



Regional Development Plan

RDP05 Burwell GSP (EPN)

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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.

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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 Burwell Grid Supply Point (GSP), a 400/132kV National Grid substation located on the eastern edge of Cambridgeshire and contains 3 x 240MVA supergrid transformers (SGTs). The UKPN owned Burwell Main Grid is the 132kV switching point within the GSP group. Burwell GSP supplies 132/33kV and 132/11kV Grid substations located on the northern and eastern periphery of Cambridge, which in turn supply 33/11kV Primary substations throughout the city of Cambridge and across Cambridgeshire.

Cambridge is a growing city both in terms of residential, industrial and commercial growth with significant developments planned to be phased across the ED1 period and beyond.

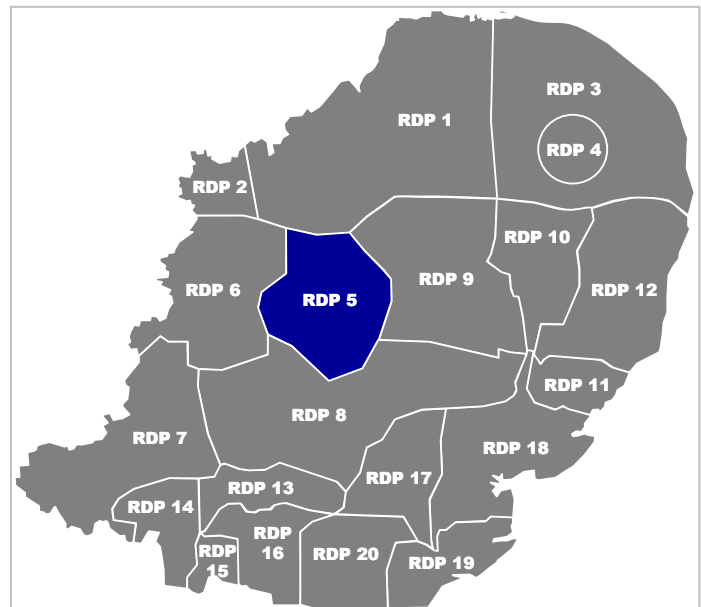


Figure 1 – Area covered by the RDP

There is a 38MW straw burning generator and 30MW wind farm, both connected at 33kV within the network covered by this RDP. The Cambridgeshire countryside has potential to accommodate renewable generation in the form of both photovoltaic and wind; applications have been quoted for generation schemes ranging from 5 – 30MW.

1.1 Summary of issues addressed

This RDP is primarily focused on 132kV reinforcement projects around Cambridge to ensure that network security at 132/33kV Grid and GSP level is maintained and ensures the planned future load growth can be connected to the network without compromising network security.

The investment in 132kV infrastructure and additional SGT capacity to be installed at Eaton Socon GSP benefits Burwell GSP through the transfer of load and the deferral of reinforcement (4th SGT) to maintain compliance with security of supply standards.

1.2 Recommended Strategy

From a load perspective the majority of the RDP expenditure is focussed around the reinforcement of 132kV circuits around the north of Cambridge and establishment of a 132kV switching station to increase the n-1 and n-2 group security and provide 132kV circuit capacity to establish an additional 132/33kV grid substation in the Horningsea area to support the existing Grid Substations sites around Cambridge.

The 132kV interaction of Burwell with Eaton Socon GSP has been considered and the required actions identified to ensure security of supply is maintained at both the GSP level and on 132kV interconnecting circuits.

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 19th February 2014 NAMP version.

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IDP	DPCR5 2013-15	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	2020 /2021	2021 /2022	2022 /2023	RIIO-ED1 Total
LRE	£2.6m	£4.5m	£2.5m	£1.5m	£0.0m	£0.1m	£2.9m	£6.1m	£4.8m	£22.4m
NLRE	£0.0m	£0.0m	£0.0m	£1.0m	£2.9m	£0.9m	£0.0m	£1.7m	£0.5m	£7.0m
TOTAL	£2.6m	£4.5m	£2.5m	£2.5m	£2.9m	£1.0m	£2.9m	£7.7m	£5.3m	£29.4m

Table 1. LRE and NLRE expenditure profile

Output Measures

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

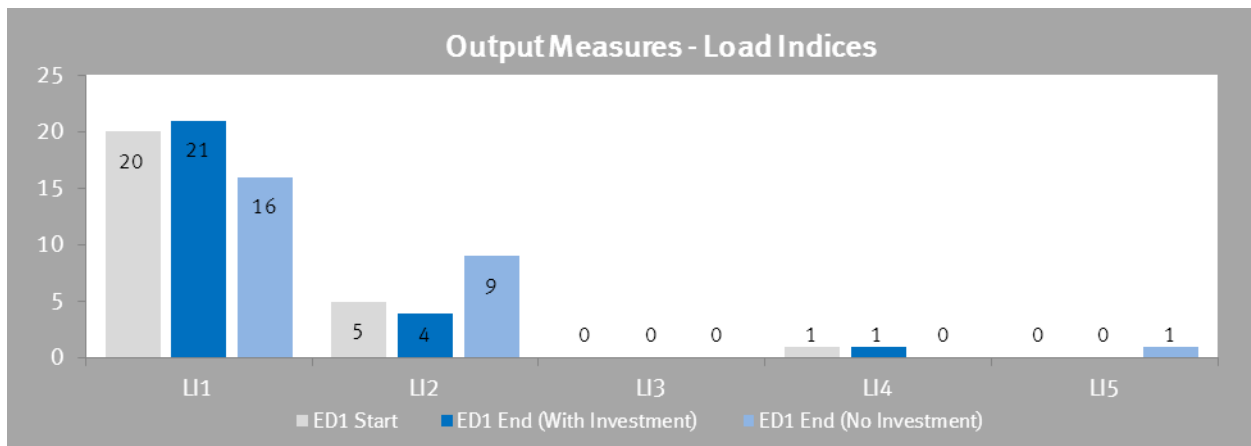
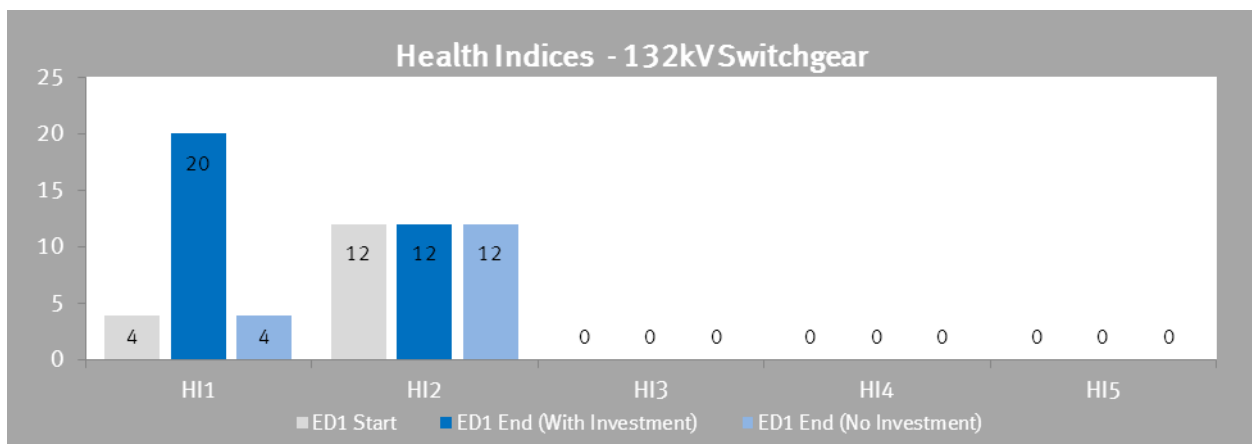


