Regional Development Plan

RDP08 Pelham & Wymondley Group (EPN)

Planner D J Whiteley

Version 2.0

Date 20/03/2014

Contents

1 Executive Summary

This Regional Development Plan (RDP) reviews sections of UK Power Networks (UKPN) EPN HV and EHV network supplied from Pelham and Wymondley Grid Supply Points (GSP) covering the geographic area of Southeast Suffolk, Northwest Essex and a large part of Hertfordshire.

This central area of the EPN network is characterized as mostly rural with several large towns such as Haverhill, Sudbury, Bishops Stortford, Stevenage and Letchworth.

Due to its location within the M11 and A1(M) axis, the area comprises a number of large commercial and industrial areas which include Stansted Airport and Rail supplies to the network from East Anglia and East Coast lines to London terminals.

There has been an increase in the number of distributed generation connected in this area, with several medium sized wind and solar generators due to be connected to Belchamp and Thaxted.

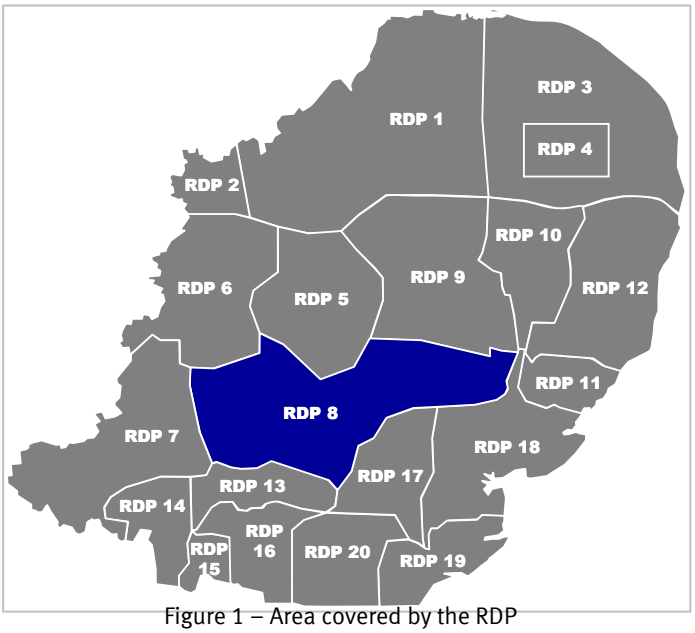


Figure 1 – Area covered by the RDP

1.1 Summary of issues addressed

At the 33/11kV level, all the predicted load increases can be accommodated by individual schemes, either as ITC and associated switchgear and/or circuit reinforcement, or new Primary sites.

Due to the predominantly rural nature of this area of North Essex, especially in the vicinity of Twinstead and Castle Hedingham, the distribution network is predominantly radial with long lengths of 11kV overhead line supplied from small/medium size primary substations with firm capacity below 24MVA such as Cornard, Halstead and Wethersfield primaries and larger load centres in the towns of Sudbury, Haverhill and Saffron Walden.

Other topics addressed in this RDP:

- 132k/33kV and 33/11kV Substation Reinforcement;
- Asset Replacement Strategy
- Development of 33kV interconnecting networks;
- 33/11kV Substations reinforcement;
- Fault Level;
- Distributed Generation;
- National Grid RIIO-T1 business plans

Investment Profile

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

RDP	Type	DPCR5 2013-15	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	2020 /2021	2021 /2022	2022 /2023	RIIO-ED1 Total
RDP08	LRE	£5.9m	£1.4m	£3.2m	£1.2m	£0.0m	£0.3m	£2.2m	£2.2m	£0.4m	£10.9m
	NLRE	£1.4m	£0.7m	£3.4m	£3.7m	£3.3m	£2.3m	£3.6m	£6.3m	£4.7m	£28.1m
	TOTAL	£7.3m	£2.1m	£6.6m	£4.9m	£3.3m	£2.6m	£5.8m	£8.6m	£5.1m	£39.0m

Table 1. LRE and NLRE expenditure profile

Output Measures

The figures below provide 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.

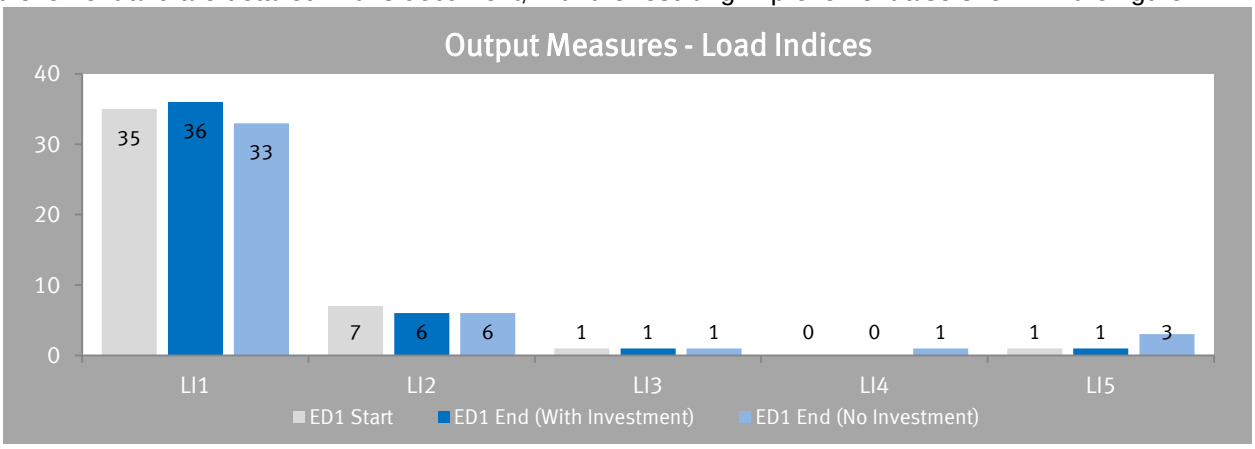
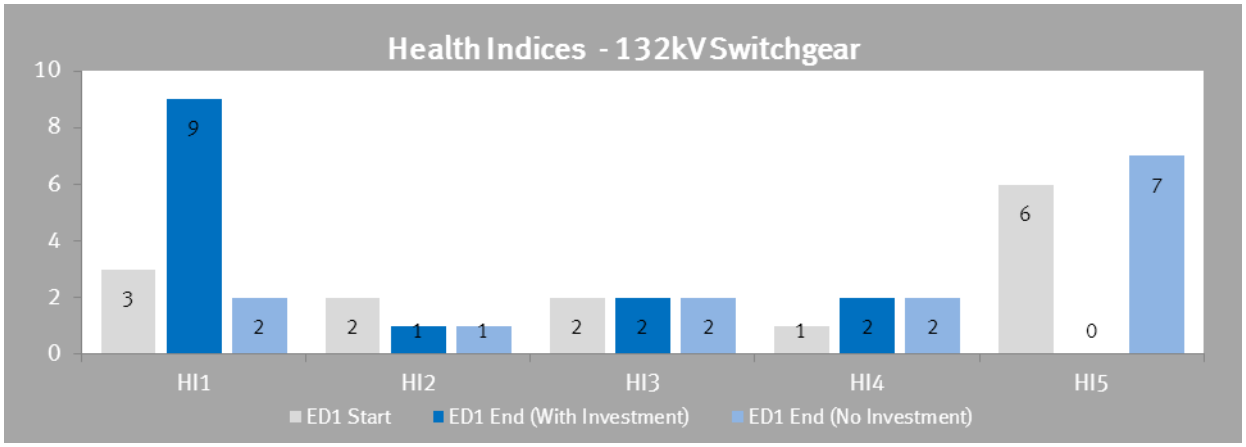
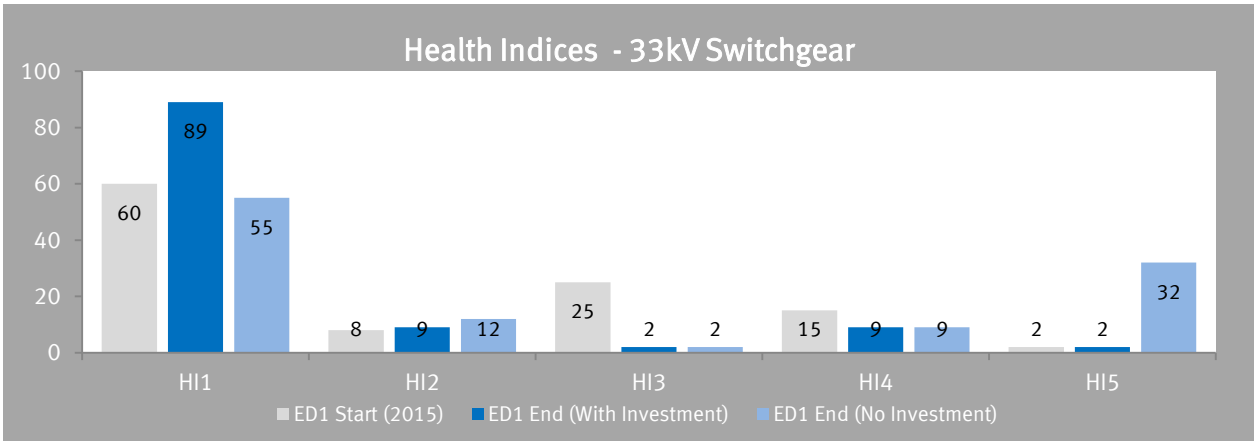


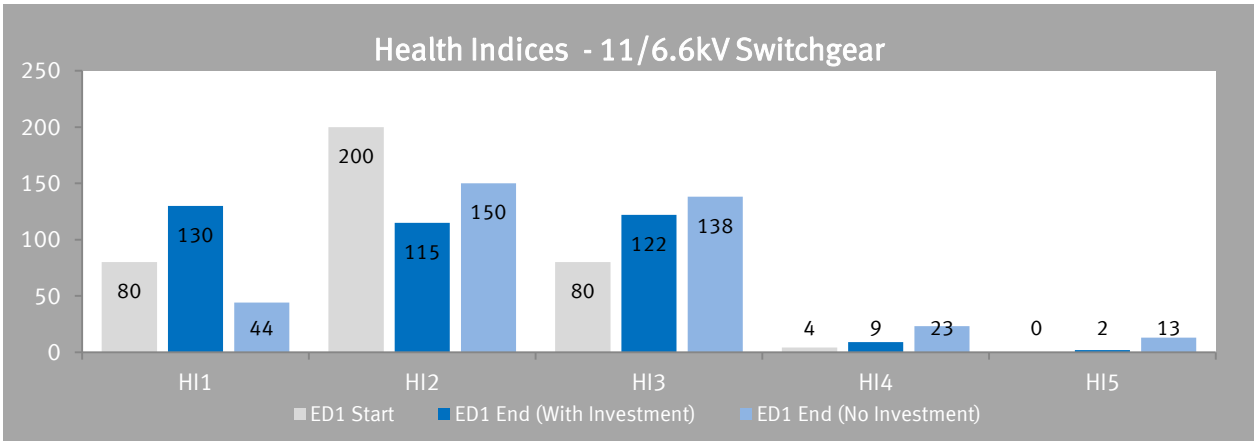
Figure 2. Load Indices (LI)

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.



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





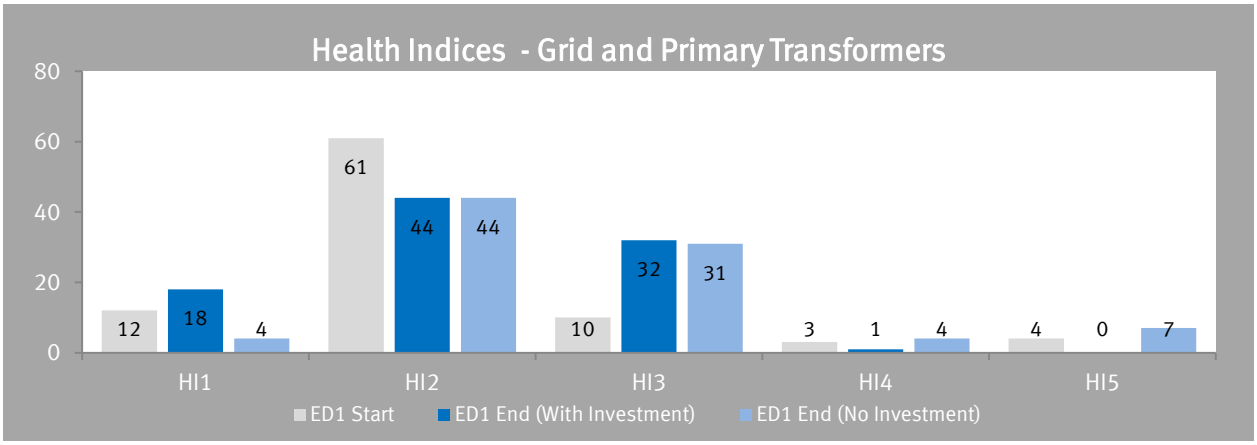


Figure 3. Health Indices by asset category

Scenarios Considered

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

RDP Dependencies and Interactions

The timing of most of these projects will be dictated by load growth and ongoing condition assessment of the plant. Other factors such as quality of supply, new connections and sustainability may change the overall priority and add previous unconsidered projects to the NAMP. The growth of embedded generation will require new approaches to network configuration and protection.

Interaction with Regional Development Plans of Bramford GSP - East, Bramford GSP – Ipswich & Cliff Quay, Rayleigh & Tilbury GSP group

2 Network configuration

2.1 Existing Network

The Pelham-Wymondley network comprises seven 132/33kV substations and associated 33/11kV primary substations which are connected to the National Grid 400kV network by two Grid Supply Points, at Pelham and Wymondley Main.

