breakers replaced with 8 new circuit breakers.

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

The condition assessment of the 1965 SWS ET Kiosk oil insulated switchgear installed at Long Rd 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements therefore this project recommends its replacement. Completion of the project will see 2 circuit breakers replaced with 2 new circuit breakers.

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

The condition assessment of the 1988 GEC VMX indoor resin insulated switchgear installed at Long Rd 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements therefore this project recommends its replacement. Completion of the project will see 11 circuit breakers replaced with 11 new circuit breakers.

Magdalen Way 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1983/84 GEC VMX indoor resin insulated switchgear installed at Magdalen Way 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements therefore this project recommends its replacement. Completion of the project will see 9 circuit breakers replaced with 9 new circuit breakers.

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

The condition assessment of the 1975 GEC BVAC indoor VAC switchgear installed at Scottow 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements therefore this project recommends its replacement. Completion of the project will see 8 circuit breakers replaced with 8 new circuit breakers.

West Beckham 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1975 GEC BVAC indoor VAC switchgear installed at West Beckham 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements therefore this project recommends its replacement. Completion of the project will see 10 circuit breakers replaced with 10 new circuit breakers.

Whapload Road 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1968 EEC UAE64 indoor oil insulated switchgear installed at Whapload 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements therefore this project recommends its replacement. Completion of the project will see 9 circuit breakers replaced with 9 new circuit breakers.

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

The condition assessment of the 1967 REY LM23T indoor oil insulated switchgear installed at Aylsham 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements therefore this project recommends its retrofit. Completion of the project will see 4 circuit breakers retrofitted.

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

The condition assessment of the 1966 REY LM23T indoor oil insulated switchgear installed at Hemblington 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements therefore this project recommends its retrofit. Completion of the project will see 7 circuit breakers retrofitted.

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Hardingham 33/11kV Primary Substation - Replace Primary Transformers (T1)

The condition assessment of the 1960 BLO Primary Transformer installed at Hardingham 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements therefore this project recommends its replacement. Completion of the project will see 1 Primary Transformer replaced with 1 new Primary Transformer.

Thorpe 132/33kV Grid Substation - Refurbish Grid Transformers (GT2B)

The condition assessment of the 1991 BLO Grid Transformer installed at Thorpe 132/33kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements therefore this project recommends its refurbish. Completion of the project will see 1 Grid Transformer refurbished.

3.3 Security of supply analysis**Rural Network**

The rural area is predominantly fed by an interconnected 'mesh' of 33kV circuits that are of largely overhead construction. No loading issues under n-1 outage conditions have been identified at present, although this needs to be monitored by means of network analysis as loads increase over time.

Analysis of other networks with similar configurations has shown that they can be vulnerable to coincident dual circuit 132kV outages, as the distances involved can mean that it is not possible to continue to supply areas from the remaining sources. This is less of an issue in the Norwich area than in some other areas, as the majority of the Grid Substations are supplied via resilient 132kV networks. However, Sall Grid is vulnerable in this way as it is fed by a long dual-circuit overhead line from Earlham 132kV.

Whilst such events do not occur frequently, they have occurred within the UK Power Networks area within recent years and therefore need to be considered. Analysis of the effects of a coincident dual circuit outage to Sall Grid at 2012/13 winter loadings has shown that this would result in unacceptably low volts at Stody, Gt Witchingham and East Dereham Primaries and the overloading of the following 33kV feeders :

- Earlham – Wymondham
- Wymondham – East Dereham
- Horsford – Gt Witchingham
- Thorpe – Sprowston

Grid Substation Issues - Norwich

The winter peak load that is seen at both Thorpe Grid and Trowse Grid is above the n-1 capacity of the sites, but since many of the Primary sites in the city are split across the two grid sites, and the rural network runs as a solid 'mesh', the load balance changes immediately post-fault which tends to reduce the residual post-fault load.

Analysis of actual outage scenarios around the time of peak load suggests that the post-fault residual loadings will be 86% of pre-fault load at Trowse and 76% at Thorpe. Applying these figures to the recorded peak demands puts the post-fault loadings at 88% of firm capacity at Trowse and 76% at Thorpe.

It is presently anticipated that by 2022 Trowse would be loaded to 119% and Thorpe to 98% following an n-1 outage at winter peak load. These load swings can also result in the load on other site increasing above the normal 'peak' load, which could then leave other sites loaded above their n-1 capacity.

Within the ED1 period, both of these sites are therefore likely to require either additional capacity to be installed or load to be moved to an alternative source.

Grid Substation Issues – Great Yarmouth

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The area around Great Yarmouth is supplied by two Grid Substations at Great Yarmouth and Gorleston. However, both of these sites only have a single transformer, and run permanently interconnected at 33kV so they need to be considered as a single 'distributed' site. As the current combined peak load across the two sites is 95MVA (winter) and 82MVA (summer), additional capacity will be needed in the future although this is currently not anticipated to be required during the ED1 period.

3.4 Operational and technical restrictions

Fault level

Thorpe Grid Substations is running close to the fault level rating of the 33kV switchgear, and as a result may require the switchgear to be replaced in the near future.

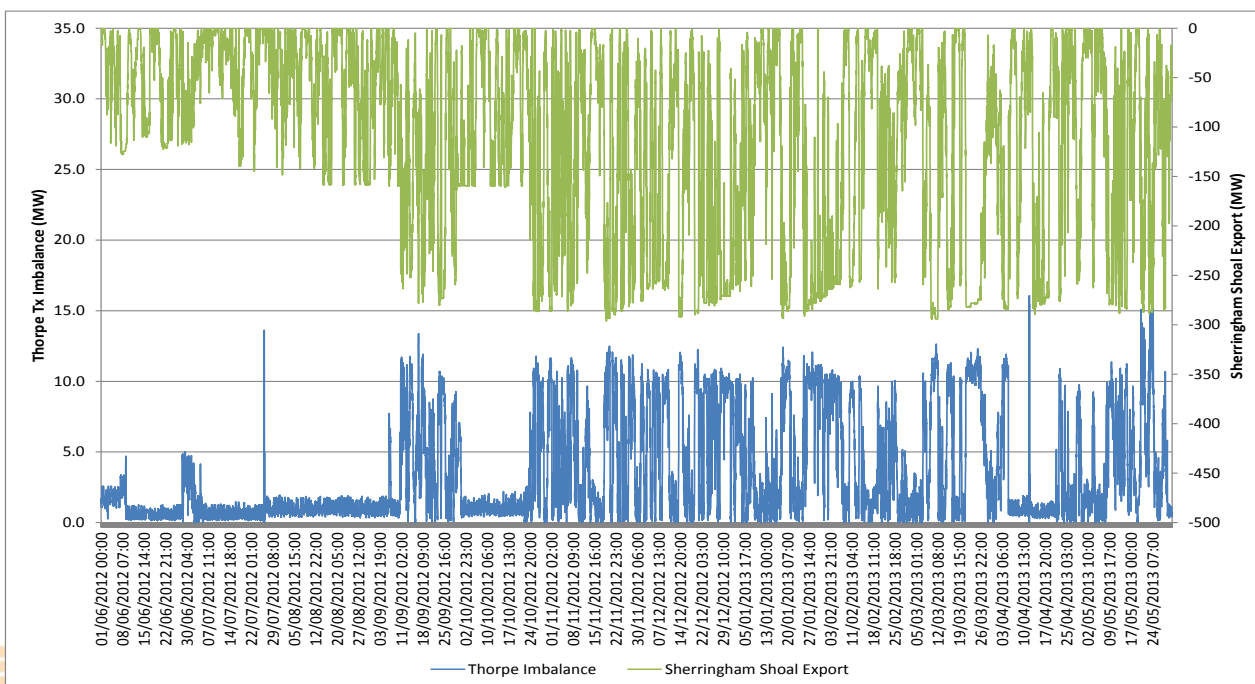
In order to manage the 132kV fault level at Trowse within the switchgear rating, the site is normally run 'split' with two of the SGTs feeding each side, and is only run solid when one of the SGTs is unavailable. However, running solid with 3 SGTs is very close to the fault level rating and this will need to be monitored with increasing levels of generation on the network. The 'normal' split arrangement has also recently started to cause some issues with load balance, which is further explained below.

Load Balance

The 132kV switchgear at Trowse Grid is a double-busbar arrangement, which presently runs with a 'left/right' split to manage the fault level issues referred to above. However, as a result of this arrangement, the grid transformers at Thorpe Grid see slightly different 'source impedances' due to the different upstream network configurations. This arrangement has been in place for many years without any issues, but as more generation is being connected to the network, issues are coming to the fore.

When the Sherringham Shoal offshore windfarm is generating, we are now seeing that the transformers at Thorpe Grid cease to share load evenly, as the generation appears to be amplifying the difference in source impedance. This is illustrated by the chart below which shows the difference in MW between the two grid transformers (blue line, left hand scale) and the total export from Sherringham Shoal (green line, right hand scale) for the period 01/06/2012 to 31/05/2013.

In itself this is not a major issue, but network modelling has shown that as more distributed generation is connected to the 33kV network, the 'net' load at Thorpe Grid will reduce, and predicts that we are on the verge of a situation where one transformer starts to have reverse powerflow whilst the other still has significant forward flow, which cannot be allowed. Until this is resolved, very little additional generation will be able to be connected to the network in the Norwich area.



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Harmonics

There is a proposal to transfer the offshore cabling to the Sherringham Shoal windfarm to an 'Offshore Transmission Operator' (OFTO). Investigations by the prospective operator have identified that there appears to be an issue with harmonics, and they are therefore reluctant to take over these assets until this has been resolved. The original modelling did not identify a problem, but we are now undertaking a more detailed study of the network to assess the scale of the issue.

Wayleave Terminations

The two dual-circuit 132kV lines between Trowse 132kV and Thorpe Grid traverse an area of land known as 'Deal Ground'. This area has been identified by the council as a development area, and an outline planning application for the site has recently been approved.