Figure 2.2022/23 Load Indices with and without interventions

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



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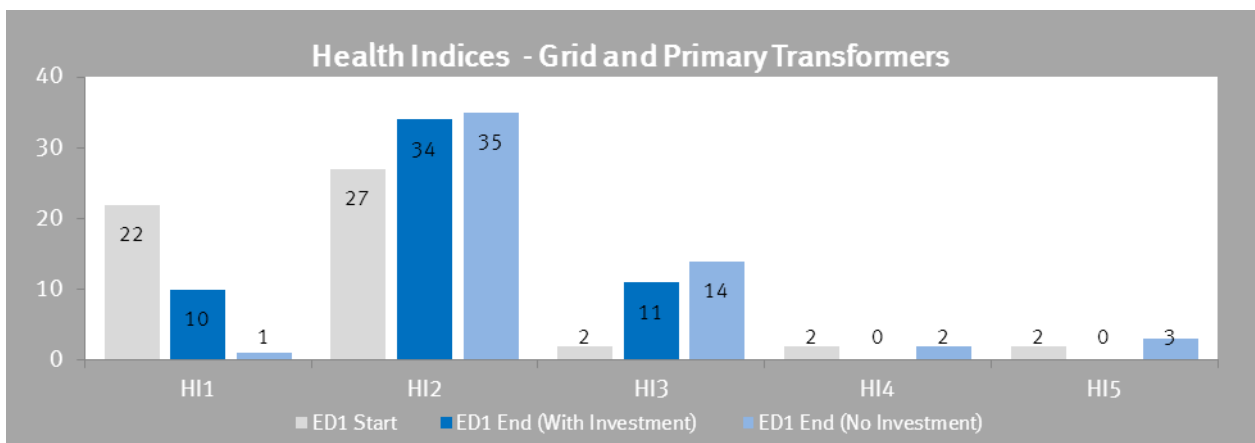
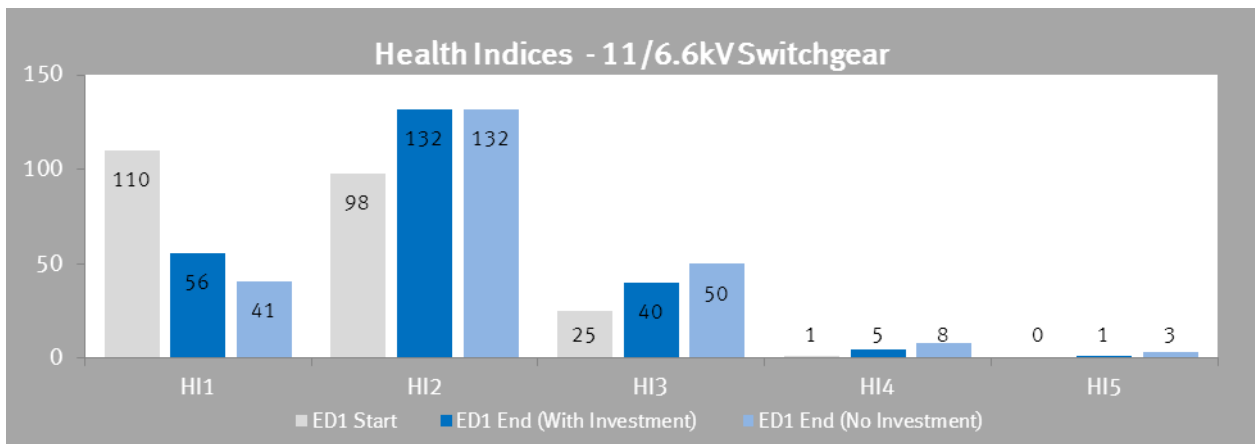
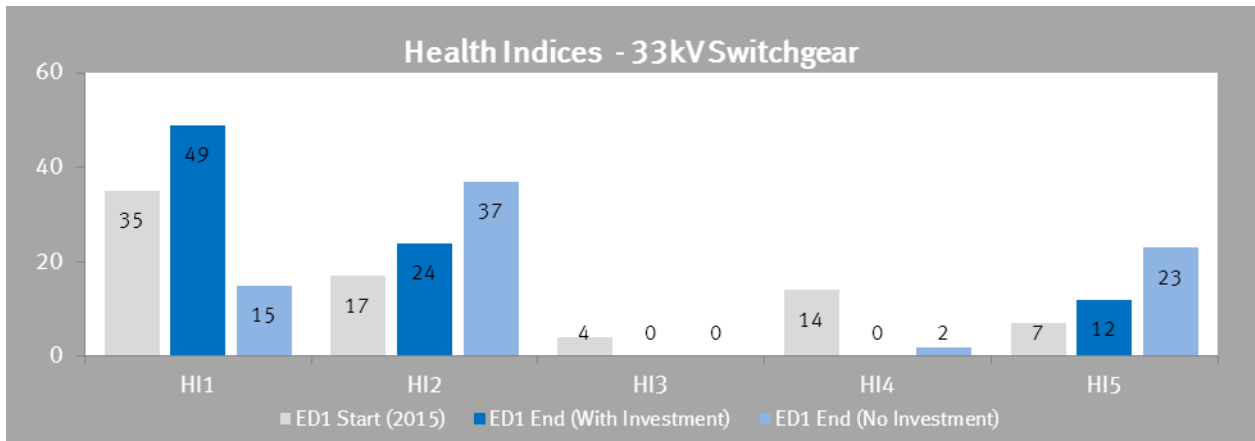