PELHAM

Pelham GSP is equipped with 2x240MVA 400/132kV SGT and supplies Bishop's Stortford Grid (2x90MVA) via an underground circuit directly off the 132kV bars and Rail supply (1 x 14MVA), Thaxted Grid (2x90MVA) and Belchamp Grid (4 x 45MVA) from a 132kV double circuit overhead line to the east (SMA1-7 and PCB234-PCB118).

WYMONDLEY

Pelham GSP is interconnected with Wymondley GSP to the west by approximately 26km of double circuit 132kV overhead line fitted with 175mm^2 ACSR conductors (PCB), circuit no1 tee off to Melbourn Grid (1x45MVA) at tower PCB273 and circuits no1+2 tee off to Stevenage Grid (2x90MVA). Wymondley GSP is equipped with 2x240MVA 400/132kV SGT and supplies Wymondley Grid (2x90MVA) and Letchworth Grid (2x90MVA).

PCB double circuit 132kV overhead line extends to the east from Pelham to Bramford, teeing off to Cliff Quay Grid and Lawford 132kV switching station. This 132kV circuit is made up of two types of OHL conductors. A 17.5km of 400mm^2, rated at 745/925A, runs between Pelham and Thaxted (to a pair of circuit breakers) and feeding Thaxted Grid and the rail track supply point. The 34.3km section from Thaxted is made up of 175mm^2 and is connected to two Bramford circuits at tower PCB5:

1. Circuit number 1 (PCB No1) is connected to the 300mm^2 Cliff Quay 4 OHL;
2. Circuit number 2 (PCB No2) is connected to the 300mm^2 Lawford 4 OHL;

Currently this section of the circuit runs open, with the HV bows broken at tower PCB16 in an area known as Burstall Bridge, approximately 3km from Bramford substation. This configuration can be altered as part of outage planning scenarios when required. The 132kV route crosses the NG 400kV circuits of Bramford-Rayleigh and Pelham-Rayleigh near the village of Twinstead. The existing 132kV double circuit provides up to 198/246MVA of transfer capacity (summer/winter on a double 132kV circuit) between Pelham-Wymondley Group and Bramford, sufficient to provide a firm supply to Thaxted and Belchamp Grid substations.

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

The Pelham-Wymondley group forms a P2/6 Class E supply with an average cold spell (ACS) maximum winter corrected demand in 2011/12 of 462MW.

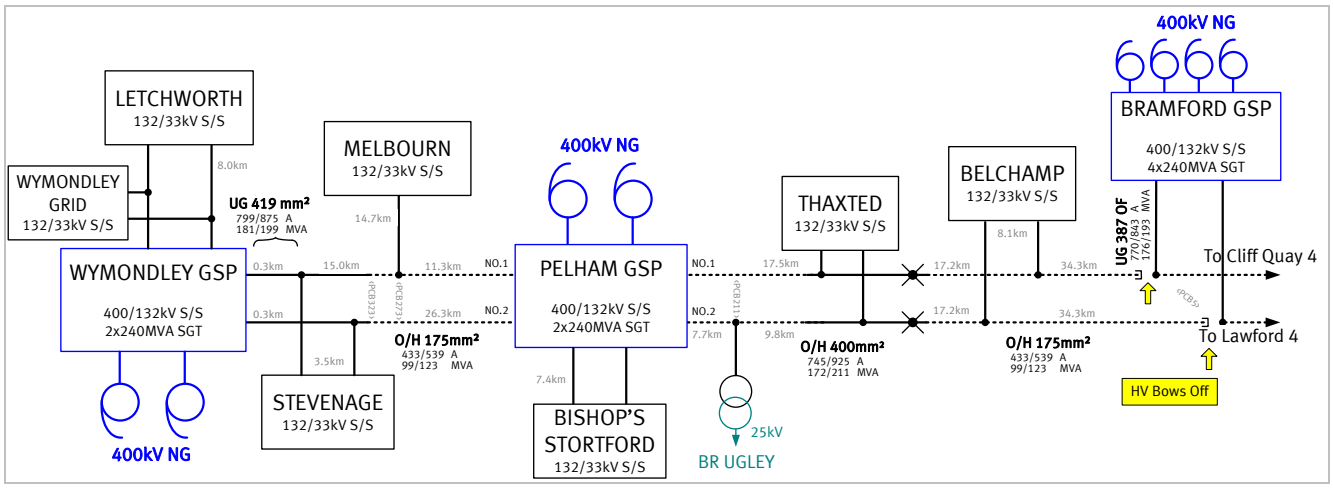


Figure 4. Pelham & Wymondley - Existing network (Conceptual schematic)

The geographical diagram and single line diagram of the existing Pelham/Wymondley section of the network is shown in Appendix A.

2.2 Network changes in progress

Pelham/Wymondley 132kV Tower Line (PCB) Circuits - Reinforce 132kV circuits (2 x 300UPAS) (N-2)

Takeley 33/11kV Primary S/S replace 11kV switchboard (2000A) and 1x 33/11kV STF 7/15MVA

Haverhill 33/11kV Primary Substation - ITC (3rd 11/18/23MVA) & 11kV switchboard

Newtown 33/11kV Primary Substation - ITC (2 x 11/18MVA)

South Stevenage 33/11kV Primary Substation - ITC (3rd 18/30/40MVA), extend 11kV switchboard and new 33kV circuit

Wymondley Grid/Verity Way Teed 33kV Circuits - install 2 x cable circuits (770A).

3 Summary of Issues

3.1 Development areas

There is significant load growth expected on the section of the 132kV network supplied from Pelham and Wymondley, due to the expansion of Stevenage and the M11 growth corridor. The Stevenage area is a government identified area for significant expansion of housing development in the next 10 years, while Stansted Airport is not expected to undergo significant expansion in the ED1 period.

It is therefore expected that without reinforcement, Pelham and/or Wymondley Main NG exit points and the network fed from them will become P2/6 Class E non-compliant in ED2.

The following two Grid substations present the most network challenges for the ED1 period

MELBOURN

The 33kV network in the Melbourn area is supplied from Melbourn 132/33kV Grid Substation. This site presently has a single 60 MVA transformer supplied by a 132kV circuit teed from the Pelham-Wymondley 132kV line. The Melbourn 33kV network interconnects with Fulbourn, Little Barford and Letchworth Grids with an auto close scheme to cater for the loss of the Melbourn 132kV supply.

This area is part of the 'Cambridge Triangle' where the load is predicted to continue to grow in the next few years, including a 5MVA increase in load to an industrial customer at Royston. This area has also seen an increase in the generation activity.

BELCHAMP

There are four 45MVA 132/33kV transformers fed from the two incoming 132kV overhead circuits arranged in pairs onto the 33kV busbars, run with the bus section CB open. Each busbar has one transformer from each incoming circuit. The winter 2011/12 ACS demand for the site was 77.7MW, predicted to rise to 83MW by 2022/23 (PLE 27/2/13) which is within the firm capacity of the existing transformers and 33kV switchgear. The site itself is situated midway between the load centres of Haverhill to the west and Sudbury/Cornard to the east. In both directions there are three 33kV circuits split 2 & 1 across the 33kV busbars, which severely limits the ability to organise busbar shutdowns. There is limited 33kV interconnection to adjacent networks, the most direct being a single circuit via Boxted to Bury Grid. A longer but direct link runs from beyond Cornard towards Bury Grid and a third via Groton and Hadleigh to Stowmarket Grid. These last two partially support the eastern network, but there is no external interconnection onto the western part. For this reason the Belchamp network is particularly vulnerable to an incoming n-2 outage.

Western network: Haverhill, Wratting and Wixoe.

Housing is expected to increase by ~2500 units in the period to 2031, with an associated increase in employment perhaps influenced by the proximity to Cambridge and the associated 'hi-tech' industries. The main industrial area is to the south of the town fed from Haverhill Primary, while the housing expansion will be on the north side where it will be possible to feed the greater part from Wratting Primary. Wixoe is a separated 3.3kV supply to a water pumping station.

Eastern network: Glemsford, Sudbury, Cornard and Groton.

Glemsford is a mainly rural Primary with one large supply to a factory fed directly from the 11kV busbars. This supply has recently increased its MPR for an additional production line. There is little other significant development expected.

Sudbury and Cornard are the main urban and industrial centres, both featuring in the local council Development Plan. A new development area (Chilton) to the north of Sudbury will provide most of the new housing and employment (~2000 homes), with a smaller area which can be fed from Cornard.

Groton is a mainly rural Primary with one large supply to a remote factory which recently increased its MPR. Any further increase would require significant 11kV network reinforcement. There is little other significant development expected. Groton Primary has one 33kV infeed from Belchamp, the other from Stowmarket via Hadleigh, run with a normally open point on the 33kV bus section.

Boxted is a rural Primary with little significant development expected. It has one 33kV infeed from Belchamp, the other from Bury, run with a normally open point on the 33kV bus section.

3.2 Asset Replacement

Wymondley/Stevenage 132kV Tower Line (PDD) - 132kV Tower Line Refurbishment

The condition assessment of the Wymondley/Stevenage 132kV Tower Line (PDD) has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 7 km of 132kV Tower Line refurbished.

Pelham/Bishops Stortford 132kV Tower Line (PCE) - 132kV Tower Line Refurbishment

The condition assessment of the Pelham/Bishops Stortford 132kV Tower Line (PCE) has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 11 km of 132kV Tower Line refurbished.

Melbourn Grid 132kV Tower Line (WPA) - 132kV Tower Line Refurbishment

The condition assessment of the Melbourn 132kV Tower Line (WPA) has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 1 km of 132kV Tower Line refurbished.

Pelham Grid/Thaxted 132kV Tower Line (SMA) - 132kV Tower Line Refurbishment

The condition assessment of the Pelham Grid/Thaxted 132kV Tower Line (SMA) has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 0.4 km of 132kV Tower Line refurbished.

Letchworth Grid/North Hitchin 33kV OHL circuit - 33kV wood pole OHL replacement

The condition assessment of the Letchworth Grid/North Hitchin 33kV OHL circuit has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 2 km of 33kV OHL circuit replaced.

Wymondley Grid/North Hitchin 33kV OHL circuit - 33kV wood pole OHL replacement

The condition assessment of the Wymondley Grid/North Hitchin 33kV OHL circuit has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 2 km of 33kV OHL circuit replaced.

Much Hadham/Thorley 33kV OHL circuit - 33kV wood pole OHL replacement

The condition assessment of the Much Hadham/Thorley 33kV OHL circuit has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 7 km of 33kV OHL circuit replaced.

Bishops Stortford Grid (Thorley)/North Harlow 33kV OHL circuit - 33kV wood pole OHL replacement

The condition assessment of the Bishops Stortford Grid (Thorley)/North Harlow 33kV OHL circuit has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 11 km of 33kV OHL circuit replaced.

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

The condition assessment of the 1966 SCO K30 and 1973 AEI JB424 outdoor oil insulated switchgear installed at Stevenage 132/33kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. UKPN recommends the replacement of 12 circuit breakers.

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

The condition assessment of the 1960 FPA ROP32 outdoor oil insulated switchgear installed at Knebworth 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. UKPN recommends the replacement of 1 circuit breaker.

Bishops Stortford 132/33kV Grid Substation - Replace 33kV Switchgear

The condition assessment of the 1967 SCO K30 and 1973 SWS EO1 outdoor oil insulated switchgear installed at Bishops Stortford 132/33kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. UKPN recommends the replacement of 11 circuit breakers.

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

The condition assessment of the 1975 GEC BVAC indoor VAC switchgear installed at Bassingbourn 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. UKPN recommends the replacement of 8 circuit breakers.

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

The condition assessment of the 1957/59 CPA ALA1 indoor oil insulated switchgear installed at Boxted 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. UKPN recommends the replacement of 7 circuit breakers.

Cherry Green 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1977 GEC BVAC indoor VAC switchgear installed at Cherry Green 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. UKPN recommends the replacement of 7 circuit breakers.

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

The condition assessment of the 1974 AEI BVRP17 indoor oil insulated switchgear installed at Shefford 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. UKPN recommends the replacement of 6 circuit breakers.

East Stevenage 33/11kV Primary Substation - Retrofit 11kV Switchgear

The condition assessment of the 1959 SWS D8-12X indoor oil insulated switchgear installed at East Stevenage 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. UKPN recommends the retrofit of 3 circuit breakers.

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

The condition assessment of the 1956-64 SWS C4X indoor oil insulated switchgear installed at Sudbury 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. UKPN recommends the replacement of 12 circuit breakers.

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

The condition assessment of the 1967 FUL Primary Transformer installed at Cornard 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. UKPN recommends the refurbishment of 2 Primary Transformers.

Wixoe WPS 33/11kV Primary Substation - Refurbish Primary Transformers (T2)

The condition assessment of the 1970 FER Primary Transformer installed at Wixoe WPS 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. UKPN recommends the refurbishment of 1 Primary Transformer.

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

The condition assessment of the 1962 FUL Primary Transformer installed at Wratting 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. UKPN recommends the replacement of 1 Primary Transformer.

Wratting 33/11kV Primary Substation - Refurbish Primary Transformers (T2)

The condition assessment of the 1989 HAWKSID Primary Transformer installed at Wratting 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. UKPN recommends the refurbishment of 1 Primary Transformer.

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

The condition assessment of the 1970 FUL/HSP Primary Transformers installed at Haverhill 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. UKPN recommends the replacement of 2 Primary Transformers.

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

The condition assessment of the 1960 YET Primary Transformer installed at Reed 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. UKPN recommends the replacement of 1 Primary Transformer.

White Roding 33/11kV Primary Substation - Replace Primary Transformers (T2)

The condition assessment of the 1958 PAR Primary Transformer installed at White Roding 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. UKPN recommends the replacement of 1 Primary Transformer.