The lines were held on terminable wayleaves with the original landowner, which were terminated following a change of ownership and as such are now held on a 'bare licence' basis. The developer involved has requested the lines to be undergrounded across this area, and UK Power Networks are presently in negotiation with them to try and find a mutually acceptable solution.

The first 11 spans of the Earham – Sall 132kV line are also planned to be undergrounded due to conflict between the line and ongoing development. The present location of this section of line was agreed with Norwich City Council in the 1980's but the council never completed the agreed easement. Parcels of land have since been sold off for development, leaving UK Power Networks with no agreements for the line in these areas, which has led to the requirement to underground the line.

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

We are not presently aware of any reinforcement works planned by National Grid in this area.

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4 Recommended strategy

4.1 Description

Security of Supply

It was identified in section 3 that a coincident dual circuit outage to Sall Grid would result in unacceptably low volts at several primary substations and the overloading of a number of 33kV lines.

This situation will be improved by planned reinforcement of the Earlham – Wymondham 33kV circuit, although the situation will need to be monitored as further reinforcement works may also be required in future.

Primary Capacity

Three Primary substations have been identified as requiring reinforcement over the ED1 period, which will be addressed by the following specific schemes:

Hapton 33/11kV Primary Substation - ITC (2x11/18/24 MVA)

The predicted load at Hapton Primary Substation will exceed the existing firm capacity, including the transfer capacity to Mulbarton. It is therefore proposed to replace the existing transformers with larger units. The existing switchgear is not fully rated for this increased load but it is being replaced as part of an asset replacement project. 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.

Caister 33/11kV Primary Substation - Demand Side Response (DSR)

Demand Side Response (DSR) involves electricity consumers reducing or shifting demand in periods of peak demand, following faults or outages on the network, thus resulting in a permanent flattening or reduction of the load profile to within the substation firm capacity. This is dependent on a number of factors such as type of demand, availability of large interruptible customers and commercial arrangements in place.

Cromer 33/11kV Primary Substation - replace 11kV switchboard (2000A)

The predicted load at level at Cromer Primary Substation will exceed the rating of the existing switchgear. It is not possible to lower the load level without compromising operational and planning requirements. It is therefore proposed to replace the existing switchgear. Completion of this project will see 8 circuit breakers replaced with 8 new circuit breakers.

Thorpe 132/33kV Grid Substation - replace 33kV switchgear (Fault Level)

The predicted fault level at Thorpe Grid Substation will exceed the rating of the existing switchgear. It is therefore proposed to replace the existing switchgear with a new installation comprising 18 circuit breakers. Completion of this project will see 14 circuit breakers replaced with 18 new circuit breakers and 2 km new underground circuits installed.

Grid Capacity

Norwich

A number of options have been considered to address the issue of insufficient 33kV capacity at Trowse and Thorpe, which was outlined in section 3. The preferred option at this time is to establish a 3rd 132/33kV 90MVA transformer at Trowse Grid, which will also require a new 33kV indoor switchboard in order to release space in the compound for the new Transformer.

This option provides additional capacity at Trowse Grid, and also allows the 'Wroxham 2' feeder to be moved across from Thorpe which will release some capacity at Thorpe Grid, without requiring any significant additional cabling to be installed. The 33kV fault level at Trowse is also approaching the limits of the existing switchgear, which will also be addressed by this solution.

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

At some point in the future it is anticipated that a new Grid Substation will be required to either the North or East of the city. Three 'reserved' sites are available for this development (Hurricane Way, Bungalow Lane and Norwich East) and the most appropriate location will therefore be determined by the location of actual and anticipated future growth.

Great Yarmouth

When the combined loading of Great Yarmouth and Gorleston Grid substations reaches capacity, it is proposed to install a second Grid Transformer at Great Yarmouth. However, at this time it may also be necessary to undertake some rationalisation of the current installation, as at present the Grid Transformer and 33kV switchgear are on separate sites about 200m apart.

132kV Reinforcement

No major works are envisaged on the 132kV network in the medium term, but the ultimate vision is for 132kV network to be installed around the northern and eastern sides of the city, Linking Trowse to Earlham via the reserved substation sites at Norwich East and Hurricane Way so as to complete a 132kV 'ring' around the city.

It may therefore be prudent to investigate the possibility of incorporating ducts for such future cables into the design of the 'Northern Distributor Road', which is proposed to run from the 'Postwick' junction on the A47 to the east of the city around to the Airport area to the north.

Innovation: Demand Side Response

Studies have been undertaken to identify suitable sites for participation in smart demand response to reduce peak load with a view to delay proposed reinforcement work. These studies identified a Demand Side Response intervention as an option to defer the reinforcement of a primary substation in this RDP.

4.2 Financial Appraisal and Benefits

The financial expenditure for all proposed projects is shown in Appendix D.

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 Grid Reinforcement Rejected Options

The options that were considered for providing additional Grid Substation capacity in Norwich are outlined below:

1. Rearrange the network to transfer load away from Trowse. This is not easy to achieve due to the existing network configuration. Network modelling has also shown that attempting to move load by reconfiguring the network often does not have the desired effect due to the interconnections between the Grid Substations.
2. Convert St Stephens Primary to Direct Transformation. The St Stephens site has been configured for direct transformation with a double-bus 11kV switchboard, but to achieve this would require the installation of 132kV cables to the site, which would be both costly and cause significant traffic disruption. The estimated cost of this option is £9.5M, and it is estimated that it would reduce the post-fault n-1 loading at Trowse to 81% of firm capacity and Thorpe to 80%.
3. Install a 3rd 132/33kV Grid Transformer at Trowse. There is little space available at Trowse other than the parking area for the office and reporting centre, so this would require the installation of a new indoor 33kV switchboard to enable the raft to be removed to make space for the transformer. However, this has other benefits as with 3 transformers the fault level would be close to the rating of the existing switchgear. The estimated cost of this option is £3.5M and would reduce the post-fault n-1 loading at Trowse to 64% of firm capacity (on each of the two remaining transformers) and Thorpe to 69% (assuming that the Wroxham 2 circuit is transferred to Trowse)
4. Establish a new Grid Substation on a reserved site to the northeast of Norwich (Norwich East). This will not have a great effect on Trowse, as there is only one feeder that will transfer to the new substation, but it would have a significant effect on Thorpe. The estimated cost of this option is £20M (due to a 9km new 132kV cable route), and it would reduce the post-fault n-1 loading at Trowse to 82% of firm capacity and Thorpe to 59%.

Option 2 has historically been the assumed approach, but as St Stephens is not presently forecast to need reinforcing within the ED1 period, and is only about 2km away from Thorpe Local 132/11kV which has spare capacity, this does not look like the best value solution at this time.

Option 3 presently looks to be the best value solution, as this has the lowest cost and also has creates headroom at both Trowse and Thorpe. This requires some further investigation into the feasibility of undertaking these works at Trowse, but is the recommended option at this time.

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

6 References

References	Description
Reference 1	Planning Load Estimates EPN Area 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	Greater Norwich Development Partnership (GNDP) www.gndp.org.uk/

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

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
Peter Rye	Infrastructure Planner		19/03/14
Nuno Da Fonseca	Infrastructure Planning Manager (EPN)		

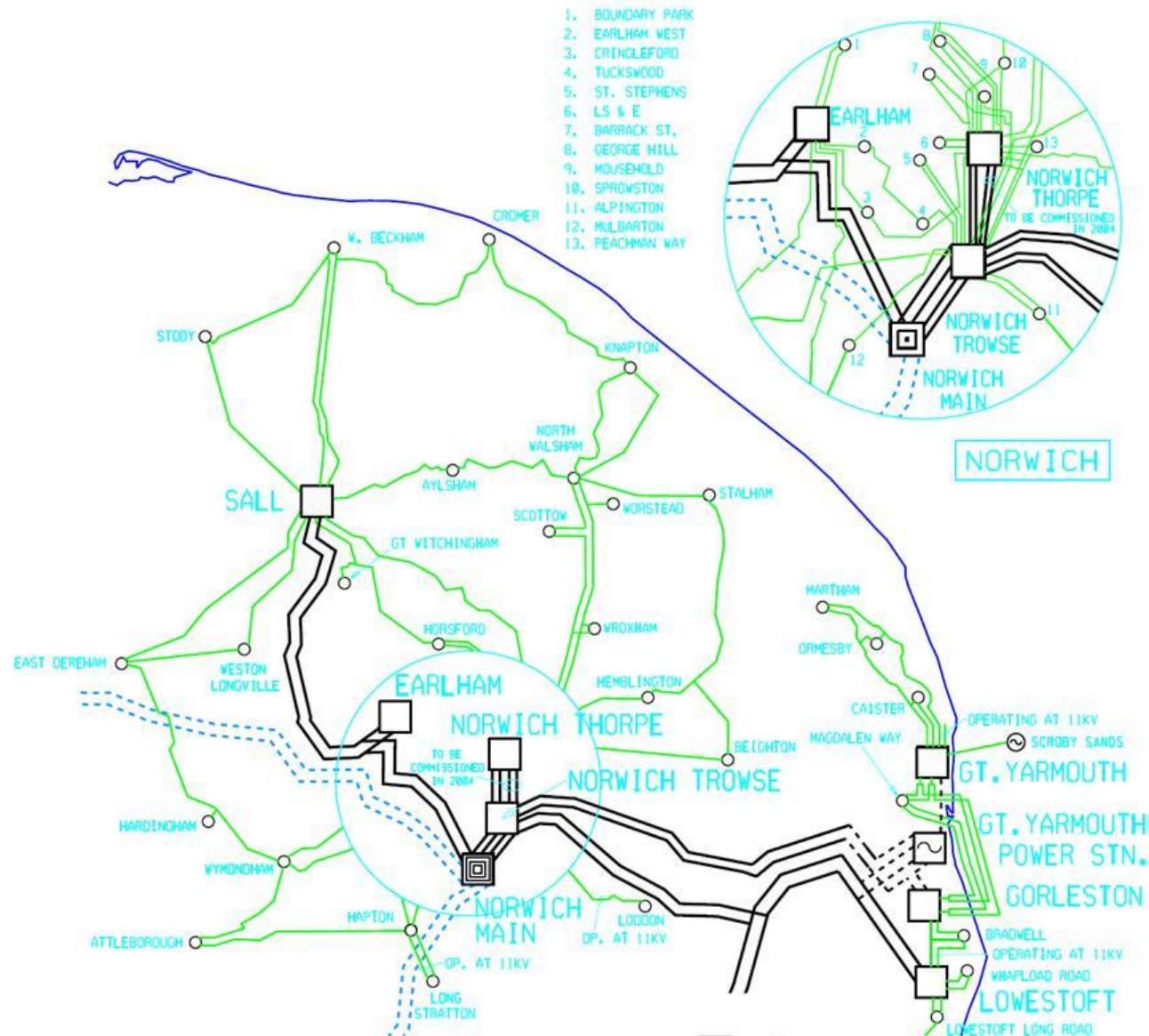
Approval by:

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

Regional Development Plan

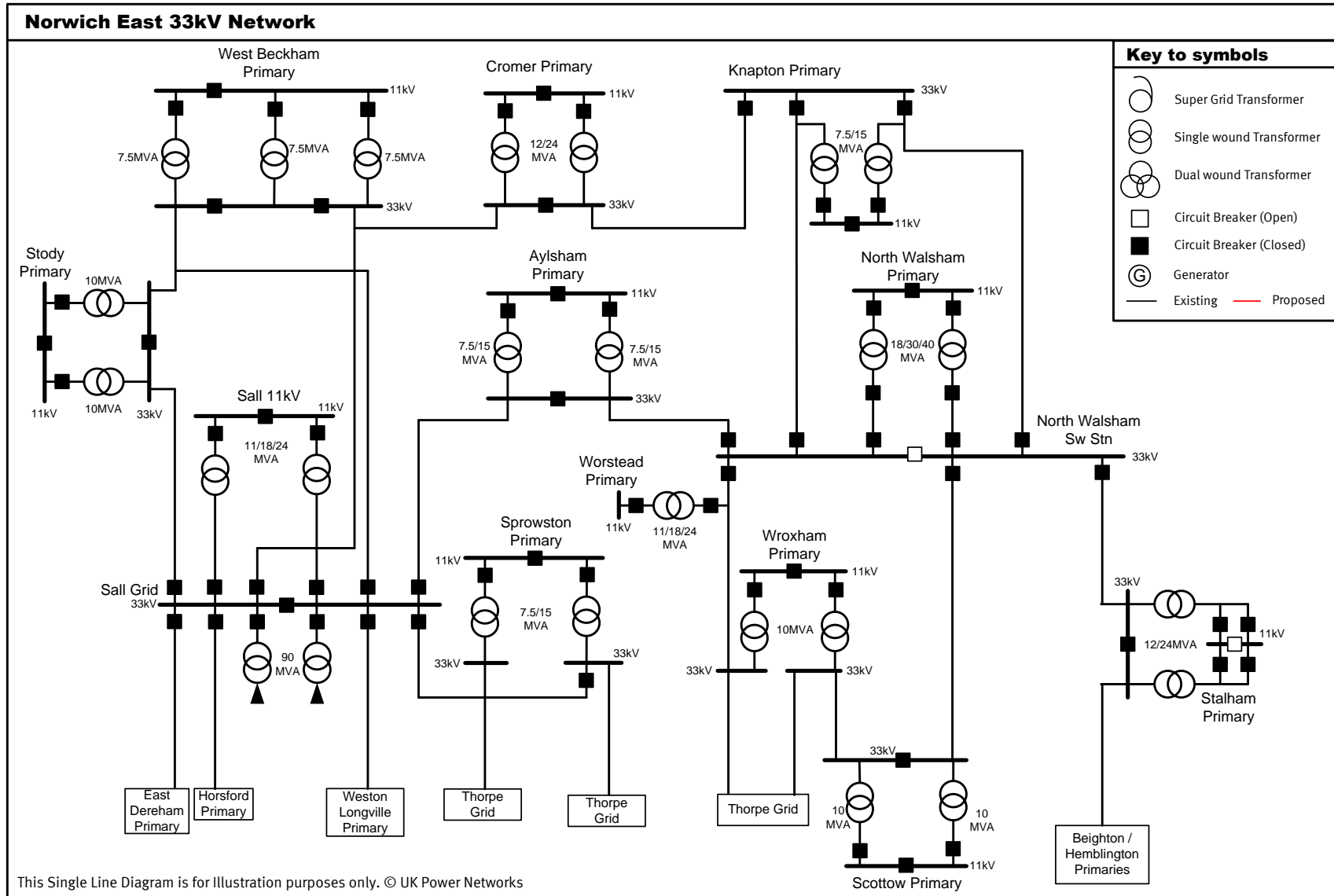
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APPENDIX A: GEOGRAPHICAL DIAGRAM