Figure 3. Health Indices by asset category

Scenarios Considered

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

RDP Dependencies and Interactions

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The planned works to establish a new 132kV switchboard and install a 3rd SGT at Eaton Socon in 2016 will defer the requirement for a 4th SGT at Burwell to outside ED1 timescales. Whilst compliance with security of supply standard ERP2/6 can be maintained, it is reliant on an intact network within the Eaton Socon group until the planned works are completed. The load related reinforcement schemes identified within this document respond to the load growth in the planning load estimates PLE and assumes that demand increase occurs at predicted rate. The outlined profile of expenditure may therefore be subject to change.

Future works to transfer load from Bramford GSP to Burwell is reliant on the construction of a 33kV switching station at Red Lodge and installation of 33kV cables from Burwell Local Grid. Further details can be found in RDP 09 - Bramford West.

2 Network configuration

2.1 Existing Network

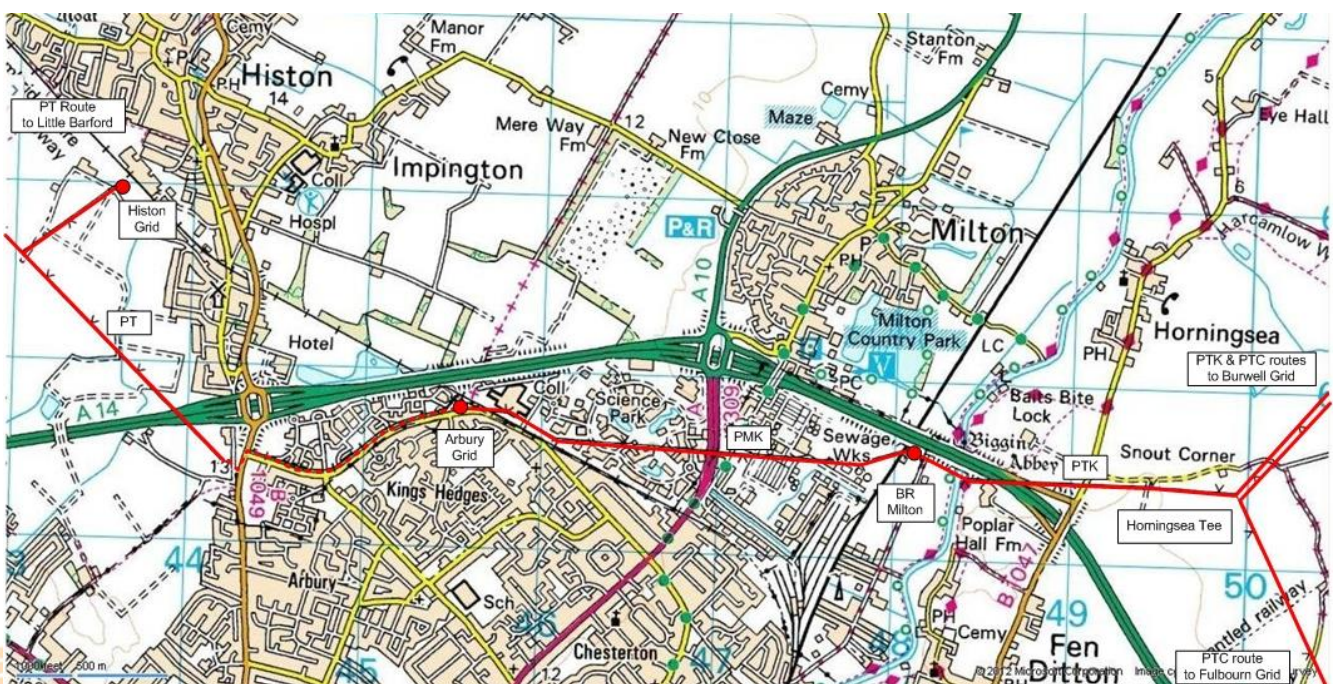
Burwell Grid Supply Point (GSP) is a 400/132kV National Grid exit point which is located on the eastern edge of Cambridgeshire and contains 3 x 240MVA supergrid transformers (SGTs). The 132kV AIS switchboard at Burwell Main 132kV is the switching point within the GSP group. The GSP supplies the Burwell Local 132/33kV Grid and remote Grid substations around Cambridge which in turn supply Primary substations across Cambridgeshire.

There are 2 x 132kV overhead line double circuits (PTC and PTK) that head south west from Burwell Main 132kV Grid for a distance of approximately 10km to Horningsea on the north east of Cambridge, both routes are constructed with 400mm² Zebra conductors to this point.

At Horningsea the PTC circuit heads south for approx 6km to Fulbourn Grid, this section is constructed with Lynx 175mm² conductors supported on traditional lattice towers. The PTK circuit crosses the northern fringe of Cambridge from Horningsea to supply BR Milton, Arbury and Histon Grids. There is approximately 4km of Lynx 175mm² overhead conductors in the PTK and PMK circuits between Horningsea and Arbury Grid of which 3 spans over the Cambridge Science Park (approx 0.6km) is supported on masts.