3.3 Security of supply analysis

Pelham & Wymondley Group

Overall Pelham - Wymondley network comprises seven 132/33kV Grid substations with associated 33/11kV primary substations and a 132/25kV Grid substation which form a P2/6 Class E supply group with an average cold spell (ACS) maximum winter corrected demand of 462MW in winter 2011/12. According to the 2012 Planning Load Estimates (PLE) the demand is expected to reach 571MW in 2022/23 hence the minimum demand to be met in this group under outage conditions is detailed in the P2/6 table below

Circuit outage	Minimum demand to be met for a class E (between 300MW and 1500MW)
First circuit outage	Immediately: Group demand ► 571MW
Second circuit outage	Immediately: All consumers at 2/3 Group Demand ► 380MW Within time to restore arranged outage: Group Demand ► 571MW

The existing network is in compliance with P2/6 security of supply. The 132kV circuits between Pelham and Bramford run normally open at the tower PCB16 and this configuration can be altered by making the HV bows on the tower as part of pre outage planning scenarios to guarantee supply to the group while works on other 132kV sections are taking place, a situation that will occur more frequently as the load in the system increases.

132kV OHL dual circuits between Pelham and Wymondley

P2/6 studies of the Wymondley/Pelham group for an estimated winter maximum demand in 2017/18 show that the loss of one SGT at Wymondley results in an increase in demand from the remaining unit to 255MVA, above the continuous rating of the SGT but still within the 6h cyclic rating of 275MVA. According to the estimates this value will be reached in 2023/24. If the option of transferring the Belchamp load to Bramford is removed (along with the Twinstead to Bramford 132kV OHL) additional Supergrid Transformer capacity will be required in the Wymondley – Pelham Group.

132kV OHL dual circuit between Pelham and Thaxted Grid

The combined demand of Thaxted and Belchamp is expected to increase due to new developments, in particular due to connection activity and developments at Haverhill and Sudbury. The 400mm^2 section of the PCB circuit between Pelham and Thaxted is rated at 211MVA and the 2012 combined demand reached 146MVA in winter 2011/12. According to the estimates, the demand is not expected to reach the circuit capacity in ED1.

Belchamp Grid

This site technically complies with the requirements of P2/6 both now, for and beyond the duration of ED1. It is however vulnerable to a sustained double circuit outage as there is limited 33kV interconnection with the remainder of the network. There is very limited 11kV interconnection across the southern boundary due to the 'Essex' phase difference. These factors have particular effect for supplies to Haverhill, which is the most remote from alternative sources.

Circuit outage	Minimum demand to be met for a class D(between 60MW and 300MW)

First circuit outage	Immediately: Group demand minus up to 20MW ►58MW Within 3 hours: Group demand
Second circuit outage	Within 3 hours: For Group demands > 100MW ► N/A Within time to restore arranged outage: Group Demand ► 78MW

3.4 Operational and technical constraints

The 132kV SGT tails at Wymondley Main 400/132kV substation were indentified for replacement in the previous version of the RDP (2009) and were replaced by National Grid in 2011.

The 132kV circuit complexity rules must be observed. UKPN policy allows a maximum of seven operations at not more than four locations to clear a fault on a section of the network. The most likely connection option for Twinstead GSP involving a teed connection from the Belchamp – Twinstead Tee PCB circuit maintains the circuit complexity.

Due to the predominantly rural nature of this area of North Essex, especially in the vicinity of Twinstead and Castle Hedingham, the distribution network is predominantly radial with long lengths of 11kV overhead line supplied from small/medium size primary substations with firm capacity below 24MVA such as Cornard, Halstead and Wethersfield primaries and larger load centres in the towns of Sudbury, Haverhill and Saffron Walden. These primaries are fed from three different Grid substations of Braintree, Belchamp and Thaxted and are part of two different GSP groups of Pelham - Wymondley and Braintree. As such there are

This area of the network is becoming attractive for the connection of distributed generation.

3.5 National Grid

National Grid requested the transfer and removal of the 132kV PCB overhead line between Twinstead Tee and Burstall Bridge to enable the construction of a 400kV overhead line. A UKPN report issued in June 2012 demonstrated system non-compliance would result from relinquishing the overhead line and put forward several options such as alternative 132kV reconfiguration or reinforcement options and compared these in terms of technical and economic

These works are driven by National Grid requirement to reinforce the 400kV transmission network to accommodate the increase in generation in East Anglia and connection agreements have been signed in respect of 15,431MW of new generation, comprising a large volume of offshore wind generation, gas-fired generation and a nuclear power station. National Grid strategic options review concluded that the construction of a new 400kV overhead transmission line between Bramford and Twinstead Tee is preferred which requires the dismantlement of UK Power Networks 132kV double overhead line running from Burstall Bridge to Twinstead Tee (PCB route) in order to build a new 400kV line.

<u>132kV network reconfiguration to accommodate wider systems works</u>
In July 2012 UKPN published a consultation document regarding NG proposal to replace the 132kV PCB overhead line between Twinstead Tee and Burstall Bridge. The removal of the 132kV circuits to Bramford would result in insufficient 33kV transfer capacity to cater for a summer second circuit outage (N-2) of the SMA/PCB overhead line between Pelham and Thaxted Grid and P2/6 non compliance of the Thaxted and Belchamp group.

A total of 48.5MW demand can be permanently supported from Bury, Stowmarket and Braintree Grids, following a series of manual and remote switching. This is below P2/6 minimum requirement. The figure below illustrates the areas normally supplied from Belchamp and Thaxted Grid and the effect of a 132kV N-2 scenario in terms of areas that can be permanently supplied or areas under rota shed (4h supply rota to individual primary substations). This result in the loss of the rail supply and approximately 35,180 customers supplied via rota shed and a substantial impact in the towns of Haverhill, Sudbury and Saffron Walden with a combined population above 50,000.

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

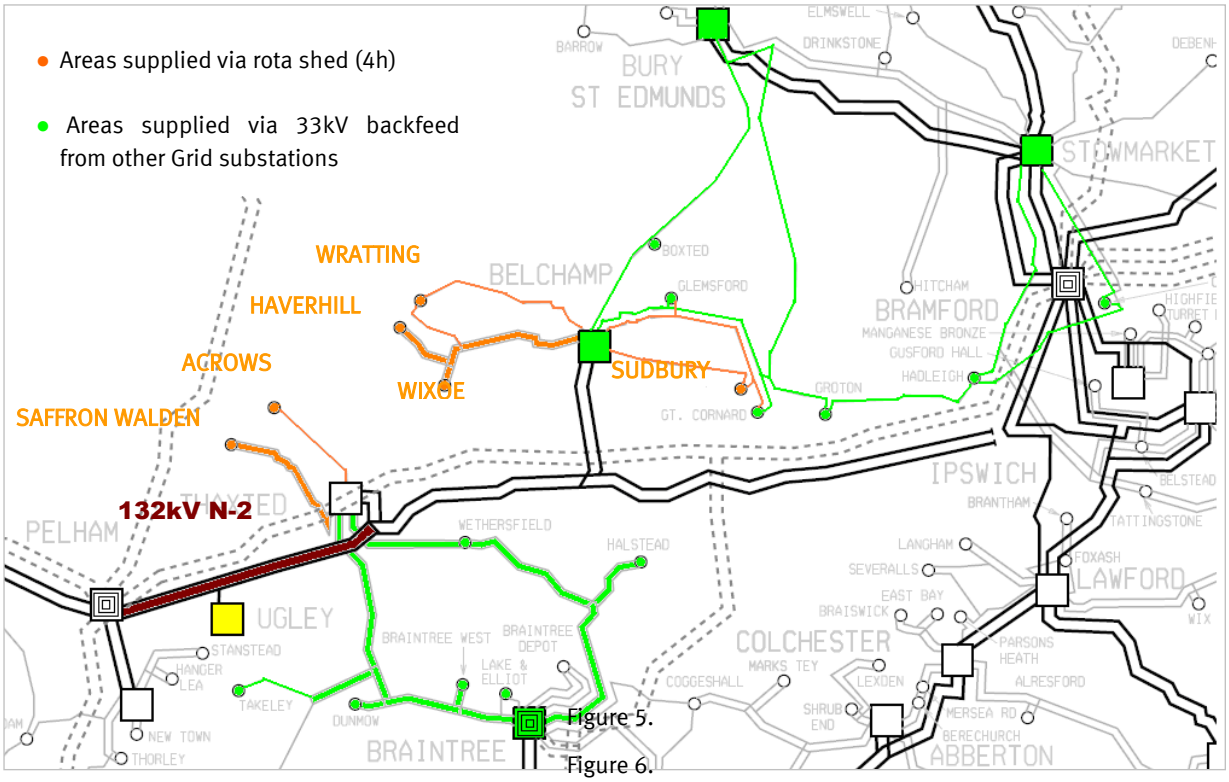


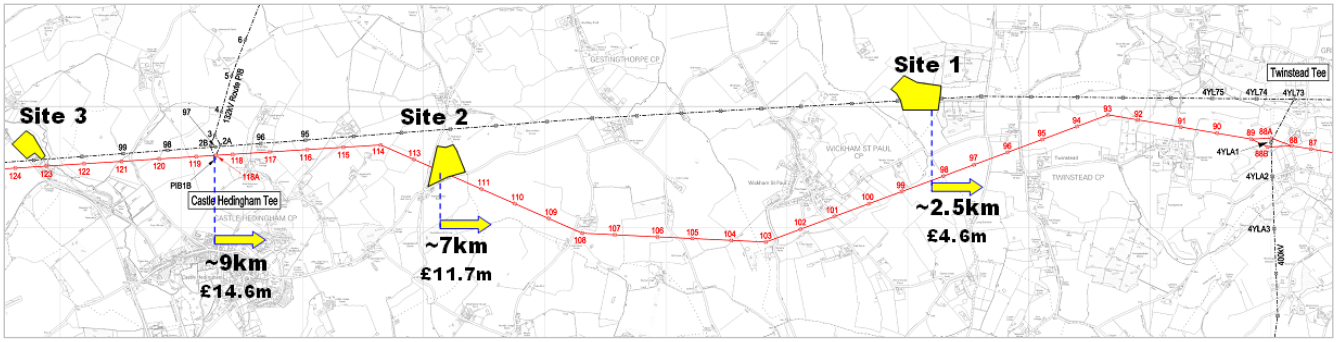
Figure 5.

Figure 6.

Figure 7. Effect of a 132kV N-2 scenario in Belchamp and Thaxted areas

(Simplified to show the affected area)

The evaluation has confirmed the need for a new Grid Supply Point in the vicinity of Twinstead as the appropriate distribution network reinforcement that should be considered in the context of transferring the existing 132kV overhead line between Twinstead Tee and Burstall Bridge. It has been determined that a 400/132kV SGT connected to a single section 132kV busbar via a SGT LV circuit breaker with two 132kV feeder circuit breakers to the existing 132kV OHL is the preferred initial configuration for Twinstead GSP, to be designed to accommodate future expansion as the DNO network evolves. It is proposed to run the new GSP in parallel to Pelham with the bus coupler open at this GSP.



4 Recommended strategy

The main aspect of the strategy in this area is concerned with the removal of the 132kV PCB dual circuit to Bramford and the creation of a new 400/132kV GSP at Twinstead. This will provide a new infeed to the 132kV network, even though connected to the same 400kV circuit between Bramford – Pelham and Wymondley, and maintain the P2/6 compliance.

4.1 Description

Reed 33/11kV Primary Substation - ITC (1 x 7.5/15MVA & 1 x 11/18/24MVA)

The predicted load at Reed Primary Substation will exceed the existing firm capacity, including the transfer capacity Royston Primary Substation. It is therefore proposed to replace the existing transformer with larger unit. The existing switchgear is fully rated for this increased load. The existing circuits supplying the transformers are fully rated for the larger units.

South Stevenage 33/11kV Primary Substation - ITC (3rd 18/30/40MVA), extend 11kV switchboard and new 33kV circuit

The predicted load at South Stevenage substation will exceed the existing firm capacity, including the transfer capacity to East Stevenage and Warren Springs Primary Substations. It is therefore proposed to replace the existing transformers with larger units. The existing switchgear is not fully rated for this increased load. It is therefore proposed to replace this switchgear. The existing circuits supplying the transformers are not fully rated for the larger units. It is therefore proposed to replace both of these circuits.

Completion of this project will see the two existing transformers replaced with two new transformers, the existing switchboard replaced with a new switchboard comprising twelve circuit breakers and two new 2.5km underground circuits installed.

East Letchworth 33/11kV Primary Substation - ITC (2 x 18/30/40MVA) & switchboard (2000A)

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

Completion of this project will see the 2 existing transformers replaced with 2 new transformers and the existing switchboard replaced with a new switchboard comprising 13 circuit breakers installed.

Melbourn Grid Local 33/11kV Primary Substation - ITC (1 x 7.5/15 & 1 x 11/18/24MVA)

The predicted load at Melbourn Primary Substation will exceed the existing firm capacity, including the transfer capacity to Bassingbourn and Royston Primary Substations. It is therefore proposed to augment the existing transformer with an additional unit. The existing switchgear is rated for this increased load but will require an additional transformer circuit breaker. The existing circuits are fully rated for the larger units but will require a 33kV circuit breaker.

Completion of this project will see the existing transformer augmented with a new transformer, the existing 11kV switchboard augmented with a new circuit breaker and a 33kV circuit breaker to supply the new transformer.

Proposed Belchamp/Sudbury 11kV Modifications

The predicted load on the Belchamp/Sudbury network will exceed the existing security arrangements. Whilst it is possible to increase the capacity, it is also possible to transfer load. Completion of this project will see a new 6km underground 11kV circuit installed.

Belchamp 132/33kV Grid Substation - Replace 33kV switchboard (Fault Level)

The predicted fault level at Belchamp Grid Substation will exceed the rating of the existing switchgear due to increasing generation connections at EHV and HV. Twelve circuit breakers are Oil insulated EEC OKM4 and SWS EO1 while the remaining circuit breakers are modern SF6/vacuum type. The fault rating of the oil circuit breakers (circa 1965/70) is 17.5kA.