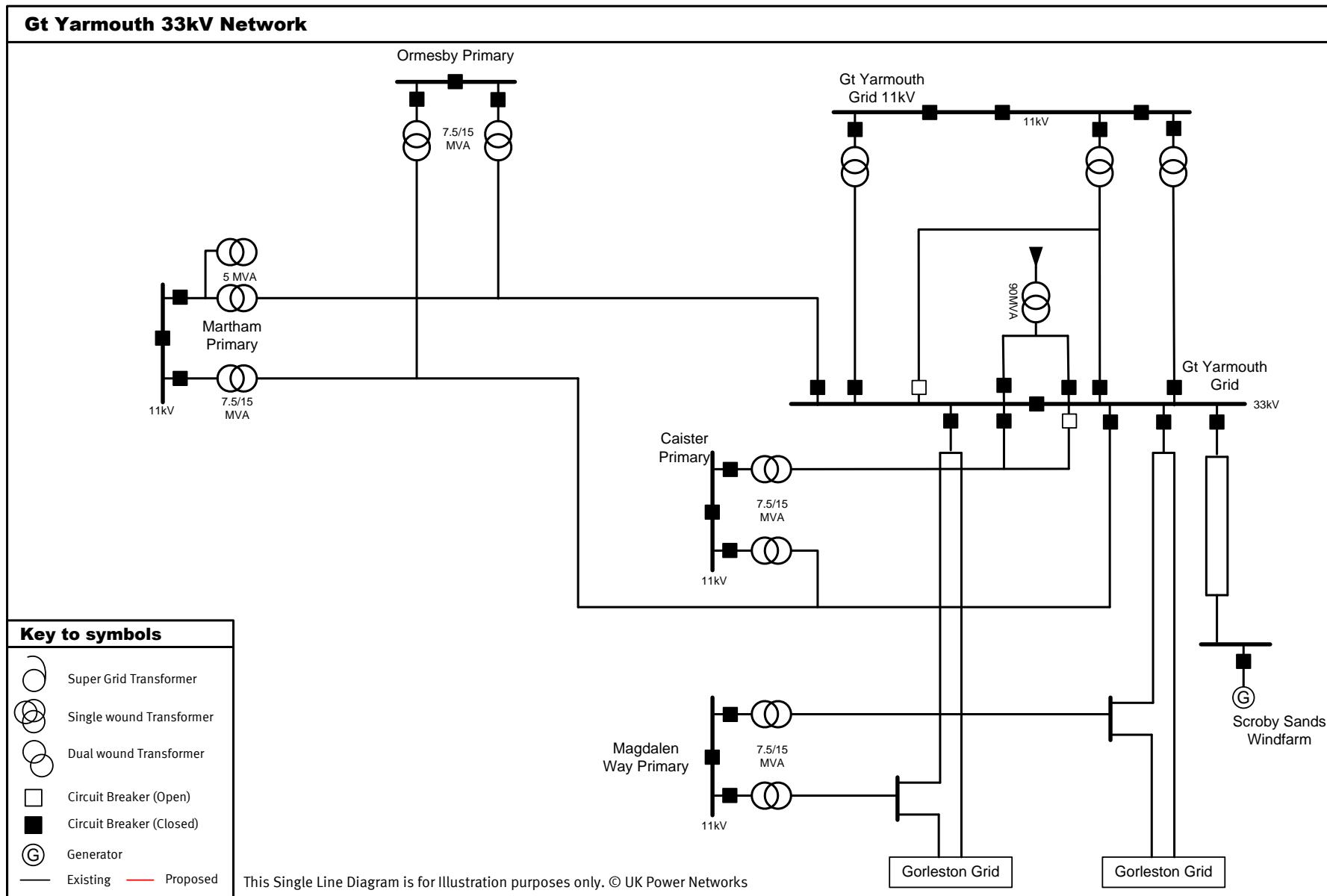


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APPENDIX B: SINGLE LINE DIAGRAM – EXISTING NETWORK

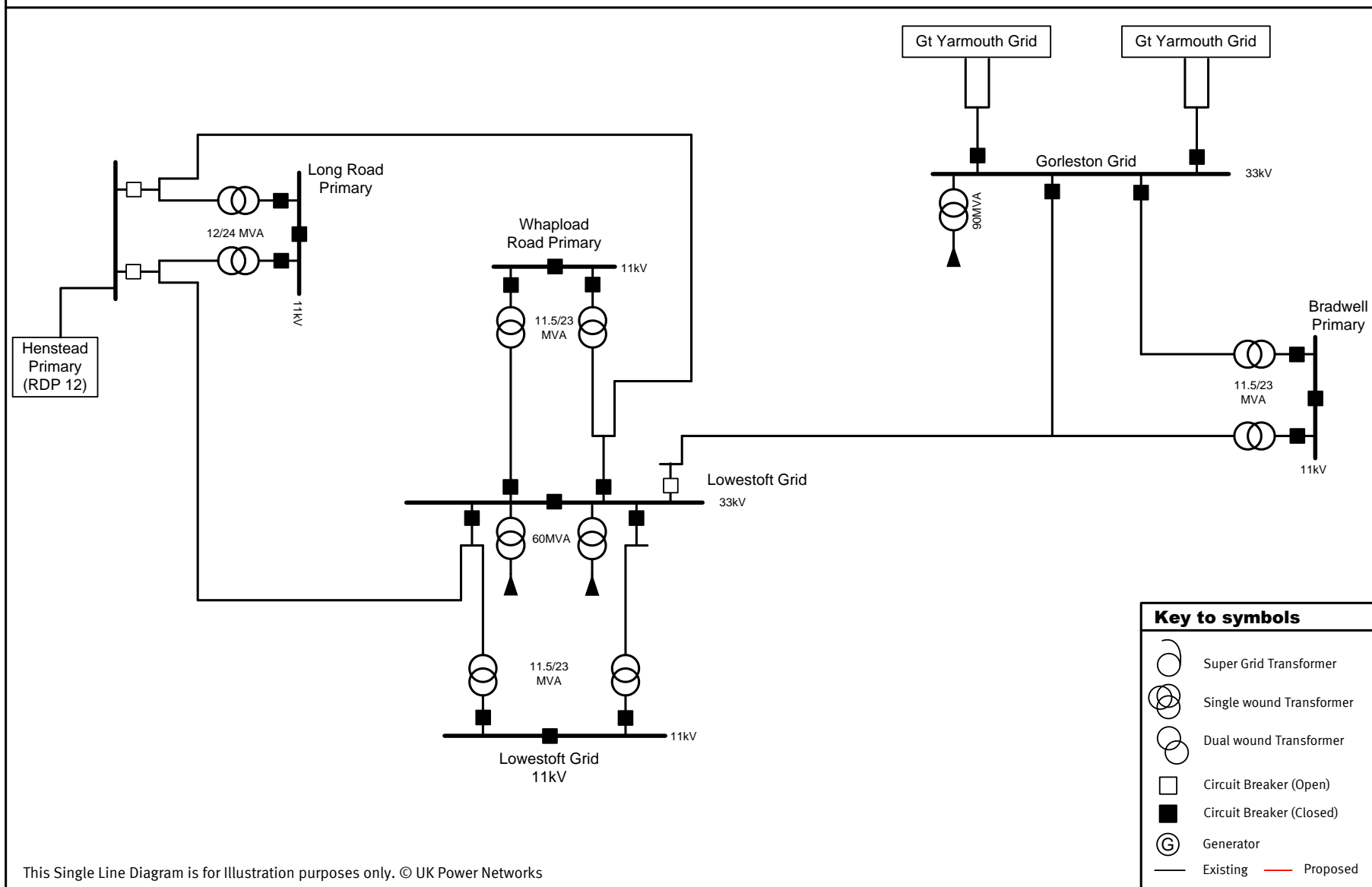


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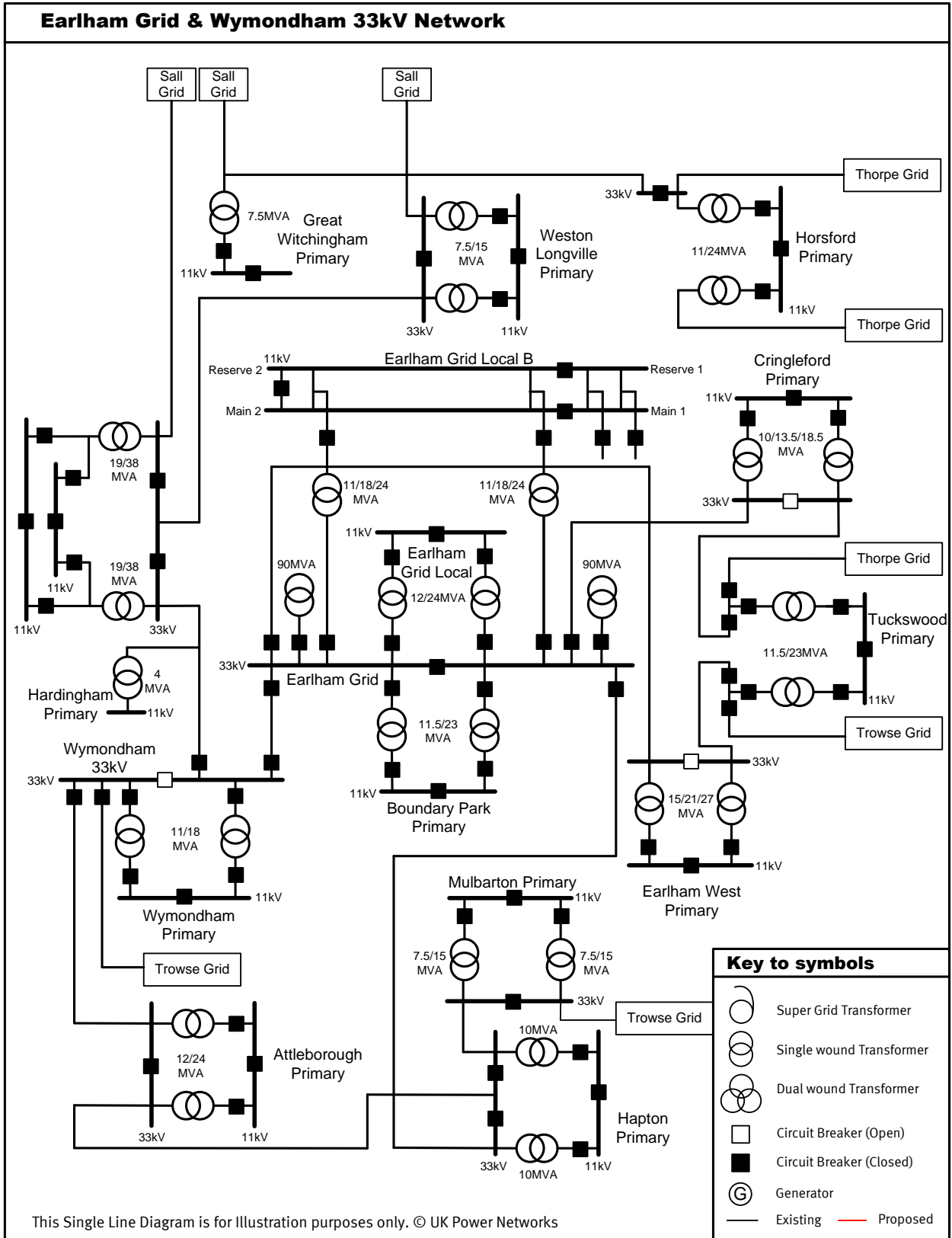


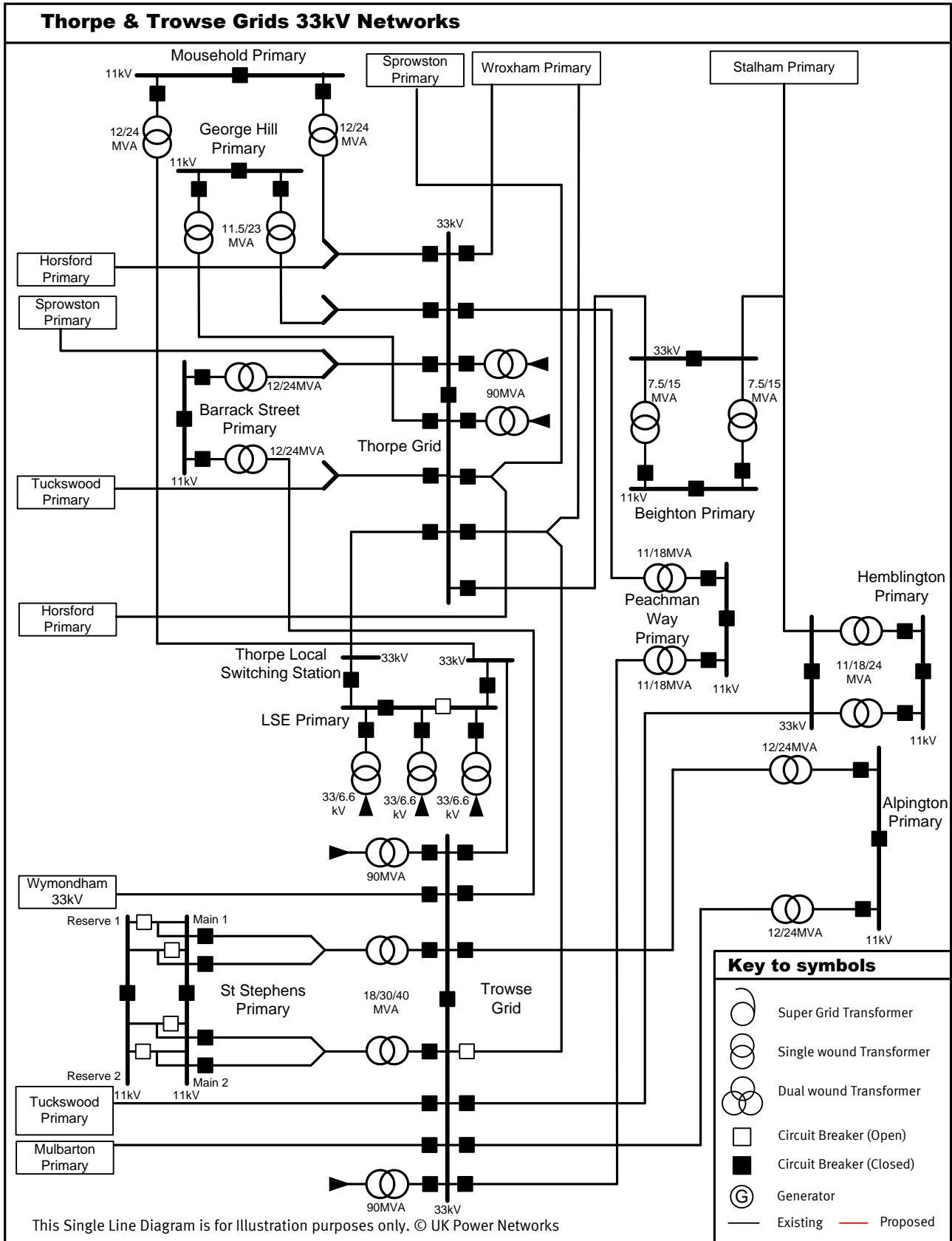
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Gorleston / Lowestoft 33kV Network