The PT circuit between Arbury and Histon Grid is constructed with 1.6km of 1600Al underground cable and a further 2.4km of Lynx overhead conductor. The PT overhead circuit heads west from the Girton tee for circa 27km and terminates at the Little Barford 132kV Grid site. Currently the line circuit breakers at Little Barford run open to keep Cambridge all supplied from Burwell GSP.

A map of the 132kV circuit routes across the north of Cambridge is shown below:



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Figure 4. 132kV circuits routes around the north of Cambridge.

Arbury Grid was commissioned in 2009, the 132/33kV site contains 2 x 90MVA Elektro Bau Ag transformers and the 33kV switchboard is 2000A Alstom WSA indoor SF6 switchgear. The Arbury 33/11kV transformers are Brush 18/30/40MVA units and the 11kV switchboard is Hawker Siddeley Eclipse 2000A switchgear.

Histon Grid contains 2 x 90MVA Associated Electric Industries (AEI) transformers dating from 1965. The 33kV outdoor switchboard contains English Electric OKM4 and 5 oil filled circuit breakers from the same period, 3 additional bays have been added at later dates which contain Alstom and Hawker Siddeley switchgear.

Fulbourn 132/33kV Grid contains 2 x 90MVA Brush transformers commissioned in 1969, the 33kV switchgear is predominantly Switchgear & Cowans K30 oil insulated. Additional bays with Alstom OX36 and FKI Horizon switchgear were added in recent years. In 2012 132/11kV 18/30/40MVA transformers were teed with the existing 90MVA transformers in 2012 to remove load from the 33kV busbar.

At BR Milton 132/25kV transformers rated at 10/14MVA provide supplies to Network Rail, the existing Hawker Siddeley Power and Bonar Long units were commissioned in 1991. UK Power Networks owns the 25kV tails from the transformer to the trackside.

Within the Burwell RDP area there are 2 generators connected at 33kV which have the potential to cause significant changes in active power flows within the network.

Generation Plants	Type	DNC (MVA)	F (%)	pf	DG Output = F*DNC		
					MVA	MW	MVA _r
Sutton Power Station	Straw Burning	-	-	-	-	38	-
Wadlow Wind Farm	Wind	-	-	-	-	30	-

Table 2. Output of generating plants used in the analysis

Sutton Power Station is located approximately 10km to the west of the city of Ely and has a maximum output of 38MW. The primary fuel source for the station is cereal straw. Sutton Power station is connected to Histon 132/33kV Grid substation via a 33kV busbar at Aldreth.

Wadlow Wind Farm is located to the east of the A11 dual carriageway, approximately 6km south-east of Fulbourn Grid. It is connected at 33kV to the circuits feeding Linton Primary. A 33kV open point at the Bottisham Tee results in the active power output being split between Burwell Local and Fulbourn Grids.

2.2 Network changes in progress

A new 33kV cable circuit has been installed from Burwell Local 33kV Grid to Soham Primary to supply T1 on a dedicated circuit which removed a tee with Ely Primary T1. The circuit upgrade facilitates the planned replacement of Soham T1 Brush 7.5/15MVA 1966 transformer with an 11/18/24MVA unit, to match the existing T2 Brush transformer dating from 2002. Ely T1 remains supplied via the original 5km overhead line, constructed with 200SCA Jaguar conductors.

At Ely Primary there are problems with volt drop which limits the load that can be supported to approximately 26MVA. Ely Primary contains 2 x 20/30/40MVA Brush transformers dating from the year 2000 is supplied from Burwell local 33kV Grid by 33kV circuits limited by the rating of 200SCA Jaguar conductors. A scheme has already been approved to install a 33kV busbar at Ely and a 3rd 33kV circuit to from Soham.

5490 - Ely Primary 33/11kV Primary Substation - establish a new 33kV switchboard

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The predicted load at Ely Substation will exceed the maximum level of load (26.6MVA) that can be supported on the existing circuits before a low voltage situation at Ely occurs, including transfer capacity to Soham and Aldreth Primary Substations. It is not possible to lower the load without compromising operational and planning requirements. It is therefore proposed to add a new 33kV switchboard at Ely Primary which will be supplied from Burwell Local Grid and a 33kV cable circuit via Soham (see 3902).

3902 - Soham-Ely Proposed 33kV circuit

The predicted load at Ely Substation will exceed the maximum level of load (26.6MVA) that can be supported on the existing circuits before a low voltage situation at Ely occurs. It is not possible to lower the load without compromising operational and planning requirements. It is therefore proposed to install a new 33kV fully rated circuit. Completion of this project will see a new 12km underground circuit installed from Soham which will form an extension of the Soham T1 circuit.

5004 - Exning 33/11kV Primary Substation - Improved 11kV Interconnection

The predicted load at Exning Substation will exceed the existing firm capacity, including the transfer capacity to Newmarket Primary Substation. It is not possible to lower the load without compromising operational and planning requirements, it is therefore proposed to install a new 11kV circuit to Soham primary to provide additional transfer capacity. Completion of this project will see a new 11kV underground circuit installed between Turners secondary and Soham Primary substation. Exning T1 is a 7.5/11.5/15MVA Bonar long unit from 1973 and T2 is a 7.5/11.5/15MVA Brush unit from 1998.