It is not possible to lower the fault level without compromising operational and planning requirements. It is therefore proposed to replace the existing 15 breaker AIS compound with a new installation comprising 14 circuit breakers.

Thaxted Primary Substation – ITC (1 x 7.5/15)

Thaxted Primary is predicted to go out of firm in 2021/22 and will require reinforcement. The existing single 33/11kV transformer is a 10MVA ONAN and it is proposed to install a second 33/11kV 7.5/15MVA OFAF

transformer. The additional 11kV capacity at Thaxted Primary can also provide 11kV support to Takeley Primary (another single transformer substation) via reinforced 11kV circuits. The reinforced 11kV circuits will provide additional resilience and performance improvement.

Wymondley Local / Letchworth Grid 132kV Fluid Filled Cables - 132kV FFC Replacement

The condition assessment of the Wymondley Local / Letchworth Grid 132kV Fluid Filled Cables 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 7.85 km of 132kV Fluid Filled Cables replaced.

Table 2. Recommended Reinforcement and other considerations

Substation	Firm Capacity (MVA)		Recommendation
	Value (Season)	Limitation	
Acrows	9.7 (W)	11kV backfeed	Demand transfer via 11kV network to the new substation of Windmill Hill when required
Cherry Green	9.7 (W)	Transformer CER	Enhanced cooling solution proposed for DPCR5
East Letchworth	23 (W)	Transformer CER 11kV switchgear	Replace 2x 23MVA transformers with 2x 20/30/40MVA units and replace the 11kV switchboard
East Stevenage	22.6 (W)	Transformer CER	Demand transfer via 11kV network to Warren Springs when required
Haverhill	23 (W)	Transformer CER 11kV switchgear	Install a 3rd 33/11kV transformer in DPCR5
Knebworth	13 (W)	Transformer CER	Demand transfer via 11kV network to Warren Springs when required
Melbourn Grid Local	6.6 (W)	11kV backfeed	Install a 2nd 33/11kV transformer
Newtown	13.5 (W)	Transformer CER	Reinforcement of 33kV network via ITC in DPCR5
North Hitchin	19.1 (W)	0.1Cu OHL circuit	Demand transfer via 11kV network to South Hitchin when required
Reed	6 (W)	11kV backfeed	Install a 2nd 33/11kV transformer
Saffron Walden	22.2 (W)	11kV switchgear	Demand transfer via 11kV network to the new substation of Windmill Hill
South Stevenage	18 (S)	Transformer Rating	ITC via a 3rd Transformer and switchboard extension
Sudbury	19 (W)	11kV switchgear	Improved 11kV interconnection
Takeley	3 (S)	Tap Changer	Replace 7.5MVA transformer with 7/11/15MVA unit and 11kV switchgear to improve 11kV interconnection
Thaxted Local	6 (W)	11kV switchgear	Replace 11kV switchboard
Wethersfield	13 (W)	Transformer CER	
White Roding	7 (W)	Transformer CER	Additional 11kV interconnection.

Innovation: Increased Overhead Line Capacity

In 2011 an IFI project was initiated to bring together a quantity of Overhead Line research projects to assess whether or how they could be applied within UKPN. This project investigated the following key areas:

- In the case of 33kV lines, examine whether a combination of using a novel conductor, larger traditional conductor, different design temperature and/or greater sag than previously assumed possible can relieve the constraint for lower cost.
- In the case of 132kV lines, examine whether re-rating the lines with individual day-time, night-time, Spring/Summer/Autumn/Winter ratings and increasing the overhead line capacity by running the conductors at a higher running temperature and resolving ESQC issues where identified.
- In the case of 132kV lines in areas of large wind generation penetration, examine the use of Dynamic Line Ratings to enable deferment.

Two circuits were identified as case studies:

- 33kV OHL between Sundon Grid and Leighton Buzzard Primary (RDP 07)
- 132kV OHL between Pelham and Wymondley GSP (RDP 08)

During the course of this investigation the profile of both overhead line circuits were confirmed with a LiDAR (Light Detection And Ranging) survey and assessed in PLS-CADD (Power Line Systems – Computer Aided Design and Drafting). This identified some existing ESQCR infringements when running the conductors higher than the design temperature.

4.2 Financial Appraisal and Benefits

Financial Appraisal including NPV if appropriate, a high level estimate using the UCI tool within PIMS/excel. Definition of the benefits such as residual headroom / capacity;

5 Rejected Strategies

5.1 Transfer Belchamp Grid to Bramford GSP

The transfer of Belchamp Grid was previously recommended in the 2009 Belchamp RDP, which formed part of DPCR5 submission.

To accommodate the expected load growth elsewhere on the Pelham group, it was proposed to connect the Belchamp load to the Bramford group via the 132kV PCB overhead line and required the extension of the existing circuits into Bramford by means of two new sections of underground cable and two new 132kV switchgear bays at Bramford. This transfer would prompt works at Bramford GSP with the connection of the 5th SGT permanently in one of the sections of the 132kV busbar and the associated 132kV switchgear works due to fault level.

As the Belchamp network would be supplied from Bramford, there is little benefit in upgrading the sections of line from Thaxted to Castle Hedingham. Therefore, to address the problems of overloading under first circuit outage conditions, the load should be carefully managed during outage conditions and periods of high demand. If necessary, small amounts of load could be transferred to neighbouring areas at Boxted and Groton. Alternatively, it may be possible to rely on a higher, short duration cyclic loading capability of the lines. Estimate cost of £6.8m.

Following the transfer of Belchamp to Bramford, the 132kV supply would be constrained by the capacity of the 175mm² ACSR conductors on the Bramford to Belchamp circuit (34km between towers PCB5 and PCB118). To be P2/6 compliant, this section of the line should be re-strung with 300mm² AAAC conductor towards the end of ED1 as it would increase the line capacity to 176MVA (winter). Estimate cost of £5.9m.

The creation of a new GSP at Twinstead removes the need for reinforcement at 132kV as there are no overload problems for a first circuit outage on the PCB overhead line between Pelham - Thaxted as the supplies to Thaxted and Belchamp can be maintained via the new GSP.

5.2 33kV Reinforcement to Belchamp Grid

The creation of a new GSP at Twinstead removes the need for reinforcement at 33kV to Belchamp Grid. Local reinforcement for Sudbury and Haverhill is still required.

5.3 Expansion of the 132kV network from Twinstead

The location of Twinstead is in a relatively sparse part of the higher voltage network and, apart from the Pelham/Belchamp PCB circuit, there are a limited number of local 132kV circuits to which interconnection would be possible. As part of the distribution network development strategy, a new Twinstead GSP presents new options to reinforce other parts of the network.

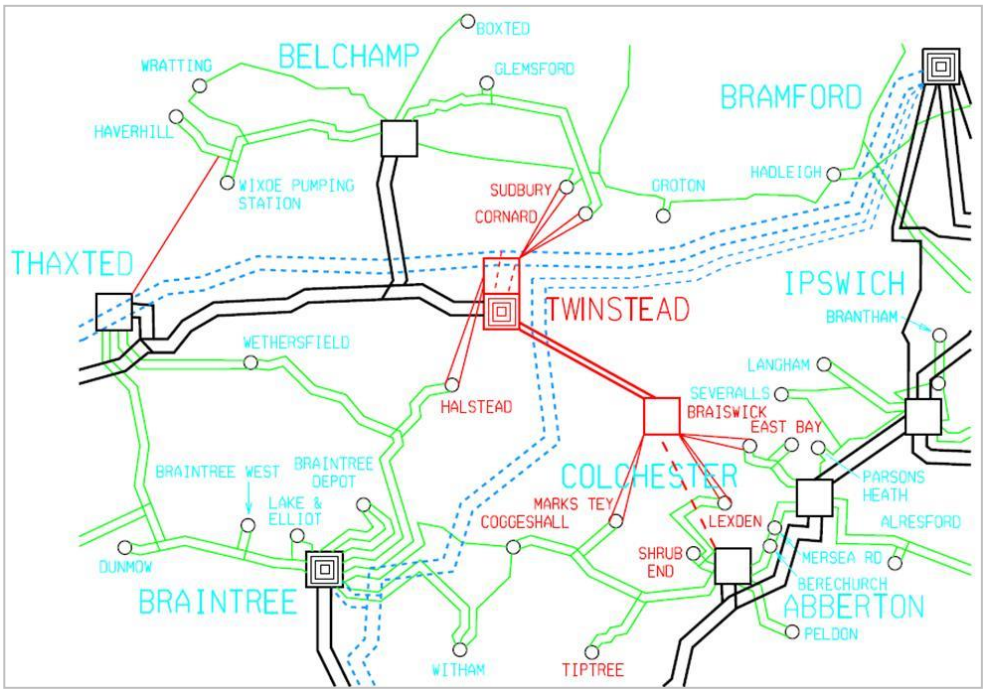


Figure 9. Twinstead GSP reinforcement.

132kV Reinforcement

The dual circuit 132kV overhead line between Rayleigh and Bramford has been previously identified for reinforcement. This presently runs open at Colchester on in-line CBs between the 132/11kV and 132/33kV tee positions. An injection of capacity possibly at Abberton or Lawford would prevent future overload on any section of that circuit. An alternative would be to build a 132/33kV substation on the northern side of Colchester which would then be able to connect to Braiswick, Lexden and Marks Tey which would allow East Bay, Shrub End plus Coggeshall and/or Tiptree to be taken off the Abberton/Colchester network. Depending on the timing of the transfers, this strategy would require reinforcement at Twinstead GSP with the installation of a second SGT and extension of the 132kV switchgear to form a double busbar with at least 4 feeder breakers.

Somewhat similar conditions apply to Braintree Grid itself, which is only interconnected via one 132kV dual-circuit line from Rayleigh, although there are long 33kV links to Thaxted and Abberton. A 132kV connection from Twinstead would ensure greater security.

33kV Reinforcement

A new 132/33kV source, either at Twinstead or at a suitable nearby location would be required as the immediate objective to reinforce the Sudbury/Cornard network which is close to capacity on the existing 33kV overhead circuits from Belchamp. This connection would remove the future necessity for an additional circuit out of Belchamp and also considerably defer any ITC reinforcement at Belchamp itself. A 33kV source would provide greatly increased interconnection into Belchamp with the possibility of better n-2 supplies into Haverhill. A route into either Sudbury or Cornard would be challenging. The river Stour presents a significant barrier to both, with the Sudbury branch line affecting Cornard and the town centre affecting Sudbury.

To the south Halstead Primary is nearest, although a future site at Sible Headingham is proposed. There are existing schemes to reinforce the area in the DPCR5/ED1 plan. A connection into this network would provide support to Braintree, and Thaxted via Wethersfield. An existing scheme for a third grid transformer at Braintree might then be further deferred. This strategy has been discounted on the basis of the load growth forecast.

5.4 Second 132kV circuit to Melbourn Grid

There are plans for a second 132kV circuit to Melbourn Grid off the Pelham-Wymondley 132kV OHL but recent network studies indicated that there is no requirement for this in the immediate future (ED1) therefore the business plan for the Pelham/Wymondley network considers only the single connection to Melbourn. With the ever increasing number of generation applications in the southwest of Cambridge and the existing fault level constraints at Burwell and predicted constraint at Fulbourn, connection of generation to Melbourn is being considered as alternative.

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	National Grid: Bramford to Twinstead Tee Connection Project http://www.nationalgrid.com/uk/electricity/MajorProjects/BramfordTwinstead

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.

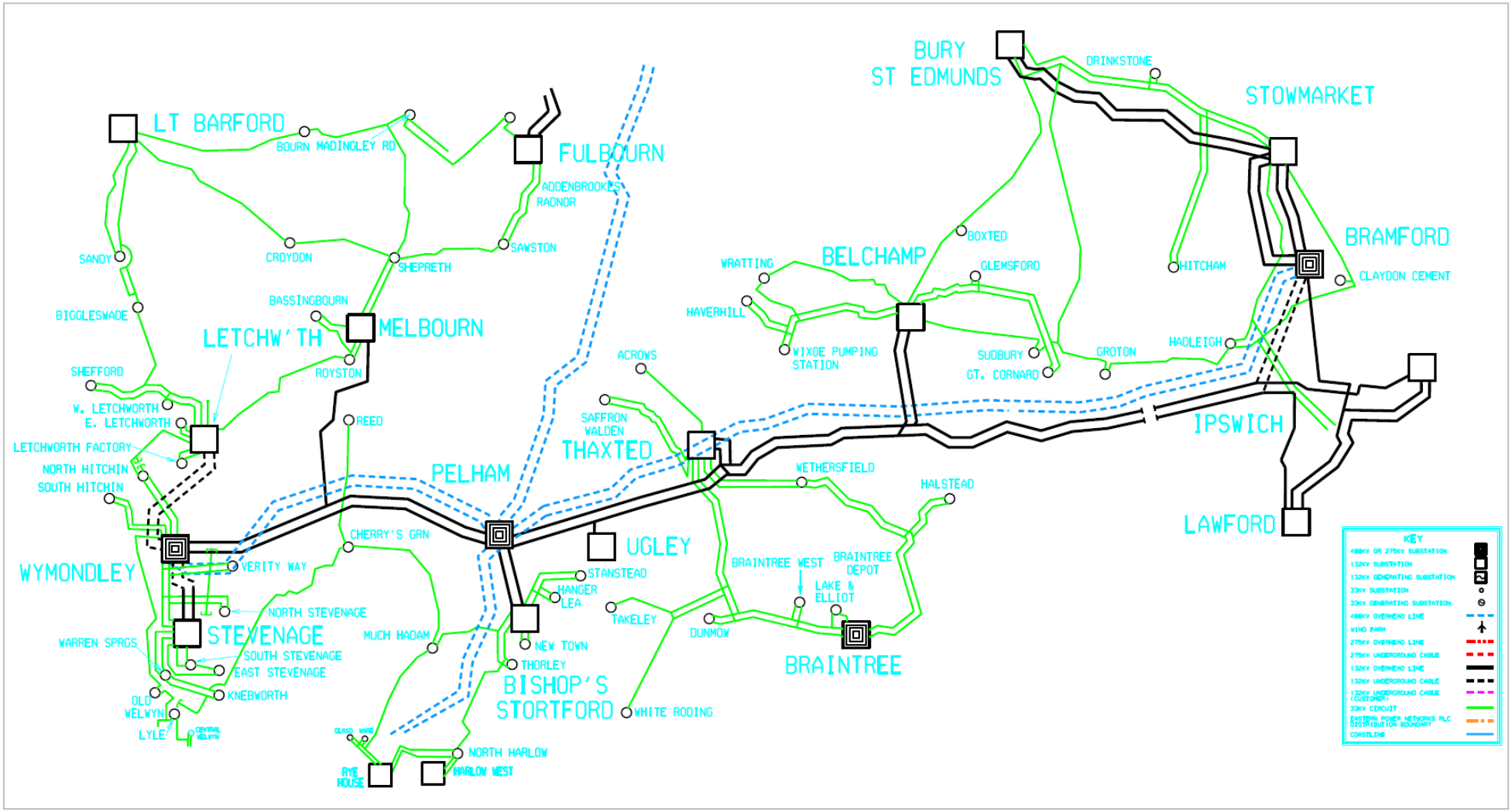
Recommended by:

Name	Role	Signature	Date
Jim Whiteley	Infrastructure Planner		19/03/14
Howard Green	Infrastructure Planner		
Nuno Da Fonseca	Infrastructure Planning Manager (EPN)		

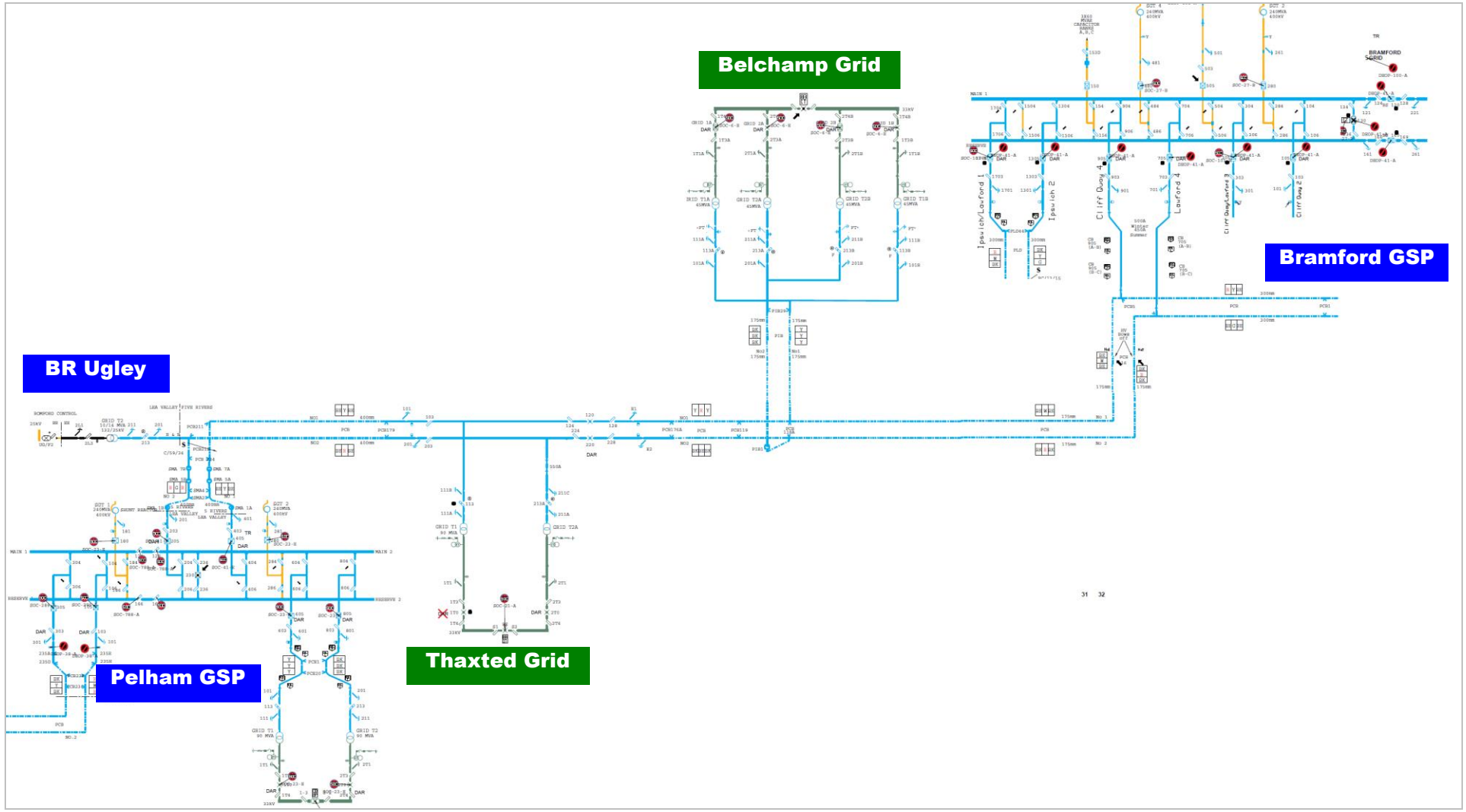
Approval by:

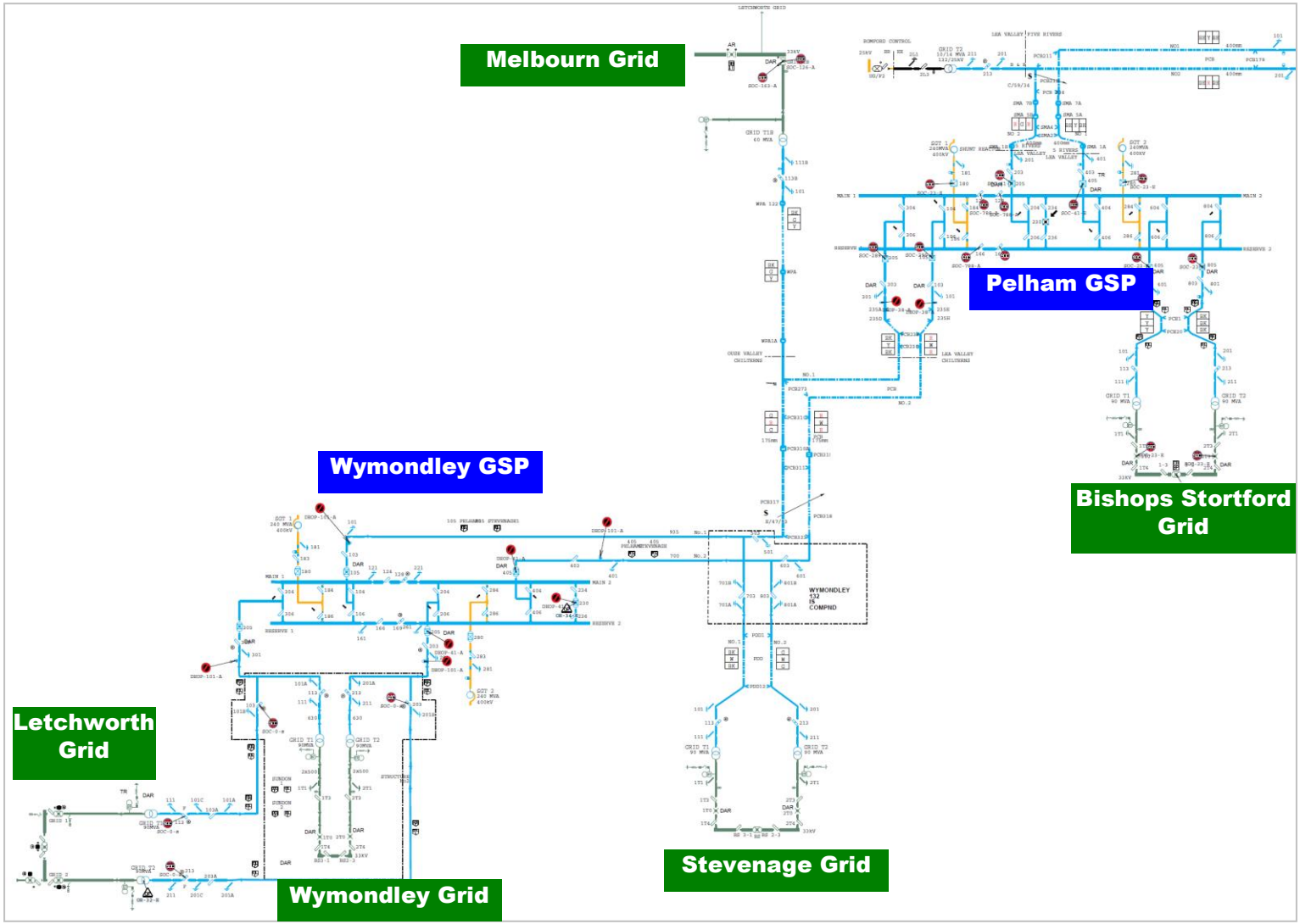
Name	Role	Signature	Date
Robert Kemp	Head of Asset Management		20/03/14
Barry Hatton	Director of Asset Management		