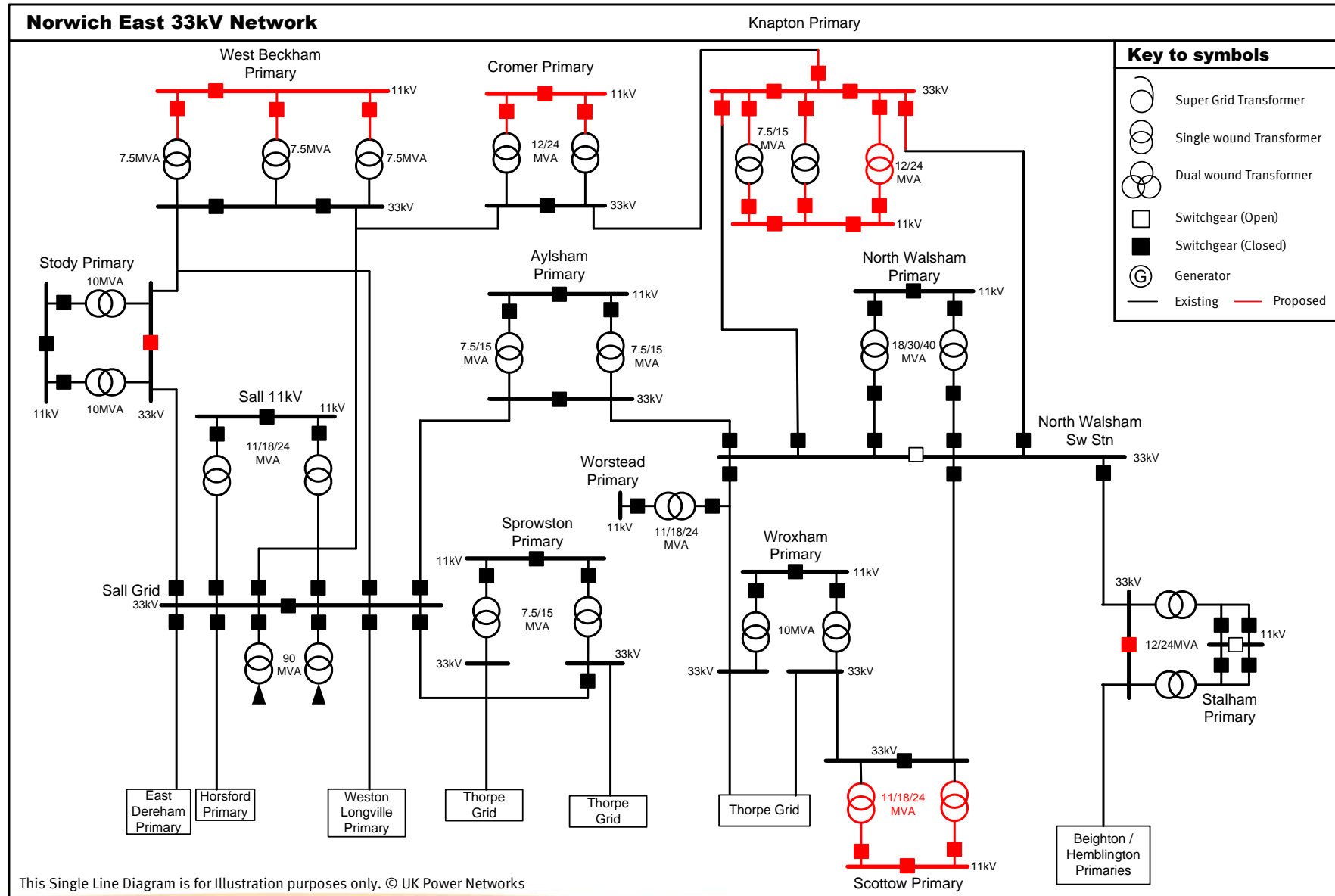


Key to symbols	
	Super Grid Transformer
	Single wound Transformer
	Dual wound Transformer
	Circuit Breaker (Open)
	Circuit Breaker (Closed)
	Generator
	Existing
	Proposed