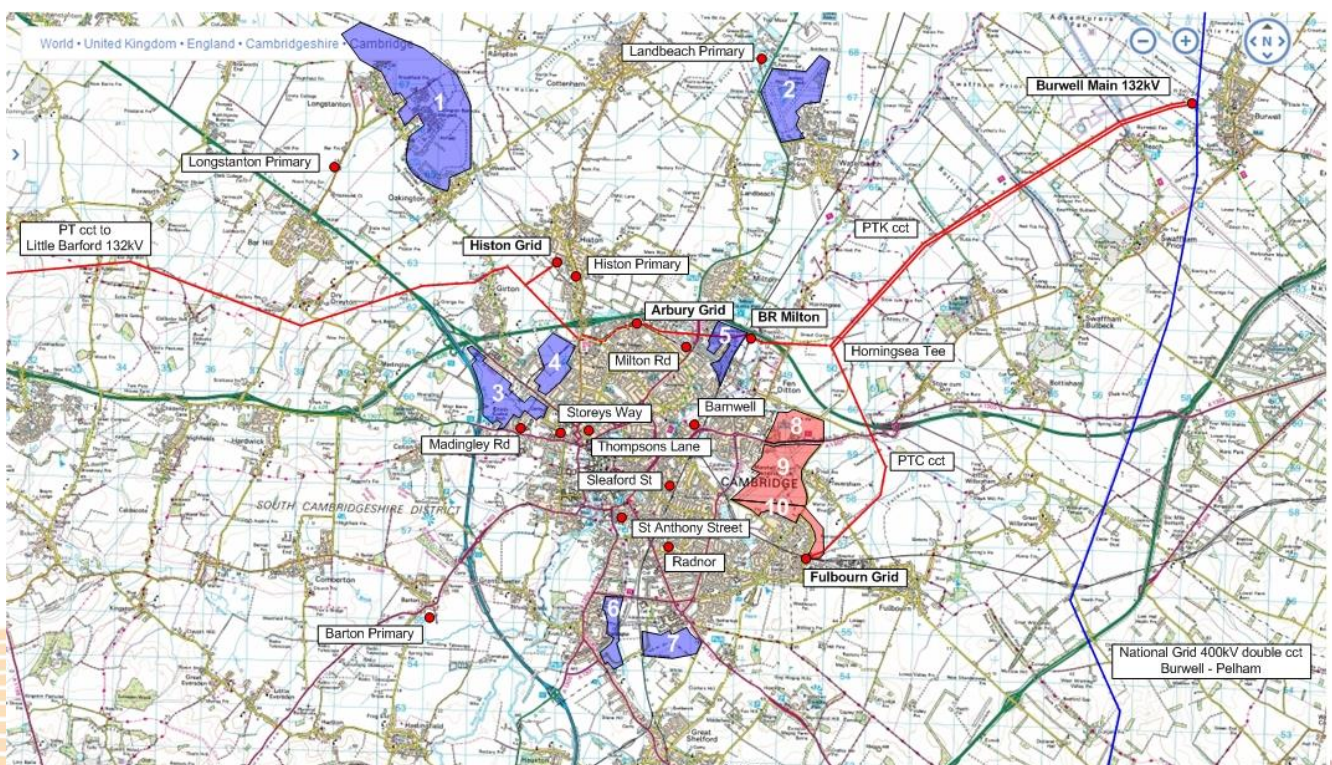
5488 - Horningsea Tee/Fulbourn 132kV OHL (PTC) Circuits - reinforce to 770A(W)

The combined predicted load supported on both Fulbourn 132/33kV and 132/11kV Grid substations will exceed the ratings of the existing 132kV Lynx PTC double circuit route under N-1 conditions. It is not possible to lower the load without compromising operational and planning requirements. It is therefore proposed to reconductor this circuit with Upas conductors. Completion of this project will see 2 x 6km overhead replacement circuits installed on existing towers.

3 Summary of Issues

3.1 Development areas

Major development within the Burwell GSP supply area is focussed around the city of Cambridge. There have been numerous connection applications over many years for some of these developments. A map of the development areas is shown below and reflects information from the Cambridge Sub-Region Strategy Major Housing Location.



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Figure 5. Development areas in and around the city of Cambridge

Plans for the development of the Cambridge Airport have been shelved. Cambridge Airport is owned by the Marshalls Group and Marshalls Aerospace and Defence which is based on the site carries out works on military aircraft and was not able to re-locate its business to RAF Mildenhall, which is still in operation as a military base.

It is also not anticipated that either of the Newmarket Road or Cherry Hinton developments will take place in the foreseeable future as the proposed high density development at Waterbeach accounts for the majority of housing that was allocated for these three areas.

An indication of the level of proposed residential development is shown in the table below. It should be noted that many of the developments also include an industrial / commercial element hence the typical load per residential dwelling and volumes are not reflective of the total development load applied for.

AREA No.	DEVELOPMENT	ESTIMATED DWELLINGS	EST PEAK LOAD (MVA)
1	Northstowe	6,000	25.0
2	Waterbeach	10,000	25.0
3	North West Cambridge	1,000	7.5
4	NIAB	1,000	7.5
5	Northern Fringe Chesterton	1900	10.0
6	Clay Farm	2460	16.3
7	Addenbrookes	400	5.0
8	Newmarket Road	2950	N/A
9	Cambridge Airport	7800	N/A
10	Cherry Hinton	1280	N/A

o **Northstowe**

This major development is situated to the North West of Cambridge and would see the creation of a new town named Northstowe which would stretch from Oakington to Longstanton. The proposed development will be boarded by the Cambridge guided bus-way. Connection applications have received for individual phases and the entire development as a whole, these applications range from circa 3MVA to 25MVA. Phase 1 of the development is situated immediately to the East of Longstanton is expected to required circa 4MVA of load, with sub-phases being completed over a 10 year period. This development is a long term project and is expected to be constructed over a 25-30 year period, and even longer depending on the economic recovery. To supply the entire development will require a new Primary Substation which would be supplied from Histon Grid.

o **Waterbeach**

This long-term development would see the former RAF Waterbeach base re-development with a mixture of high density housing and industrial / commercial units. As previously mentioned this development replaces the developments on the Eastern fringe of Cambridge. The predicted total load requirement of circa 25MVA is shared equally between the residential and commercial elements of the development.

o **North West Cambridge**

Plans from August 2011 indicated that the North West Cambridge development strategy was to be phased between 2014 and 2024. This area land is owned by the University of Cambridge and the development proposed a mixture of residential development with community facilities, student accommodation, commercial and research facilities. Applications for connections have been made for early phases of the development which require 6.5MVA of load, the total projected load requirement for the entire development is circa 22MVA.