APPENDIX A: GEOGRAPHICAL DIAGRAM

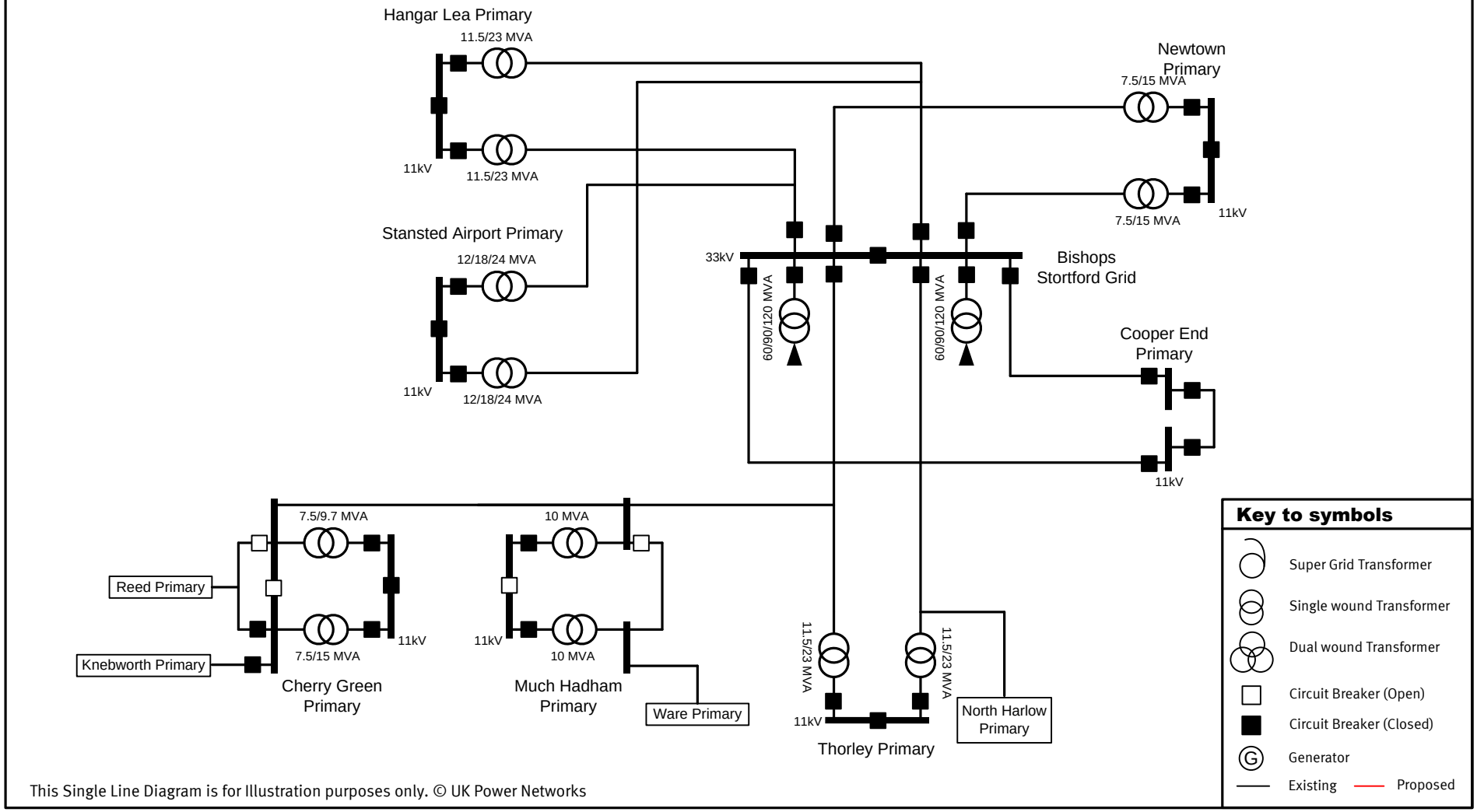


APPENDIX B: SINGLE LINE DIAGRAM – EXISTING NETWORK

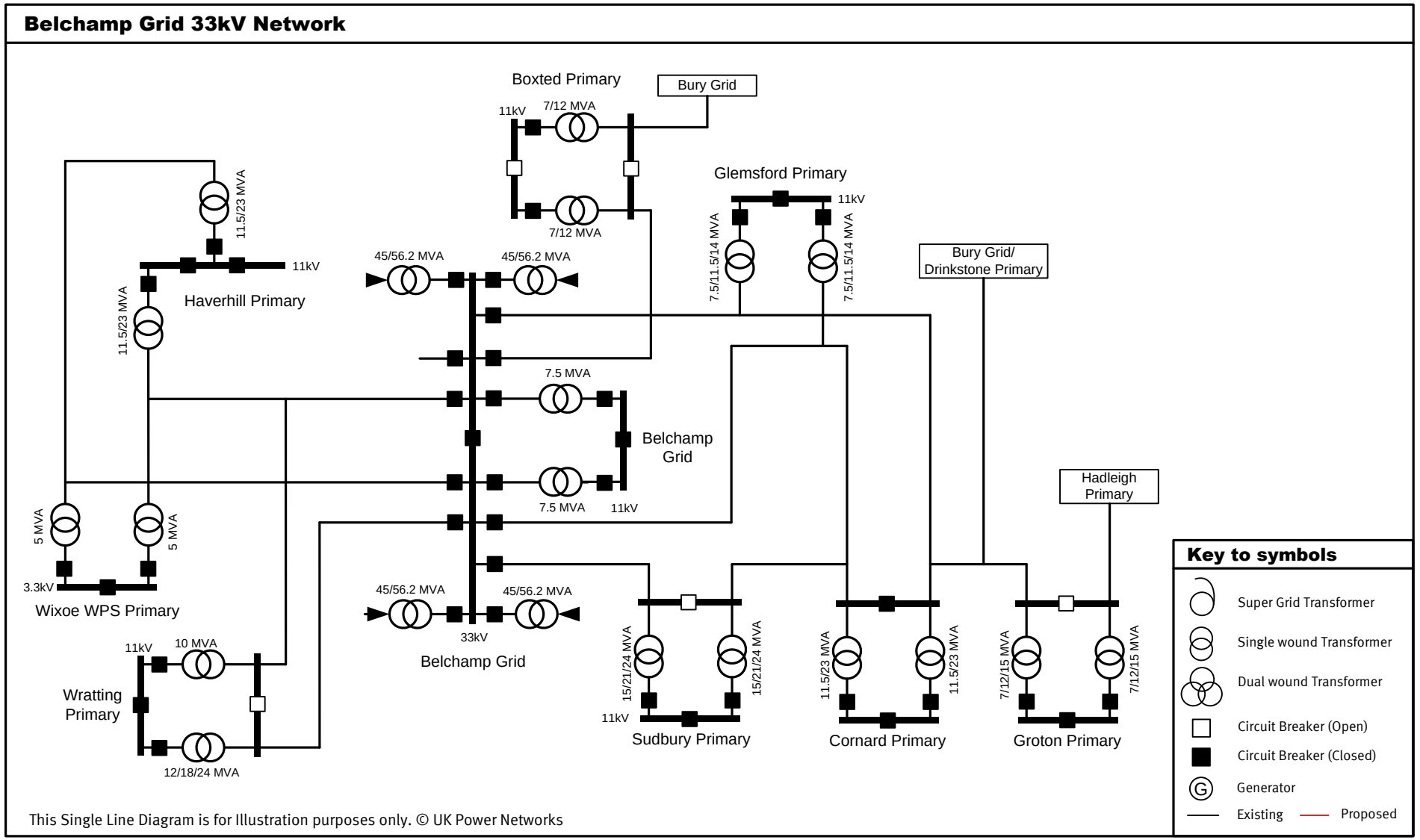



Melbourn Grid
Pelham GSP
Wymondley GSP
Bishops Stortford Grid
Letchworth Grid
Stevenage Grid
Wymondley Grid

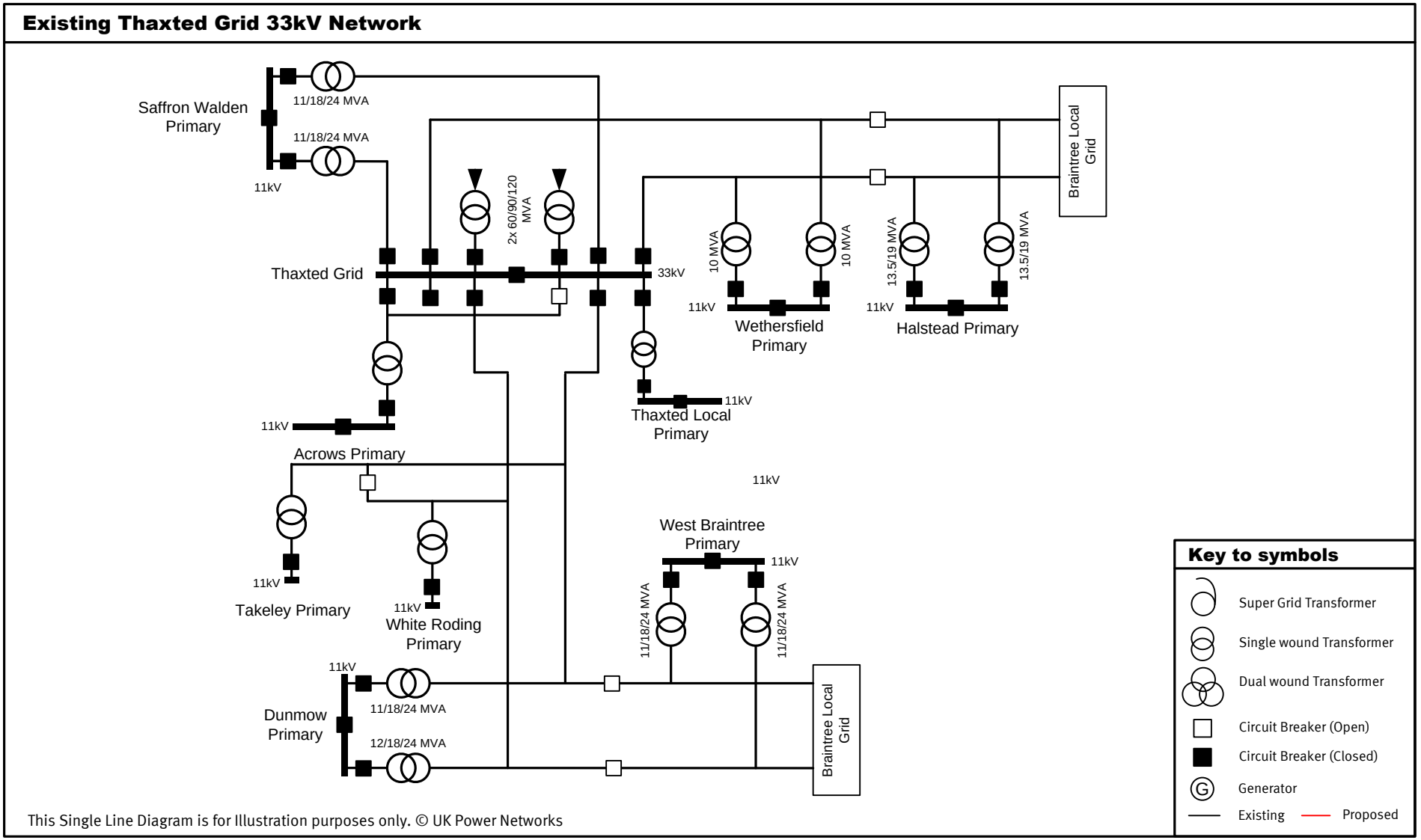
Bishops Stortford 33kV Network



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


Belchamp Grid 33kV Network
Boxted Primary
Bury Grid
11kV
7/12 MVA
7/12 MVA
Glemsford Primary
11kV
7.5/11.5/14 MVA
7.5/11.5/14 MVA
Bury Grid/
Drinkstone Primary
11.5/23 MVA
11kV
Haverhill Primary
11.5/23 MVA
45/56.2 MVA
45/56.2 MVA
7.5 MVA
Belchamp
Grid
7.5 MVA
11kV
Hadleigh
Primary
5 MVA
5 MVA
3.3kV
Wixoe WPS Primary
45/56.2 MVA
45/56.2 MVA
33kV
Belchamp Grid
11kV
10 MVA
Wratting
Primary
12/18/24 MVA
15/21/24 MVA
15/21/24 MVA
11kV
Sudbury Primary
11.5/23 MVA
11.5/23 MVA
Cornard Primary
7/12/15 MVA
7/12/15 MVA
Groton Primary
Key to symbols
Super Grid Transformer
Single wound Transformer
Dual wound Transformer
Circuit Breaker (Open)
Circuit Breaker (Closed)
G
Generator
Existing
Proposed
This Single Line Diagram is for Illustration purposes only. © UK Power Networks