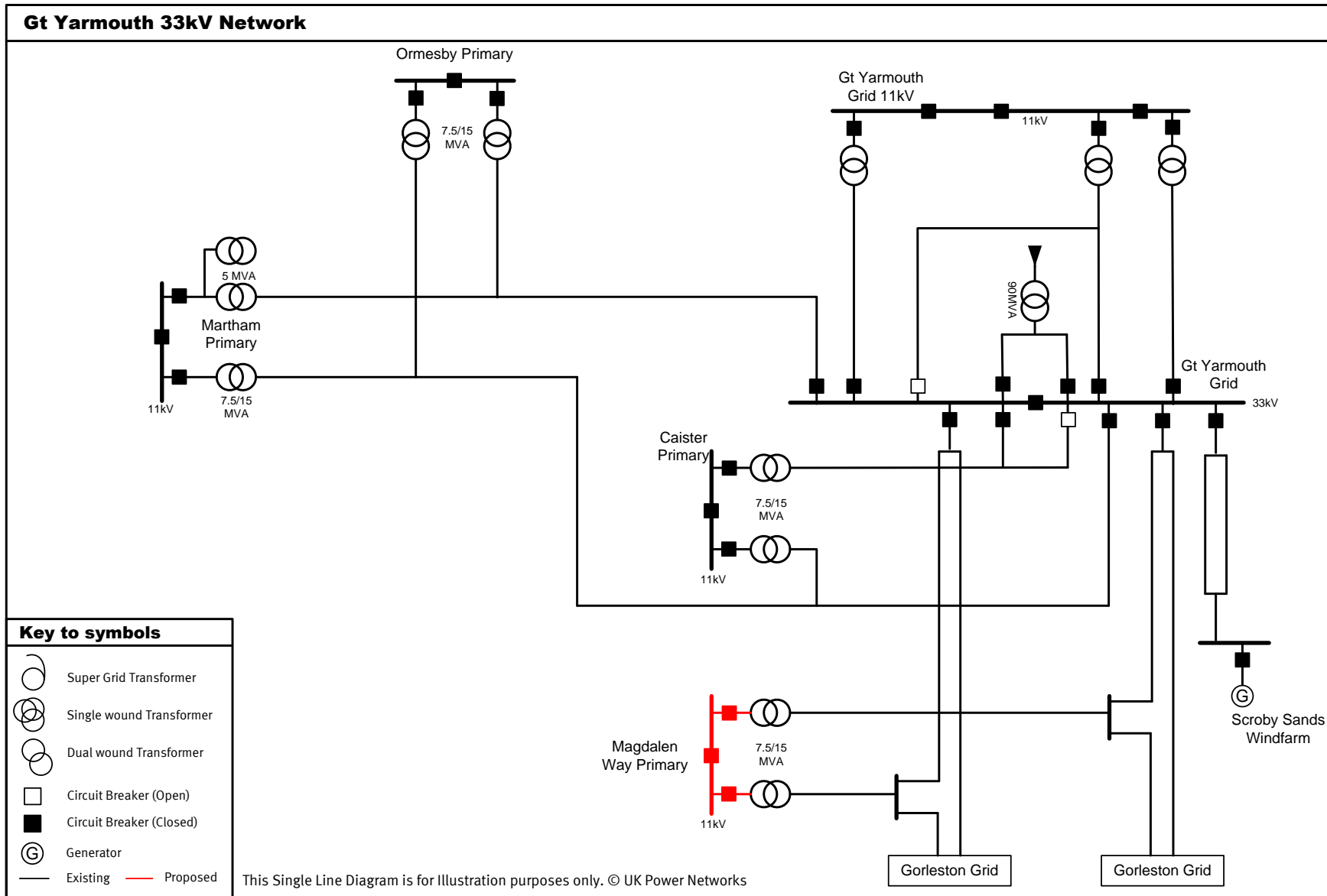




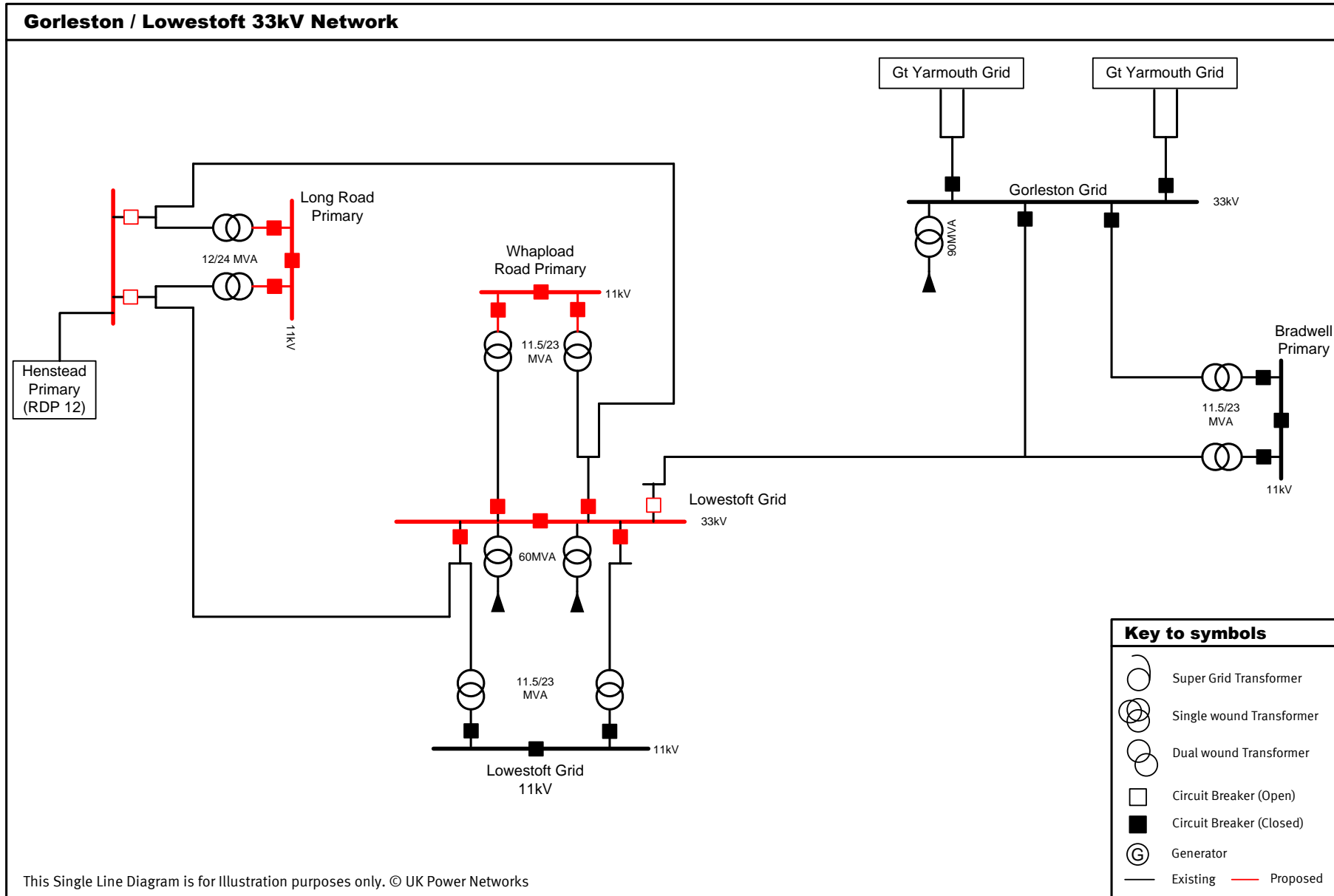
APPENDIX C: SINGLE LINE DIAGRAM – RECOMMENDED STRATEGY

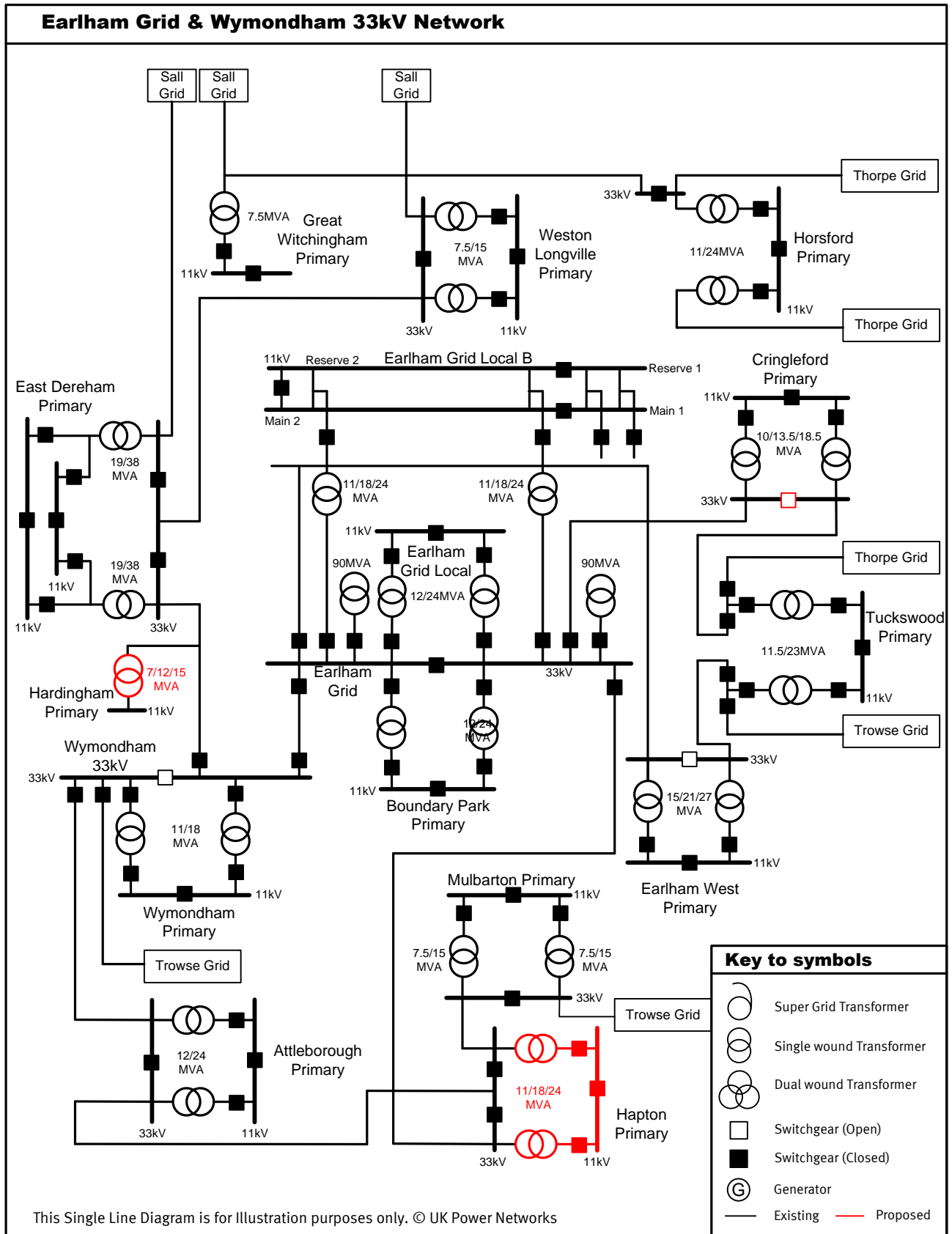


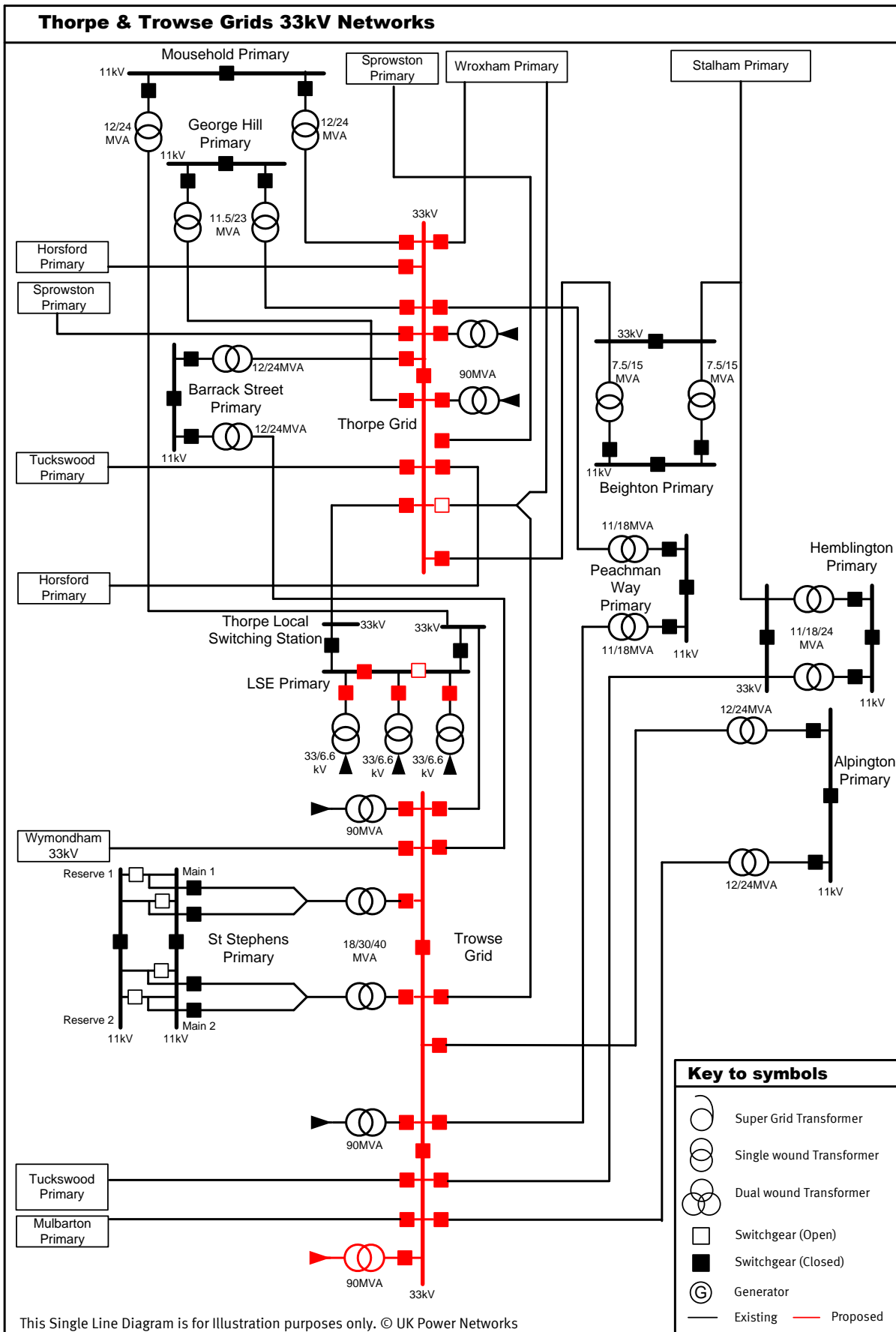
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APPENDIX D: DETAILED COSTS FOR RECOMMENDED STRATEGY