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o National Institute of Agricultural Botany (NIAB)

The National Institute of Agricultural Botany (NIAB) is an independent plant research and information centre based in Cambridge which owns land both on the north and south of the A14 dual carriageway. The land to the south has been marked for development and numerous connection applications have been made by consultants for various phases of this development which range from approximately 1MVA up to 7.6MVA.

o Northern Fringe Chesterton

The Northern Fringe development will include the re-development of the Anglian Water sewerage treatment works. The area of land identified in area 5 is boarded to the North by the A14 dual carriageway and to the East by the Network Rail Fen line, which runs from Cambridge to Kings Lynn. The BR Milton 132/25kV substation is located on the East side of the tracks.

o Addenbrookes and Clay Farm

Addenbrookes Hospital campus has supplies from Radnor and Addenbrookes Primary Substations. The campus has 7MVA of reserved capacity from Radnor which is almost fully utilised and a 13.7MVA connection from the dedicated Addenbrookes Primary, of which circa 8.7MVA is currently utilised. Addenbrookes has an agreement to increase load on the dedicated primary to 18MVA which will take place up to circa 2019.

The UKPN owned Addenbrookes 'A' Primary was constructed as a contestable scheme at full cost to the NHS trust to supply an inset network, which would then retrospectively charge new customers to connect. Due to the slow uptake of customer connections the full 18MVA has not been utilised. The surrounding land is owned by the NHS trust, which refuses to grant UKPN permission for any 11kV network to be established for connections to the busbar.

Relations in the original consortium consisting of the NHS trust, Countryside Properties and the Medical Research Institute have broken down and as a result the Clay Farm development if fully developed would be supplied from a new Addenbrookes 'B' Primary, on the agreement that the connection to Radnor is relinquished. The existing 4.1km 300Cu 33kV cables from Fulbourn Grid which supplies the existing 'A' site are rated to circa 37MVA, a down-rating from the nominal 778/871A (44.5/49.7MVA).

The installation of 132/11kV direct transformation at Fulbourn to transfer load from the busbar whilst allowing Addenbrookes to utilise their full 18MVA from the 'A' Primary does not permit the Clay Farm development to increase its load to the maximum anticipated 16.3MVA. The proposed future development of the Horningsea Grid Substation to transfer load from Fulbourn and Arbury at 33kV is a preferred option to provide relief for the Fulbourn 33kV busbar.

3.2 Asset Replacement

7567 - Arbury/BR Milton 132kV Tower Line (PMK) - 132kV Insulator & Fitting Replacement

The condition assessment of the Arbury / BR Milton 132kV Tower Line (PMK) has shown that the probability of failure due to degradation will become unacceptable in the future. 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 supporting the earth conductor.

7654 - Longstanton 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1969 EEC UAE612 indoor oil insulated switchgear installed at Longstanton 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.

7686 - Exning 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1962/64 REY LM23T indoor oil insulated switchgear installed at Exning 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

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therefore this project recommends its replacement. Completion of the project will see 8 circuit breakers replaced with 8 new circuit breakers.

7713 - Burwell Local Grid - Replace Grid Transformers (GT1, GT2, GT3)

The condition assessment of the 1953 Fuller Grid Transformer installed at Burwell 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 their replacement. Completion of the project will see the 3 existing Grid Transformers replaced with 3 new Grid Transformers. Note: GT1 & 2 are 45MVA Fuller units from 1953. GT1 is a 45MVA Johnson & Phillips unit from 1991.

Milton 132/25kV Grid Substation - Replace Grid Transformers (GT1)

The condition assessment of the 1985 HSP Grid Transformer installed at Milton 132/25kV 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 Grid Transformer replaced with 1 new Grid Transformer.

Note: This project is due to commence circa 2015, however Network Rail have indicated (formal application expected summer 2013) that a load increase of approx 10MVA is required. This would require the existing 14MVA transformers to be replaced. GT1 is a Hawker Siddeley unit from 1985. GT2 is a Bonar Long unit from 1990.

3.3 Security of supply analysis

Substation	Demand (MW)	Supply Class	Demand (MVA)			P2/6	Comments
			2015	2018	2021		
Burwell GSP	317	E	378	405	420	Compliant	P2/6 compliant but demand transfer required to prevent cascade trip of SGT for n-2 event.
Burwell GSP less Histon Grid from 2016	317	E	378	316	328	Compliant	P2/6 compliant but demand transfer required to prevent cascade trip of SGT for n-2 event.

Table 3. P2/6 Assessment table

3.4 Operational and technical constraints

The 33kV subsar at Aldreth Primary runs split between Histon and Burwell Local Grids, due to fault level and active power flow issues. The Sutton Power generator connects to the T1 side of the 33kV bar which is supplied from Histon. The output of Sutton Power has to be constrained in some cases to prevent overloads on the 33kV circuits in reverse power flow situations.

Camro (formerly Sutton) Data Centre, located on the Elean Business Park and in close proximity to Sutton Power Station, has recently been quoted for a load increase from 6MVA to 25MVA. The data centre previously paid for ducts to be installed as part of the works for a 19MVA connection that was never utilised. Prior to the recent application for load increase the data centre re-declared their MPR to 6MVA and have accepted a quotation for the works to provide the initial 6MVA connection which involves establishment of a single transformer primary on the customer site, with scope for an additional unit when additional capacity is required.

The 132kV double circuit between Horningsea and Histon Grid over-sails the A14 dual carriageway on both the north-east and north-west sides of Cambridge.

At Burwell Main 132kV Grid there is a teed connection off the PTC1 tower (SMF circuit) that heads east to GT3 at Burwell Local 33kV Grid. GT1 and 2 are connected via underground cables. The SMF circuit is supported on masts and is over-sailed by the National Grid 400kV Burwell – Pelham double circuit.

There are no cable bridges or 132kV diamond crossings with National Grid 400kV circuits within this RDP area.