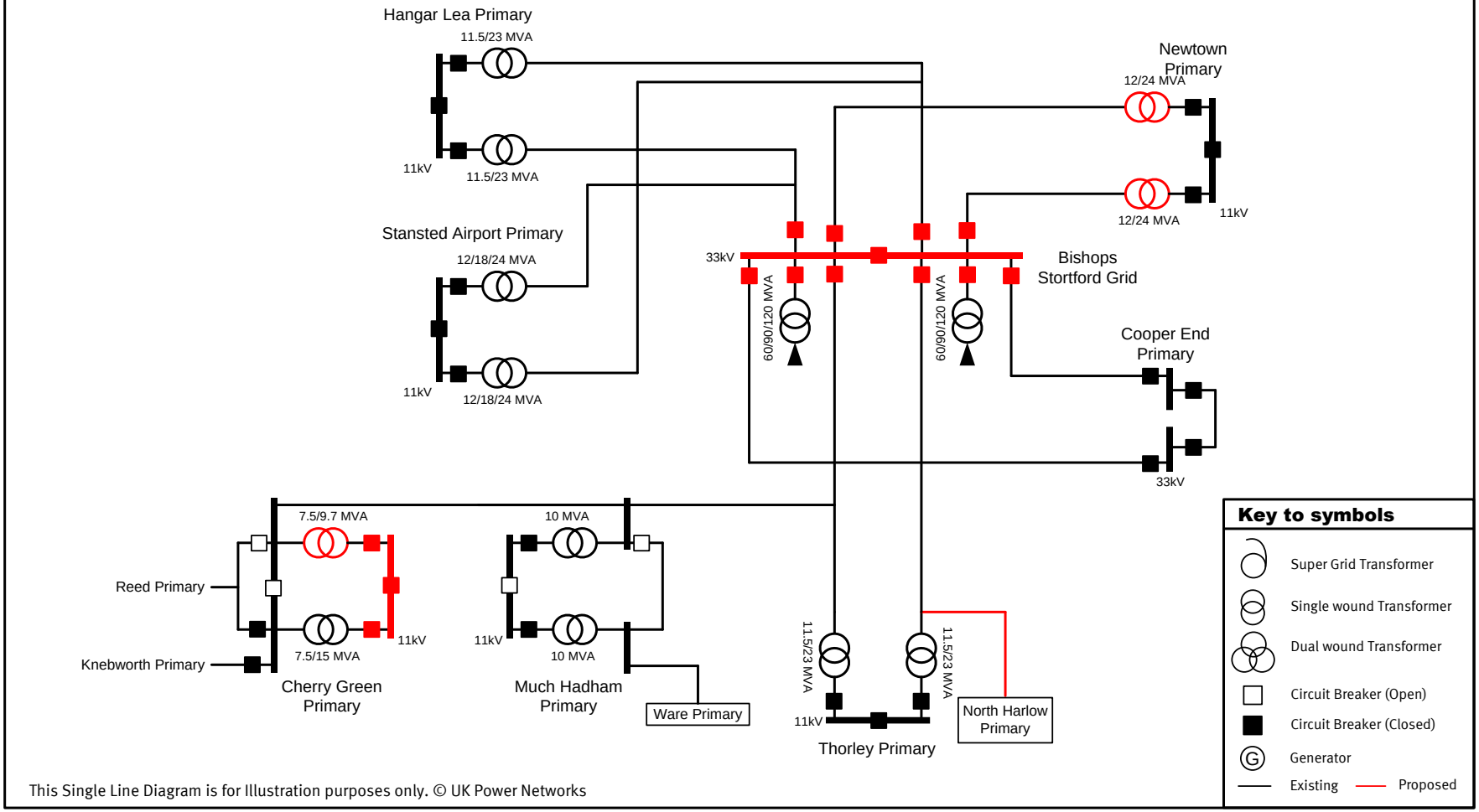
Existing Thaxted Grid 33kV Network



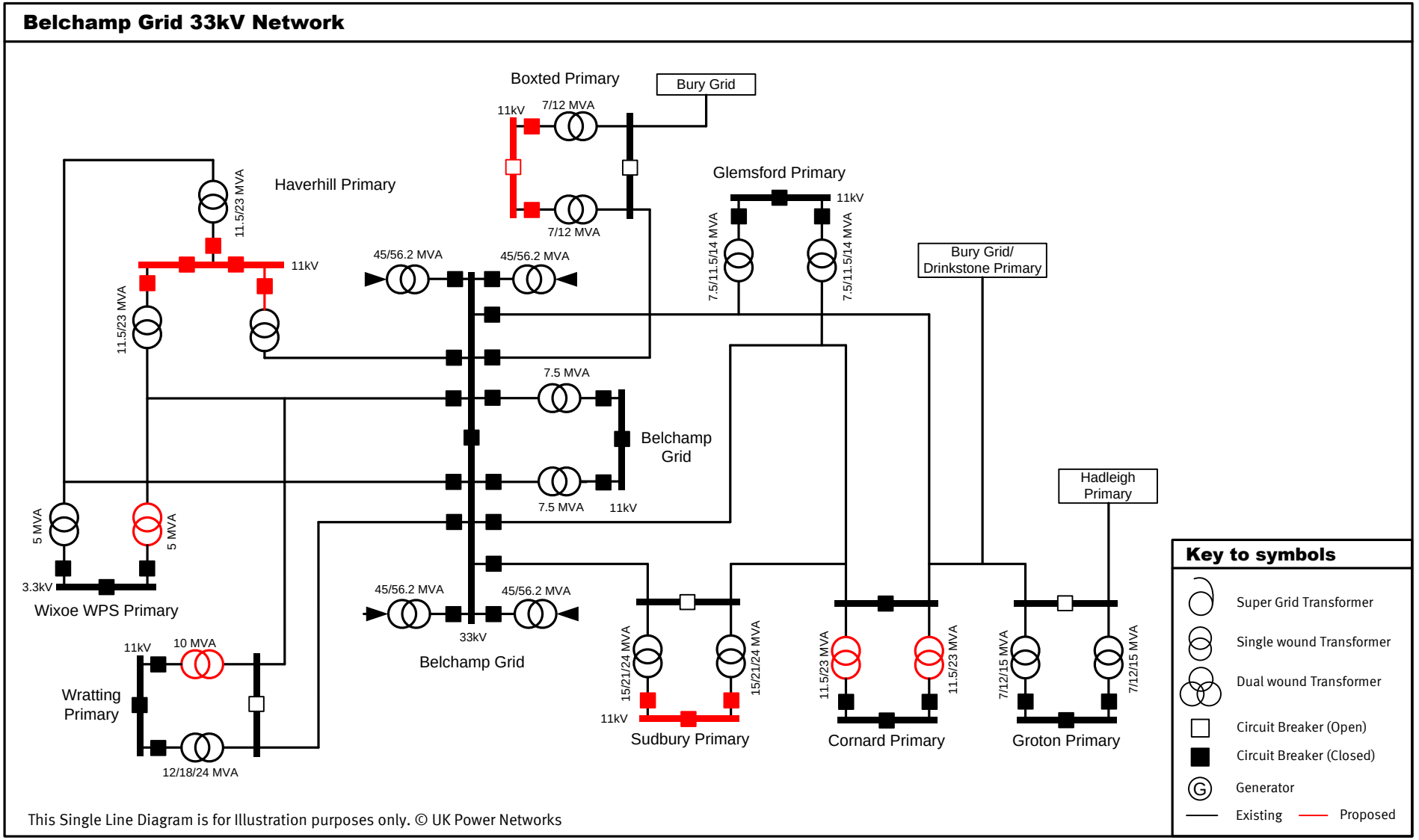
This Single Line Diagram is for Illustration purposes only. © UK Power Networks

APPENDIX C: SINGLE LINE DIAGRAM – RECOMMENDED STRATEGY

Proposed Bishops Stortford 33kV Network

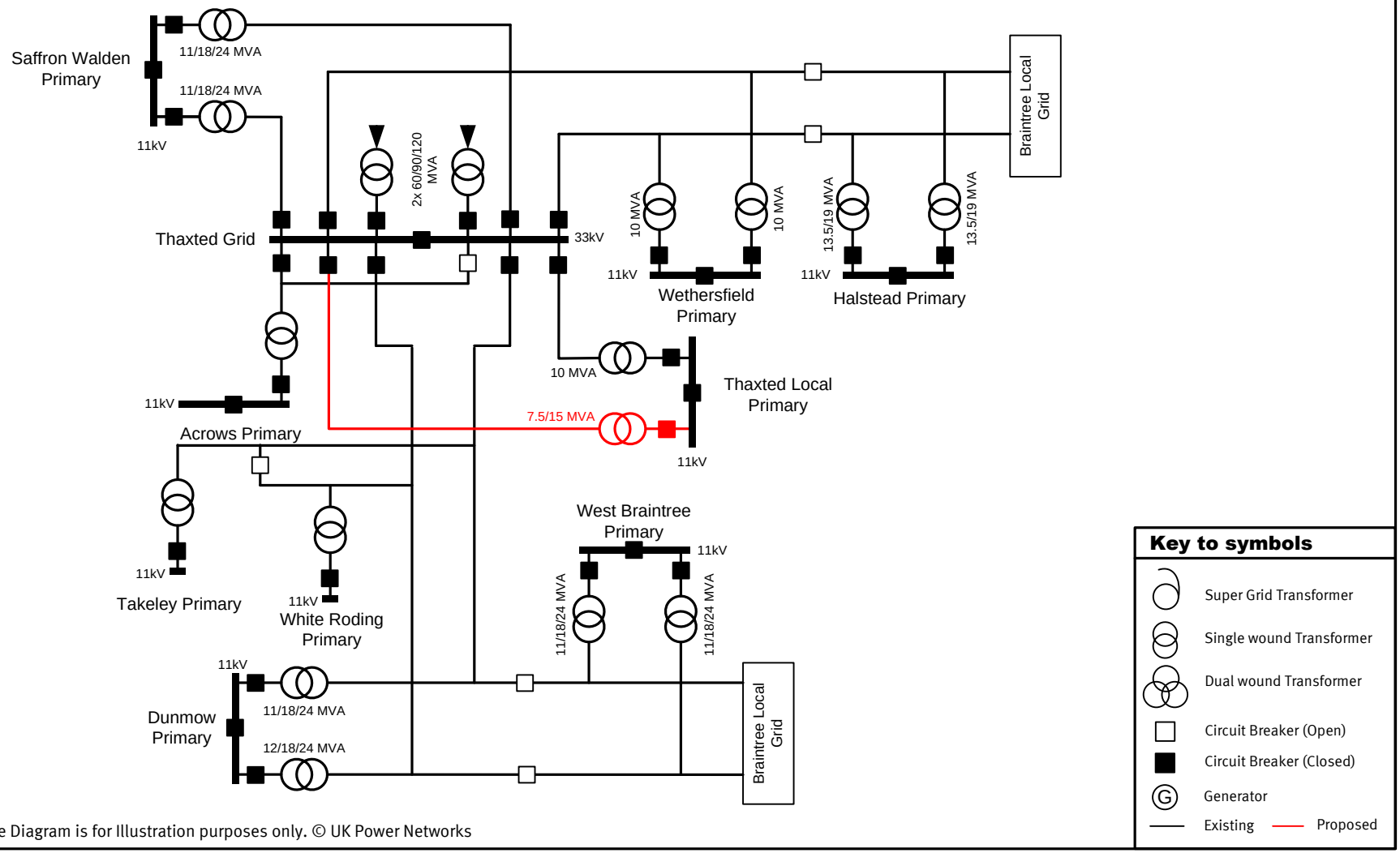


This Single Line Diagram is for Illustration purposes only. © UK Power Networks


Belchamp Grid 33kV Network
Boxted Primary
Bury Grid
11kV
7/12 MVA
7/12 MVA
Haverhill Primary
11.5/23 MVA
11kV
11.5/23 MVA
45/56.2 MVA
45/56.2 MVA
Glemsford Primary
11kV
7.5/11.5/14 MVA
7.5/11.5/14 MVA
Bury Grid/
Drinkstone Primary
7.5 MVA
Belchamp
Grid
7.5 MVA
11kV
Hadleigh
Primary
5 MVA
5 MVA
3.3kV
Wixoe WPS Primary
45/56.2 MVA
45/56.2 MVA
33kV
Belchamp Grid
11kV
10 MVA
Wratting
Primary
12/18/24 MVA
15/21/24 MVA
15/21/24 MVA
11kV
Sudbury Primary
11.5/23 MVA
11.5/23 MVA
Cornard Primary
7/12/15 MVA
7/12/15 MVA
Groton Primary
Key to symbols
Super Grid Transformer
Single wound Transformer
Dual wound Transformer
Circuit Breaker (Open)
Circuit Breaker (Closed)
G
Generator
Existing
Proposed
This Single Line Diagram is for Illustration purposes only. © UK Power Networks

Pelham & Wymondley Group (EPN)

Proposed Thaxted Grid 33kV Network



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

Pelham & Wymondley Group (EPN)

APPENDIX D: DETAILED COSTS FOR RECOMMENDED STRATEGY

NAMP version: Table J Less Ind Baseline 19th February 2014

Cat	Namp Line	Project ID	Description	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
A	1.02.03	7536	PDD - Wymondley/Stevenage - Conductor Replacement									108,176	324,528
A	1.02.03	7543	PCE - Pelham - Bishops Stortford - Conductor Replacement								169,991	509,973	
A	1.02.03	7550	WPA - Melbourn Grid - Conductor Replacement						15,454	46,361			
A	1.02.03	7555	SMA - Pelham Grid - Thaxted - Conductor Replacement				15,453	46,360					
A	1.02.90	4008	Pelham/Wymondley 132kV Tower Line (PCB) Circuits - Reinforce 132kV Circuits (2 x 300UPAS) (N-2)	248,522	532,547	17,752							
A	1.09.01	7571	Letchworth Grid/North Hitchin 33kV OHL Circuit - 33kV Wood Pole OHL Replacement									24,415	94,910
A	1.09.01	7580	3J05B - Wymondley Grid/North Hitchin - 33kV Wood Pole OHL Replacement							125,771			
A	1.09.01	7581	3F41G - Bishops Stortford Grid/Thorley Much Hadham - 33kV Wood Pole OHL Replacement						244,453	135,686			
A	1.09.01	7585	3F41C - Bishops Stortford Grid (Thorley)/North Harlow - 33kV Wood Pole OHL Replacement					187,138	441,653				
A	1.48.01	7664	Letchworth 132/33kV Grid Substation - Removal of 132kV Redundant Plant	25,209									
A	1.48.02	7612	Knebworth 33/11kV Primary Substation - Replace 33kV Switchgear					105,017					
A	1.48.06	2152	Pelham 132kV Grid Supply Point - Replace 132kV Switchgear				1,476,989	2,535,569	2,609,347	1,267,145			
A	1.48.08	2151	Thaxted 132/33kV Grid Substation - Replace 132kV CBs (1200A)	431,829									
A	1.48.11	7610	Stevenage 132/33kV Grid Substation - Replace 33kV Switchgear								331,992	845,789	263,472
A	1.48.11	7618	Bishops Stortford 132/33kV Grid Substation - Replace 33kV Switchgear								324,573	823,079	226,198
A	1.50.01	5643	Royston 33/11kV Primary Substation - Replace 11kV The Hollies Tee / The Ridings CB	27,650									
A	1.50.01	7630	Bassingbourn 33/11kV Primary Substation - Replace 11kV Switchgear							234,119	539,771		
A	1.50.01	7632	Boxted 33/11kV Primary Substation - Replace 11kV Switchgear							234,085	539,054		
A	1.50.01	7638	Cherry Green 33/11kV Primary Substation - Replace 11kV Switchgear									232,605	509,141
A	1.50.01	7663	Shefford 33/11kV Primary Substation - Replace 11kV Switchgear										196,093
A	1.50.01	7683	East Stevenage 33/11kV Primary Substation - Replace 11kV Switchgear										253,523
A	1.50.01	7707	Sudbury 33/11kV Primary Substation - Replace 11kV Switchgear			252,267	653,264						

Pelham & Wymondley Group (EPN)

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	1.51.03	7758	Haverhill 33/11kV Primary Substation - Replace Primary Transformers (T1, T2)				457,505	868,899					
A	1.51.03	7767	Reed 33/11kV Primary Substation - Replace Primary Transformers (T1)			174,619	396,583						
A	1.51.03	7775	White Roding 33/11kV Primary Substation - Replace Primary Transformers (T2)			174,619	396,583						
A	1.51.03	7776	Wratting 33/11kV Primary Substation - Replace Primary Transformers (T1)							174,618	396,582		
A	1.51.11	7726	Cornard 33/11kV Primary Substation - Refurbish Primary Transformers (T1, T2)							51,020	250,814		
A	1.51.11	7741	Wixoe WPS 33/3.3kV Primary Substation - Refurbish Primary Transformers (T2)		25,510	125,407							
A	1.51.11	7742	Wratting 33/11kV Primary Substation - Refurbish Primary Transformers (T2)							25,510	125,407		
A	1.55.02	8431	Pelham 132kV GSP - BTH 132kV VT Replacement	104,591									
H	1.29.02	7598	Wymondley Local / Letchworth Grid 132kV Fluid Filled Cables - 132kV FFC Replacement								943,740	3,774,959	2,831,220
R	1.11.14	8381	Fairview Royston Plot B 33kV Diversion	126,750									
R	1.33.01	2134	Takeley 33/11kV Primary S/S Replace 11kV Switchboard (2000A) and 1x 33/11kV STF 7/15MVA	1,496,574	183,802								
R	1.33.01	2138	Haverhill 33/11kV Primary Substation - ITC (3rd 11/18/23MVA) & 11kV Switchboard	308,092	800,608								
R	1.33.01	2497	Newtown 33/11kV Primary Substation - ITC (2 x 11/18MVA)	294,021	740,139								
R	1.33.01	4291	Reed 33/11kV Primary Substation - ITC (1 x 7.5/15MVA & 1 x 11/18/24MVA)								512,302	1,862,915	395,629
R	1.33.01	4306	South Stevenage 33/11kV Primary Substation - ITC (3rd 18/30/40MVA), Extend 11kV Switchboard and New 33kV Circuit			393,594	1,487,804	1,186,138					
R	1.33.01	4406	East Letchworth 33/11kV Primary Substation - ITC (2 x 18/30/40MVA) & Switchboard (2000A)		143,070	960,474	619,542						
R	1.33.01	5729	Thaxted Local Primary 11kV Reinforcment			42,916	1,054,895						
R	1.33.06	5873	Cherry Green 33/11kV Primary Substation - Enhanced Cooling & TC Replacement	70,000									
R	1.34.02	4398	Proposed Belchamp/Sudbury 11kV Modifications							10,737	161,056	386,534	
R	1.36.03	2141	Belchamp 132/33kV Grid Substation - Replace 33kV Switchboard (Fault Level)							258,027	1,539,720		
R	1.37.07	4289	Wymondley Grid/Verity Way Teed 33kV Circuits - Install 2 x Cable Circuits (770A)	1,721,542									