NAMP version: 19 February 2013

Cat	Project ID	Description	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
A	7546	PMB - Trowse - Thorpe - Conductor Replacement							46,361	139,083		
A	7556	PO - Norwich Main - Earham - Conductor Replacement				204,080	970,403					
A	7563	PHC - Norwich - Trowse - Insulator & Fitting Replacement							24,816	74,450		
A	2314	Wymondham/Dereham 33kV OHL - Rebuild (575A(W))	1,744,209									
A	2323	Cringleford 33/11kV Primary S/S - Replace 33kV Bus Section OCB (1200A)	93,995									
A	7121	Stalham 33/11kV Primary Substation - Replace 33kV Bus Section CB	115,211									
A	7604	Stody 132/33kV Grid Substation - Replace 33kV Switchgear									105,017	
A	7620	LS & E 33/11kV Primary Substation - Replace 33kV Switchgear										210,034
A	7623	Long Rd 33/11kV Primary Substation - Replace 33kV Switchgear					210,034					
A	7621	Lowestoft 132/33kV Grid Substation - Replace 33kV Switchgear									345,727	835,506
A	2329	Dereham 33/11kV Primary Substation - Replace 33kV Bus Section CBs (1200A)	91,875									
A	7653	Long Rd 33/11kV Primary Substation - Replace 11kV Switchgear									251,179	637,429
A	7657	Magdalen Way 33/11kV Primary Substation - Replace 11kV Switchgear							234,836	555,099		
A	7662	Scottow 33/11kV Primary Substation - Replace 11kV Switchgear						234,119	539,771			
A	7666	West Beckham 33/11kV Primary Substation - Replace 11kV Switchgear						39,111	823,146			
A	7667	Whapload Road 33/11kV Primary Substation - Replace 11kV Switchgear						234,836	555,099			
A	7669	Aylsham 33/11kV Primary Substation - Retrofit 11kV Switchgear										
A	7690	Hapton 33/11kV Primary Substation - Replace 11kV Switchgear	380,762	506,147								
A	7693	Hemblington 33/11kV Primary Substation - Retrofit 11kV Switchgear										130,611

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Cat	Project ID	Description	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
A	5833	Scottow 33/11kV Primary Substation - Replace 33/11kV Transformers	201,000	900,000								
A	7757	Hardingham 33/11kV Primary Substation - Replace Primary Transformers (T1)									174,618	396,583
A	7712	Thorpe 132/33kV Grid Substation - Refurbish Grid Transformers (GT2B)					34,013	116,904				
R	3439	Trowse Grid - Divert the 4 x Trowse/Thorpe Circuits (PVB & PMB)				969,223	3,392,282	4,846,117	4,361,505			
R	3817	Earlham/Sall 132kV double circuit (PS) : Diversions	76,762	498,448	2,492,242	2,685,289						
R	5724	Hapton 33/11kV Primary Substation - ITC (2x11/18/24 MVA)			330,765	967,611						
R	5733	Caister 33/11kV Primary Substation - Demand Side Response (DSR)				7,425	29,700	29,700	29,700	29,700	29,700	29,700
R	2316	Cromer 33/11kV Primary Substation - Replace 11kV Switchboard (2000A)					9,709	223,308	616,664			
R	6353	Trowse 132/33kV Grid Substation - Install 3rd 132/33kV GT and Replace 33kV Switchboard					19,987	372,557	1,412,680	1,204,815		
R	3699	St Stephens 33/11kV Primary S/S - ITC (2 x 30/30MVA 132/11kV Units)										
R	4305	Earlham 132/33kV Grid Substation - Install 132kV Switchboard	2,102,111									
R	5010	Thorpe 132/33kV Grid Substation - Replace 33kV Switchgear (Fault Level)				19,789	375,995	1,094,451				
R	2313	Earlham Grid/Wymondham 33kV Circuit - Reinforce (575A(W))	605,727									
R	3382	Norwich Main/Earlham 132kV Circuits - Install 3rd 132kV Circuit	326,388									
R	5779	Earlham Grid/Wymondham 33kV Circuit - Phase 2 Reinforcement (770A(W))						9,361	502,680	1,497,743		
W	5892	Knapton 33/11kV Primary Substation - Security Works	519,793	681,207								

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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
Alpington	W	Transformer	24.0		24.0	12.0	13.4	LI1	LI1		24.0	LI1	C	Yes
Attleborough Total	W	Switchgear	20.9		20.9	14.9	15.5	LI1	LI1		20.9	LI1	C	Yes
Aylsham	W	Transformer	15.0		15.0	7.7	8.2	LI1	LI1		15.0	LI1	B	Yes
Barrack Street Total	W	Transformer	24.0		24.0	9.5	11.0	LI1	LI1		24.0	LI1	B	Yes
Bighton	S	Transformer	11.5		11.5	4.4	5.0	LI1	LI1		11.5	LI1	B	Yes
Boundary Park	S	Transformer	17.3		17.3	13.1	14.2	LI1	LI2		17.3	LI2	C	Yes
Bradwell	S	Transformer	17.3		17.3	10.2	11.0	LI1	LI1		17.3	LI1	B	Yes
Caister	S	Transformer	11.5		11.5	11.2	12.3	LI3	LI2	5733	13.7	LI2	C	Yes
Cringleford Total	W	Switchgear	15.2		15.2	10.1	10.9	LI1	LI1		15.2	LI1	B	Yes
Cromer	W	Switchgear	15.2		15.2	13.1	14.3	LI2	LI2	2316	24.0	LI1	C	Yes
Earlham Grid 33	S	Transformer	98.9		98.9	59.5	62.4	LI1	LI1		98.9	LI1	D	Yes
Earlham Grid Local A	S	Transformer	20.6		20.6	15.3	15.6	LI1	LI1		20.6	LI1	C	Yes
Earlham West Total	W	Circuit Rating	21.9		21.9	14.9	16.4	LI1	LI1		21.9	LI1	C	Yes
East Dereham	W	Circuit Rating	32.9		32.9	23.8	25.5	LI1	LI1		32.9	LI1	C	Yes
George Hill	W	Transformer	23.0		23.0	16.1	17.4	LI1	LI1		23.0	LI1	C	Yes
Gorleston Grid 33	S	Backfeed	34.4		37.7	21.5	23.1	LI1	LI1		37.7	LI1	C	Yes
Great Yarmouth Grid	S	Transformer	36.0		36.0	24.6	26.6	LI1	LI1		36.0	LI1	C	Yes

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				Dpcr5 Intervention		RIIO-ED1 without intervention				RIIO-ED1 with intervention			P2/6 at end of ED1	
Substation	Season	First Limitation	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	Comply
Great Yarmouth Grid 33	W	Backfeed	67.4		70.8	56.5	62.2	LI1	LI2		70.8	LI2	D	Yes
Hapton total	W	Aux equipment	10.0		10.0	10.5	11.3	LI5	LI5	5724	24.0	LI1	B	Yes
Hardingham	W	Backfeed	3.6		3.6	3.1	3.0	LI2	LI2		3.6	LI2	B	Yes
Hemblington	W	Switchgear	15.2		15.2	10.1	11.1	LI1	LI1		15.2	LI1	B	Yes
Horsford	W	Switchgear	23.9		23.9	18.0	19.8	LI1	LI2		23.9	LI2	C	Yes
Knapton	W	Transformer	15.0		15.0	9.3	10.1	LI1	LI1		15.0	LI1	B	Yes
Long Road	W	Transformer	24.0		24.0	16.2	17.8	LI1	LI1		24.0	LI1	C	Yes
Lowestoft Grid	S	Transformer	28.5		28.5	22.5	24.2	LI1	LI2		28.5	LI2	C	Yes
Lowestoft Grid 33	W	Switchgear	68.5		68.5	53.7	58.0	LI1	LI2		68.5	LI2	C	Yes
Magdalen Way	W	Transformer	24.0		24.0	17.7	19.2	LI1	LI1		24.0	LI1	C	Yes
Martham	W	Transformer	11.5		11.5	8.4	9.6	LI1	LI2		11.5	LI2	B	Yes
Mousehold Total	W	Transformer	24.0		24.0	20.1	21.3	LI2	LI2		24.0	LI2	C	Yes
Mulbarton	S	Transformer	11.5		11.5	7.0	7.6	LI1	LI1		11.5	LI1	B	Yes
North Walsham	W	Circuit Rating	22.6		22.6	11.6	12.8	LI1	LI1		22.6	LI1	C	Yes
Ormesby	S	Transformer	11.5		11.5	8.0	9.1	LI1	LI1		11.5	LI1	B	Yes
Peachman Way total	S	Transformer	18.0		18.0	6.7	6.7	LI1	LI1		18.0	LI1	B	Yes
Sall Grid	S	Transformer	18.0		18.0	7.0	7.6	LI1	LI1		18.0	LI1	B	Yes
Sall Grid 33	W	Transformer	148.5		148.5	85.1	90.5	LI1	LI1		148.5	LI1	D	Yes
Scottow	W	Transformer	13.0		13.0	4.2	4.8	LI1	LI1		13.0	LI1	B	Yes

Regional Development Plan



Norwich GSP (EPN)