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3.5 National Grid

National Grid has a programme of works to replace supergrid transformers (SGTs) 1 & 2 at Burwell circa 2014/15, which are both 400/132kV 240MVA units which date from 1967. There are no plans to replace SGT3.

It has been identified that a 4th SGT will be required at Burwell GSP in the future to maintain P2/6 compliance. These works currently are not expected to be required within ED1 timescales as a result of the addition of the 3rd SGT at Eaton Socon GSP (due 2015/16) and the subsequent transfer of Histon Grid from the Burwell GSP group. The requirement to transfer load from Bramford GSP has the potential to bring the requirement for the Burwell 4th SGT forward.

4 Recommended strategy

4.1 Description

Histon Grid transferred to Eaton Socon GSP from 2016.

Following construction of the new 132kV switchboard at Eaton Socon and installation of the 3rd SGT, removing Histon Grid from Burwell GSP will ensure that Burwell remains P2/6 compliant beyond the ED1 period. The analysis of the GSP indicates that maintaining P2/6 compliance over a 3 year period from 2014 to 2016 is reliant on the ability to transfer Histon temporarily into the Eaton Socon group, until the 3rd SGT is installed it would be reliant on having an intact 132kV network within the Eaton Socon GSP group and arranging the 132kV network to shed demand for a subsequent n-1 SGT loss to avoid a cascade trip situation.

When Burwell is eventually reinforced with the 4th SGT it will be possible to operate the 132kV network (pending circuit reinforcement to Arbury Grid) with Histon transferred back to Burwell GSP from Eaton Socon. Supplying Histon from Burwell GSP is preferred as this means all Grid sites supplying Cambridge and the surrounding area are supplied from the same GSP and Cambridge is both geographically and electrically closer to Burwell GSP.

Burwell Grid Supply Point – 132kV Network LRE NAMP Projects:

2234 - Horningsea Tee - Arbury 132kV OHL (PTK/PMK) Circuits - reinforce to 925A(W)

The combined predicted future loads on Arbury, BR Milton and Histon Grid substations will exceed the N-1 rating of the Lynx conductor sections in the Horningsea Tee - Arbury circuits. It is not possible to lower the load without compromising operational and planning requirements. It is therefore proposed to replace both of these circuits to provide fully rated circuits. This project will see approximately 4km of Lynx 175mm² OHL circuit at the north of Cambridge undergrounded to increase the circuit ratings, given that the single circuit masts supporting conductors over-sailing the Cambridge Science Park will not allow the equivalent rating of a Zebra 400mm² conductor to be achieved. This project will alleviate a current loading issue on the 132kV circuits and allow Histon Grid to remain supplied from Burwell in the long-term but also be readily transferred between Burwell and Eaton Socon (pending 3rd SGT works) GSPs to manage load on either site accordingly for SGT planned outages or faults. There are various developments in and around Cambridge which will trigger these works which include:

- Camro Data Centre – Load increase from 6 to 25MVA (additional 19MVA)
- Northstowe Development (north Cambridge) – 25MVA mixed development
- BR Milton load increase – Network Rail anticipated additional load of 10MVA.

2240 - Horningsea T/Fulbourn reinforce 132kV capacity - Establish new 132kV switching station

The predicted combined load at Fulbourn, Arbury and Histon 132/33kV Grid Substations will exceed the existing firm capacities at these sites, including transfer capacity between these Grid Substations. It is not possible to lower the load without compromising operational and planning requirements. It is therefore proposed to add a new 132kV switching installation at Horningsea to permit establishment of a new Grid Substation (see 5562). This proposed switching station will be connected into the Burwell/Milton/Arbury (PTK) and Burwell Fulbourn

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(PTC) 132kV circuits to increase the n-1 and n-2 132kV circuit capacity available to supply Cambridge and surrounding areas.

5562 - Horningsea Tee 132/33kV Grid Substation – Establish new site

The predicated loads at Arbury, Histon and Fulbourn 132/33kV Grid substations will exceed the site firm capacities. It is not possible to lower the load at these sites without compromising operational and planning requirements. It is therefore proposed to establish a new 132kV/33kV Grid substation at Horningsea Tee, which will connect to the new 132kV Horningsea Switching Station and transfer load from Arbury, Histon and Fulbourn by establishment of new 33kV connections. The headroom created will also facilitate connection of major developments on the North and North West of Cambridge. Note this project will take place within ED2 timescales.

Grid and Primary Substations – LRE NAMP Projects.

3448 - Soham Primary 33/11kV Substation - ITC (1 x 12/18/24MVA)

The predicted load at Soham S/S will exceed the existing firm capacity, including the transfer capacity to Exning and Ely S/Ss. Currently T1 is a 7.5/15 MVA Brush unit from 1966 (HI3) and T2 is 11/18/24MVA brush unit from 2002 (HI2). It is therefore proposed to replace T1 with a 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.

2169 - Burwell 132/33kV Grid Substation - Replace 33kV switchboard (Fault Level)

The predicted fault level at Burwell 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 AEI JB424 while the remaining circuit breaker is modern SF6/vacuum type. The fault rating of the oil circuit breakers (circa 1991) 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 13 breaker AIS compound with a new installation comprising 13 circuit breakers.

6342 - Fulbourn 132/33kV Grid Substation - Replace 33kV switchboard (Fault Level)

The predicted fault level at Fulbourn Grid Substation will exceed the rating of the existing switchgear due to increasing generation connections at EHV and HV. Eleven circuit breakers are Oil insulated SCO K1/K30 while the remaining five circuit breakers are modern SF6/vacuum type. The fault rating of the oil circuit breakers (circa 1954) is 13.1kA. It is not possible to lower the fault level without compromising operational and planning requirements. It is proposed to replace the existing 16 breaker AIS compound with a new installation comprising 16 circuit breakers.