Pelham & Wymondley Group (EPN)

APPENDIX E: OUTPUT MEASURES - LOAD INDICES (LI)

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

Substation	Season	First Limitation	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
Acrows	W	Backfeed	7.6		7.6	6.5	7.1	LI2	LI2		7.6	LI2	B	Yes
Bassingbourn	W	Transformer	15.0		15.0	8.5	9.1	LI1	LI1		15.0	LI1	B	Yes
Belchamp Grid	W	Transformer	10.0		10.0	5.5	6.2	LI1	LI1		10.0	LI1	B	Yes
Belchamp Grid 33	W	Circuit Rating	117.0		117.0	80.7	86.5	LI1	LI1		117.0	LI1	D	Yes
Bishops Stortford Grid 33	W	Transformer	108.0		108.0	69.6	75.2	LI1	LI1		108.0	LI1	D	Yes
Cherry Green Total	W	Transformer	9.8	5873	15.0	10.2	11.1	LI1	LI1		15.0	LI1	B	Yes
Cornard	W	Switchgear	22.8		22.8	11.2	12.0	LI1	LI1		22.8	LI1	C	Yes
Dunmow	W	Switchgear	23.9		23.8	13.9	16.2	LI1	LI1		23.8	LI1	C	Yes
East Letchworth	W	Transformer	23.0		23.0	22.9	24.3	LI3	LI5	3508	28.0	LI2	C	Yes
East Stevenage	W	Circuit Rating	22.6		22.6	16.3	18.1	LI1	LI1		22.6	LI1	C	Yes
Glemsford	W	Transformer	14.0		14.0	9.3	10.1	LI1	LI1		14.0	LI1	B	Yes
Groton total	W	Transformer	15.0		15.0	7.8	8.5	LI1	LI1		15.0	LI1	B	Yes
Hanger Lea	W	Transformer	23.0		23.0	16.0	17.5	LI1	LI1		23.0	LI1	C	Yes
Haverhill	S	Transformer	17.3	2138	34.5	18.9	20.2	LI1	LI1		34.5	LI1	C	Yes
Knebworth	W	Transformer	13.0		13.0	10.9	12.0	LI2	LI2		13.0	LI2	B	Yes
Letchworth Factory	W	Circuit Rating	22.8		22.8	16.6	17.9	LI1	LI1		22.8	LI1	C	Yes
Letchworth Grid 33	W	Transformer	108.0		108.0	79.7	86.3	LI1	LI1		108.0	LI1	D	Yes
Melbourn Grid 33	W	Backfeed	60.5		60.5	30.3	33.0	LI1	LI1		60.5	LI1	C	Yes
Melbourn Primary	W	Backfeed	6.6		6.6	5.0	5.4	LI1	LI2		6.6	LI1	B	Yes
Newtown	W	Transformer	15.0	2497	24.0	14.5	15.1	LI1	LI1		24.0	LI1	C	Yes
North Hitchin	W	Circuit Rating	19.2		19.2	17.1	18.8	LI2	LI3		19.2	LI3	C	Yes
North Stevenage	W	Switchgear	22.9		22.8	15.5	16.8	LI1	LI1		22.8	LI1	C	Yes
Reed	W	Backfeed	6.0		6.0	5.5	6.1	LI2	LI5	4187	6.0	LI5	B	Yes
Royston total	W	Transformer	46.0		46.0	19.2	20.9	LI1	LI1		46.0	LI1	C	Yes

Pelham & Wymondley Group (EPN)

OUTPUT MEASURES - LOAD INDICES (LI)

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

				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
Saffron Walden	W	Circuit Rating	22.3		22.3	16.4	18.7	LI1	LI2		22.3	LI2	C	Yes
Shefford	W	Switchgear	22.8		22.8	11.6	12.8	LI1	LI1		22.8	LI1	C	Yes
Shepreth	W	Transformer	20.0		20.0	11.3	12.5	LI1	LI1		20.0	LI1	C	Yes
South Hitchin	W	Transformer	19.5		19.5	12.7	13.9	LI1	LI1		19.5	LI1	C	Yes
South Stevenage	S	Transformer	18.0		18.0	19.7	20.4	LI5	LI5	6667	36.0	LI1	C	Yes
Stansted Airport	W	Transformer	24.0		24.0	10.7	11.0	LI1	LI1		24.0	LI1	B	Yes
Stevenage Grid 33	S	Transformer	90.0		90.0	61.8	65.4	LI1	LI1		90.0	LI1	D	Yes
Stevenage Primary	S	Transformer	17.3		17.3	10.1	10.9	LI1	LI1		17.3	LI1	B	Yes
Sudbury	W	Aux equipment	19.1		19.1	16.6	17.6	LI2	LI2	8322	19.1	LI2	C	Yes
Takeley	W	Backfeed	3.7	2134	10.0	5.7	6.4	LI1	LI1		10.0	LI1	B	Yes
Thaxted Grid 33	W	Switchgear	114.3		114.3	61.1	68.5	LI1	LI1		114.3	LI1	D	Yes
Thaxted Local	W	Backfeed	5.9		5.9	5.4	6.1	LI2	LI4	7418	10.0	LI1	B	Yes
Thorley	W	Switchgear	22.8		22.8	16.1	17.7	LI1	LI1		22.8	LI1	C	Yes
Verity Way	W	Transformer	24.0		24.0	17.4	18.6	LI1	LI1		24.0	LI1	C	Yes
Warren Springs	S	Transformer	18.0		18.0	13.0	13.2	LI1	LI1		18.0	LI1	C	Yes
West Letchworth	W	Switchgear	22.8		22.8	9.2	10.6	LI1	LI1		22.8	LI1	B	Yes
Wethersfield	W	Transformer	13.0		13.0	8.8	9.2	LI1	LI1		13.0	LI1	B	Yes
White Roding	W	Backfeed	7.0		7.0	5.7	6.4	LI2	LI2		7.0	LI2	B	Yes
Wratting	S	Transformer	10.0		10.0	6.6	7.0	LI1	LI1		10.0	LI1	B	Yes
Wymondley Grid 33	W	Switchgear	114.3		114.3	64.6	70.2	LI1	LI1		114.3	LI1	D	Yes

APPENDIX F: OUTPUT MEASURES - HEALTH INDICES (HI)

	132kV Switchgear														
	ED1 Start (2015)					ED1 End (2023) No Investment					End of ED1 (2023) With Investment				
Substation	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
PELHAM GRID				1	6					7	7				
THAXTED GRID	2					2					2				
WYMONDLEY MAIN	1	2	2				1	2	2			1	2	2	
TOTAL	**3**	**2**	**2**	**1**	**6**	**2**	**1**	**2**	**2**	**7**	**9**	**1**	**2**	**2**	

	33kV Switchgear														
	ED1 Start (2015)					ED1 End (2023) No Investment					End of ED1 (2023) With Investment				
Substation	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
BELCHAMP GRID		2	11	1			2			12	12	2			
BISHOPS STORTFORD GRID	2	1	2	5	1		3			8	11				
BOXTED PRIMARY															
CHERRY GRN PRIMARY		1		1				1		1			1		1
COOPERS END PRIMARY	2					2									
DUNMOW PRIMARY	2					2					2				
GROTON PRIMARY		2					2				2	2			
KNEBWORTH PRIMARY				1						1	1				
LETCHWORTH GRID	15					15					15				
MELBOURN GRID			9						8	1				8	1
ROYSTON PRIMARY			2					1	1				1	1	
SHEPRETH PRIMARY	11					10	1				10	1			
STEVENAGE GRID	2	1	1	7	1	2	1			9	12				
SUDBURY PRIMARY		1					1					1			
TAKELEY PRIMARY											1				
THAXTED GRID	13					13					13				
VERITY WAY PRIMARY	2						2					2			
WYMONDLEY GRID	10					10					10				
TOTAL	**60**	**8**	**25**	**15**	**2**	**55**	**12**	**2**	**9**	**32**	**89**	**9**	**2**	**9**	**2**

OUTPUT MEASURES - HEALTH INDICES (HI)

	11/6.6kV Switchgear														
	ED1 Start (2015)					ED1 End (2023) No Investment					End of ED1 (2023) With Investment				
Substation	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
ACROWS PRIMARY		6					1	5				1	5		
BASSINGBOURN PRIMARY			8						3	5	8				
BELCHAMP GRID		7						7					7		
BOXTED PRIMARY		6	1					7			7				
CHERRY GRN PRIMARY		1	6						7		7				
CORNARD PRIMARY		3	7					9	1				9	1	
DUNMOW PRIMARY	12					12					12				
EAST LETCHWORTH PRIMARY		6	8				1	12	1		14				
EAST STEVENAGE PRIMARY		10	3				10	2	1		13				
GLEMSFORD PRIMARY		9	2				2	9				2	9		
GROTON PRIMARY		7					5	2				5	2		
HANGER LEA PRIMARY		4	5				3	6				3	6		
HAVERHILL PRIMARY	17						17				17				
KNEBWORTH PRIMARY		8						8					8		
LETCHWORTH FACTORY	14					14					14				
MELBOURN PRIMARY		3					3					3			
NEWTOWN PRIMARY		12					12					12			
NORTH HITCHIN PRIMARY			16					13	2	1			13	2	1
NORTH STEVENAGE PRIMARY		9					9					9			
REED PRIMARY		4					1	3				1	3		
ROYSTON PRIMARY	3	13				2	11	3			3	11	2		
SAFFRON WALDEN PRIMARY		14					14					14			
SHEFFORD PRIMARY		3	3					3	2	1			3	2	1
SHEPRETH PRIMARY	14					14					14				
SOUTH HITCHIN PRIMARY		9					1	8				1	8		
SOUTH STEVENAGE PRIMARY	3	8					11				5	11			
STANSTED AIRPORT MAIN PR		4						3	1				3	1	
STEVENAGE PRIMARY		11					4	7				4	7		
SUDBURY PRIMARY		3	5	4			1	2	3	6	12				
TAKELEY PRIMARY		1	3					4			9				
THAXTED LOCAL		2	3					5					5		
THORLEY PRIMARY		8	2					8	2				8	2	
VERITY WAY PRIMARY	12					2	10				2	10			
WARREN SPRINGS PRIMARY		11					11					11			
WEST LETCHWORTH PRIMARY		4	5				3	6				3	6		
WETHERSFIELD PRIMARY		8					8					8			
WHITE RODING PRIMARY		3	1					4					4		

	11/6.6kV Switchgear														
	ED1 Start (2015)					ED1 End (2023) No Investment					End of ED1 (2023) With Investment				
Substation	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
WIXOE PRIMARY		2						2					2		
WRATTING PRIMARY	5	3	2				6	4				6	4		
TOTAL	**80**	**201**	**85**	**4**		**44**	**145**	**144**	**24**	**13**	**137**	**112**	**112**	**8**	**2**

	Grid and Primary Transformers														
	ED1 Start (2015)					End of ED1 (2023) No Investment					End of ED1 (2023) With Investment				
Substation	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
ACROWS PRIMARY		1						1					1		
BASSINGBOURN PRIMARY		2						2					2		
BELCHAMP GRID		2	4					5	1				5	1	
BISHOPS STORTFORD GRID		2						2					2		
BR UGLEY		1					1					1			
CHERRY GRN PRIMARY		1			1		1			1		1	1		
CORNARD PRIMARY		1	1				1		1			2			
DUNMOW PRIMARY	1	1					1	1				1	1		
EAST LETCHWORTH PRIMARY		2						2			2				
EAST STEVENAGE PRIMARY		1	1					2					2		
GLEMSFORD PRIMARY		2					2					2			
GROTON PRIMARY		2					1	1				1	1		
HANGER LEA PRIMARY		2					1	1				1	1		
HAVERHILL PRIMARY				1	1					2	3				
KNEBWORTH PRIMARY		2					2					2			
LETCHWORTH FACTORY	1	1				1	1				1	1			
LETCHWORTH GRID		2					2					2			
MELBOURN GRID		1						1					1		
MELBOURN PRIMARY		1					1				1	1			
NEWTOWN PRIMARY	1	1					2				2				
NORTH HITCHIN PRIMARY		2					1	1				1	1		
NORTH STEVENAGE PRIMARY		2						2					2		
REED PRIMARY					1					1	2				
ROYSTON PRIMARY	1	2				1	1	1			1	1	1		
SAFFRON WALDEN PRIMARY	1	1					2					2			

	Grid and Primary Transformers														
	ED1 Start (2015)					End of ED1 (2023) No Investment					End of ED1 (2023) With Investment				
Substation	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
SHEFFORD PRIMARY	2						2					2			
SHEPRETH PRIMARY		2	1					3					3		
SOUTH HITCHIN PRIMARY		1	1					2					2		
SOUTH STEVENAGE PRIMARY		2					2				1	2			
STANSTED AIRPORT MAIN PR		2					2					2			
STEVENAGE GRID		2					2					2			
STEVENAGE PRIMARY		2					1	1				1	1		
SUDBURY PRIMARY		2						2					2		
TAKELEY PRIMARY			1						1		1				
THAXTED GRID	2						2					2			
THAXTED LOCAL		1					1				1	1			
THORLEY PRIMARY		2					2					2			
VERITY WAY PRIMARY	1	1					2					2			
WARREN SPRINGS PRIMARY		2					2					2			
WEST LETCHWORTH PRIMARY		2					2					2			
WETHERSFIELD PRIMARY		2					2					2			
WHITE RODING PRIMARY				1						1	1				
WIXOE PRIMARY		1			1			1		1			2		
WRATTING PRIMARY			1	1					1	1		1	1		
WYMONDLEY GRID	2					2					2				
TOTAL	**12**	**61**	**10**	**3**	**4**	**4**	**44**	**31**	**4**	**7**	**18**	**44**	**32**	**1**	**0**

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.