				Dpcr5 Intervention		RIIO-ED1 without intervention				RIIO-ED1 with intervention			P2/6 at end of ED1	
Substation	Season	First Limitation	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	Comply
Sprowston	W	Transformer	15.0		15.0	9.4	10.2	LI1	LI1		15.0	LI1	B	Yes
St Stephens	S	Transformer	30.0		30.0	22.9	24.9	LI1	LI2		30.0	LI2	C	Yes
Stalham	W	Transformer	24.0		24.0	11.5	12.9	LI1	LI1		24.0	LI1	C	Yes
Stody	W	Transformer	13.0		13.0	9.3	9.3	LI1	LI1		13.0	LI1	B	Yes
Thorpe Grid 33	W	Switchgear	141.7		141.7	102.5	112.0	LI1	LI1		141.7	LI1	D	Yes
Thorpe Grid Local	S	Transformer	60.0		60.0	27.7	29.5	LI1	LI1		60.0	LI1	C	Yes
Trowse Grid 33	W	Switchgear	130.3		130.3	121.5	131.5	LI2	LI4	6353	244.7	LI1	D	Yes
Tuckwood total	S	Transformer	17.3		17.3	9.3	10.2	LI1	LI1		17.3	LI1	B	Yes
West Beckham	W	Transformer	17.2		17.2	11.9	12.8	LI1	LI1		17.2	LI1	C	Yes
Weston Longville	W	Transformer	15.0		15.0	6.3	6.3	LI1	LI1		15.0	LI1	B	Yes
Whapload Road	S	Transformer	17.3		17.3	10.3	10.7	LI1	LI1		17.3	LI1	B	Yes
Worstead	W	Backfeed	1.0		1.0	4.7	4.8	LI5	LI5		1.0	LI5	B	Yes
Wroxham	S	Transformer	10.0		10.0	6.5	7.1	LI1	LI1		10.0	LI1	B	Yes
Wymondham total	W	Transformer	18.0		18.0	14.5	15.4	LI2	LI2		18.0	LI2	C	Yes
Earlham Grid Local B	W	Transformer	24.0		24.0	13.3	13.7	LI1	LI1		24.0	LI1	C	Yes
Great Witchingham	S	Transformer	3.1		3.1	3.5	3.5	LI5	LI5		3.1	LI5	B	Yes

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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
EARLHAM 132	13					13					13				
NORWICH MAIN 132	5					5					5				
TROWSE GRID	3	12	1			1	3	11		1	1	3	11		1
TOTAL	21	12	1			19	3	11		1	19	3	11		1

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
ATTLEBOROUGH PRIMARY	1					1					1				
AYLSHAM PRIMARY	1						1					1			
BEIGHTON PRIMARY		1					1					1			
CRINGLEFORD PRIMARY	1					1					1				
CROMER PRIMARY	1						1					1			
EARLHAM GRID	5	8				2	11				4	11			
EARLHAM WEST PRIMARY			1							1					1
EAST DEREHAM PRIMARY	2					2					2				
GORLESTON GRID		5					1	4				1	4		
GT YARMOUTH GRID	15						15					15			
HAPTON PRIMARY		2					2					2			
HEMBLINGTON PRIMARY	1					1					1				
HORSFORD PRIMARY				1						1					1
KNAPTON PRIMARY	3						3					3			
LONG RD PRIMARY				2						2	2				
LOWESTOFT GRID			2	6						8	8				
MULBARTON PRIMARY	1					1					1				
NORTH WALSHAM PRIMARY	2					2					2				
SALL GRID	15						15					15			
SCOTTOW PRIMARY		1						1					1		
SPROWSTON PRIMARY		1						1					1		
STALHAM PRIMARY	1					1					1				
STODY PRIMARY				1						1	1				
THORPE GRID		14					14				18				
TROWSE GRID		15					15					15			
TUCKSWOOD PRIMARY	2					2					2				
WEST BECKHAM PRIMARY	2					2					2				

Norwich GSP (EPN)

	33kV Switchgear												
	ED1 Start (2015)					ED1 End (2023) No Investment				End of ED1 (2023) With Investment			
WESTON LONGVILLE PRIMARY	1					1				1			
WORSTEAD PRIMARY	1					1				1			
WYMONDHAM PRIMARY	7					7				7			
LSE PRIMARY	1 1					2				2			
TOTAL	61	48	4	11		23	79	7	15	56	65	7	2

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
ALPINGTON PRIMARY	11					11					11				
ATTLEBOROUGH PRIMARY	11					11					11				
AYLSHAM PRIMARY	5 2					5 2					7				
BARRACK ST PRIMARY	9					9					9				
BEIGHTON PRIMARY	6 1					1 6					1 6				
BOUNDARY PARK PRIMARY	4 6					10					10				
BRADWELL PRIMARY	4 6					8 1 1					8 1 1				
CAISTER PRIMARY	6 4					1 8 1					1 8 1				
CRINGLEFORD PRIMARY	8 3					11					11				
CROMER PRIMARY	8					5 3					8				
EARLHAM GRID LOCAL	11					11					11				
EARLHAM GRID LOCAL B	25					25					25				
Earlham Grid Local B	25					25					25				
EARLHAM WEST PRIMARY	4 7					11					11				
EAST DEREHAM PRIMARY	12 5					8 9					8 9				
GEORGE HILL PRIMARY	14					14					14				
GT YARMOUTH GRID	20					19 1					19 1				
HAPTON PRIMARY	7					7					7				
HARDINGHAM PRIMARY	1 1					1 1					1 1				
HEMBLINGTON PRIMARY	3 5					5 3					8				
HORSFORD PRIMARY	12					12					12				
KNAPTON PRIMARY	4 3 1					5 2 1					5 2 1				
LONG RD PRIMARY	11					7 4					11				
LOWESTOFT GRID	1 16					15 2					15 2				
MAGDALEN WAY PRIMARY	9					9					9				
MARTHAM PRIMARY	8					8					8				
MOUSEHOLD PRIMARY	13					13					13				
MULBARTON PRIMARY	4 3					6 1					6 1				

Norwich GSP (EPN)

	11/6.6kV Switchgear														
	ED1 Start (2015)					ED1 End (2023) No Investment					End of ED1 (2023) With Investment				
NORTH WALSHAM PRIMARY	13					13					13				
ORMESBY PRIMARY	3		4			7					7				
PEACHMAN WAY PRIMARY	10					10					10				
SCOTTOW PRIMARY	8					3			5		8				
SPROWSTON PRIMARY	8					6		2			6		2		
ST STEPHENS PRIM	26					26					26				
STALHAM PRIMARY	2		9			1	10				1	10			
STODY PRIMARY	8					8					8				
THORPE GRID	33					33					33				
TUCKSWOOD PRIMARY	11					11					11				
WEST BECKHAM PRIMARY	1	9				1	9				10				
WESTON LONGVILLE PRIMARY	8	1				9					9				
WHAPLOAD RD PRIMARY	7			2		4			5		9				
WORSTEAD PRIMARY	3					3					3				
WROXHAM PRIMARY	11					11					11				
WYMONDHAM PRIMARY	11					11					11				
TOTAL	216	188	100	2	1	100	222	124	26	35	155	231	111	7	3

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
ALPINGTON PRIMARY	1	1				1	1				1	1			
ATTLEBOROUGH PRIMARY		2				2					2				
AYLSHAM PRIMARY		2				2					2				
BARRACK ST PRIMARY		2				2					2				
BEIGHTON PRIMARY		2				2					2				
BOUNDARY PARK PRIMARY		2				2					2				
BRADWELL PRIMARY		2				1	1				1	1			
CAISTER PRIMARY		2				2					2				
CRINGLEFORD PRIMARY		2						2					2		
CROMER PRIMARY		2				1	1				1	1			
EARLHAM GRID		2				2					2				
EARLHAM GRID LOCAL		2				2					2				
EARLHAM GRID LOCAL B		2				2					2				
Earlham Grid Local B		2				2					2				
EARLHAM WEST PRIMARY		2				2					2				
EAST DEREHAM PRIMARY		2						2					2		

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	Grid and Primary Transformers													
	ED1 Start (2015)				End of ED1 (2023) No Investment					End of ED1 (2023) With Investment				
GEORGE HILL PRIMARY	2				2					2				
GORLESTON GRID	1				1					1				
GT YARMOUTH GRID	2	2			3	1				3	1			
HAPTON PRIMARY	2				2					2				
HARDINGHAM PRIMARY	1				1					1				
HEMBLINGTON PRIMARY	2				2					2				
HORSFORD PRIMARY	2				2					2				
KNAPTON PRIMARY	2				2					2				
LONG RD PRIMARY	2				2					2				
LOWESTOFT GRID	4				2	2				2	2			
MAGDALEN WAY PRIMARY	2				2					2				
MARTHAM PRIMARY	1	2			1	1	1				1	1	1	
MOUSEHOLD PRIMARY	2				2					2				
MULBARTON PRIMARY	2				2					2				
NORTH WALSHAM PRIMARY	1	1			2					2				
ORMESBY PRIMARY	2				2					2				
PEACHMAN WAY PRIMARY	2				1	1				1	1			
SALL GRID	1	1	2		2	2				2	2			
SCOTTOW PRIMARY	2				2					2				
SPROWSTON PRIMARY	2				2					2				
ST STEPHENS PRIM	1	1			1	1				1	1			
STALHAM PRIMARY	2				1	1				1	1			
STODY PRIMARY	2				2					2				
THORPE GRID	3	1	1		4	1				4	1			
TROWSE GRID	1	1			1	1				1	1			
TUCKSWOOD PRIMARY	2				2					2				
WEST BECKHAM PRIMARY	1	2			1	2				1	2			
WESTON LONGVILLE PRIMARY	2				2					2				
WHAPLOAD RD PRIMARY	2				2					2				
WORSTEAD PRIMARY	1				1					1				
WROXHAM PRIMARY	1	1			2					2				
WYMONDHAM PRIMARY	1	1			1	1				1	1			
TOTAL	13	77	11	3	3	64	24	11	2	6	64	25	8	1

Norwich GSP (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.