5566 - St Anthony Street 33/11kV Primary Substation - ITC (2 x 18/30/40MVA) and 11kV switchboard

The predicted load at St Anthony St S/S will exceed the existing firm capacity, including the transfer capacity to Radnor, Sleaford Street and Thompsons Lane Primary Substations. It is therefore proposed to replace the existing 11.5/23MVA transformers with larger units. The existing Reyrolle 1200A indoor oil switchgear is not fully rated for this increased transformer capacity. It is therefore proposed to replace this switchgear. The existing circuits supplying the transformers are fully rated for the larger units. Completion of this project will see the existing transformers and the 3 section switchboard replaced.

Substation	Firm Capacity		Year	Recommendation
	Value (S/W)	Limitation		
Soham	15MVA (W)	Transformer T1	2014	ITC (2 nd 12/18/24MVA)
St Anthony Street	23MVA(W)	Transformers	2020	ITC and switchboard
Exning	11.5MVA(S)	Transformers	2013	Additional 11kV interconnection capacity

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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.

Ely	26.6MVA(W)	Reactive power flow	2015	33kV switchboard and 3 rd U/G circuit
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Table 4. Recommended Reinforcement

4.2 Financial Appraisal and Benefits

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

The financial expenditure is shown in the Appendices.

5 Rejected Strategies

5.1 3rd Grid transformers at Arbury and Fulbourn (£23m – excluding switching station).

An alternative to the establishment of the Horningsea Grid substation would see a 3rd transformer installed at both Arbury and Fulbourn Grid Substations. This scheme would require a new 132kV circuit to both Arbury and Fulbourn Grids from Horningsea and it is proposed that the Horningsea switching station is constructed to maintain group security for the loss of the PTC or PTK 132kV circuits from Burwell Main Grid as the cross connection of the new circuits onto the PTC and PTK circuits to avoid the construction of the switching station would create a network that is difficult to operate and would place larger areas of Cambridge at risk for overhead line faults.

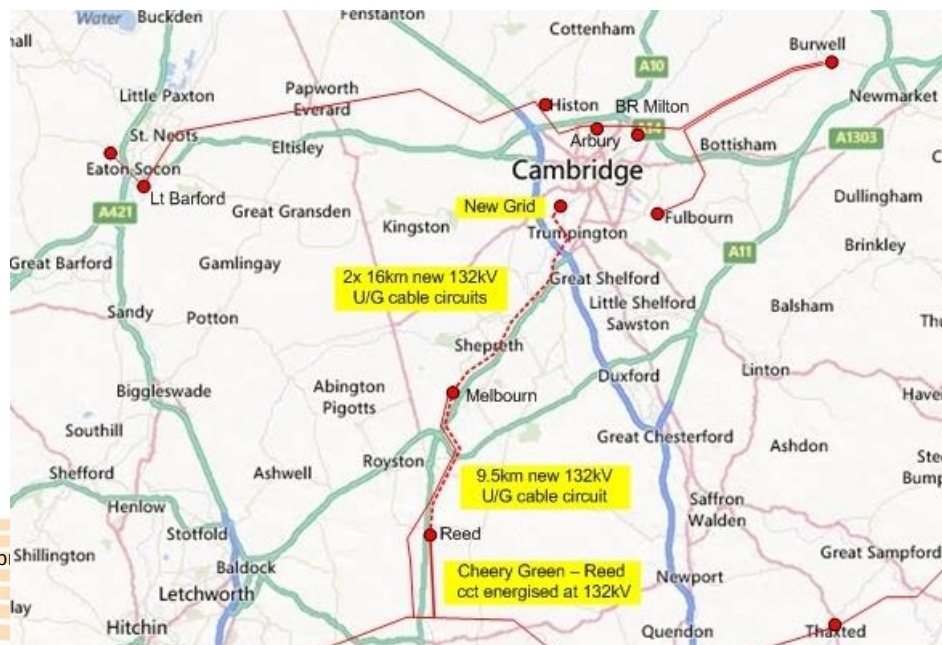
The switching of load between Burwell and Eaton Socon GSPs is crucial to the future strategy for the wider 132kV network. Installation of a 3rd transformer at Arbury Grid would result in further operational difficulties when supplying Histon and potentially Arbury in emergency situations from Eaton Socon.

5.2 Establishing 132kV circuits and Grid at south-west Cambridge (£36m).

Melbourn Grid is a single transformer site which is teed off the Pelham – Wymondley No.1 132kV circuit at the Throcking Tee. Works to re-build the Cherry Green – Reed circuit were completed in 2012, this wood pole circuit operates at 33kV but has been constructed to 132kV specification to allow a second 132kV circuit to Melbourn Grid from the Throcking tee to be established when the 2nd Grid transformer is required at Melbourn. Reed would have to then become a direct transformation site.

To establish 132kV circuits to Cambridge would require a new 9.5km single circuit to be established between Reed Primary and Melbourn Grid. A further new 16km dual circuit from Melbourn Grid to the south of Cambridge would need to be established, which would need to cross the M1 motorway.

Due to the majority of the development now being focussed around the north of Cambridge and the significant amount of 132kV cables to be installed this is not considered an acceptable solution.



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

Figure 6. Indicative cable routes to establish 132kV circuits to south-west Cambridge.

6 References

References	Description
Reference 1	20 Aug 2012 Planning Load Estimates EPN Area
Reference 2	132kV Network HV Schematic Operating Diagrams East of England (2012)
Reference 3	33kV Network HV Schematic Operating Diagrams East of England (2012)
Reference 4	Cambridge Sub-Region Strategy Major Housing Location

6.1 Appendices

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

6.2 Document history

Version	Date of Issue	Author	Details
1.0	01/03/2013	Paul Ramsbotham	Draft for review
1.3	24/06/2013	Paul Ramsbotham	Updates to reflect new position for RIIO-ED1
1.4	20/03/2014	D J Whiteley	Updated for re-submission

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

7 Document sign off

Sign-off of this Mandate certifies that the Sponsor has ratified the above and approval is sought to proceed to the development of the necessary PG&C Gate B documentation.

Recommended by:

Name	Role	Signature	Date
Paul Ramsbotham	Infrastructure Planner		
Jim Whiteley	Infrastructure Planner		19/04/14
Nuno da Fonseca	Infrastructure Planning Manager (EPN)		

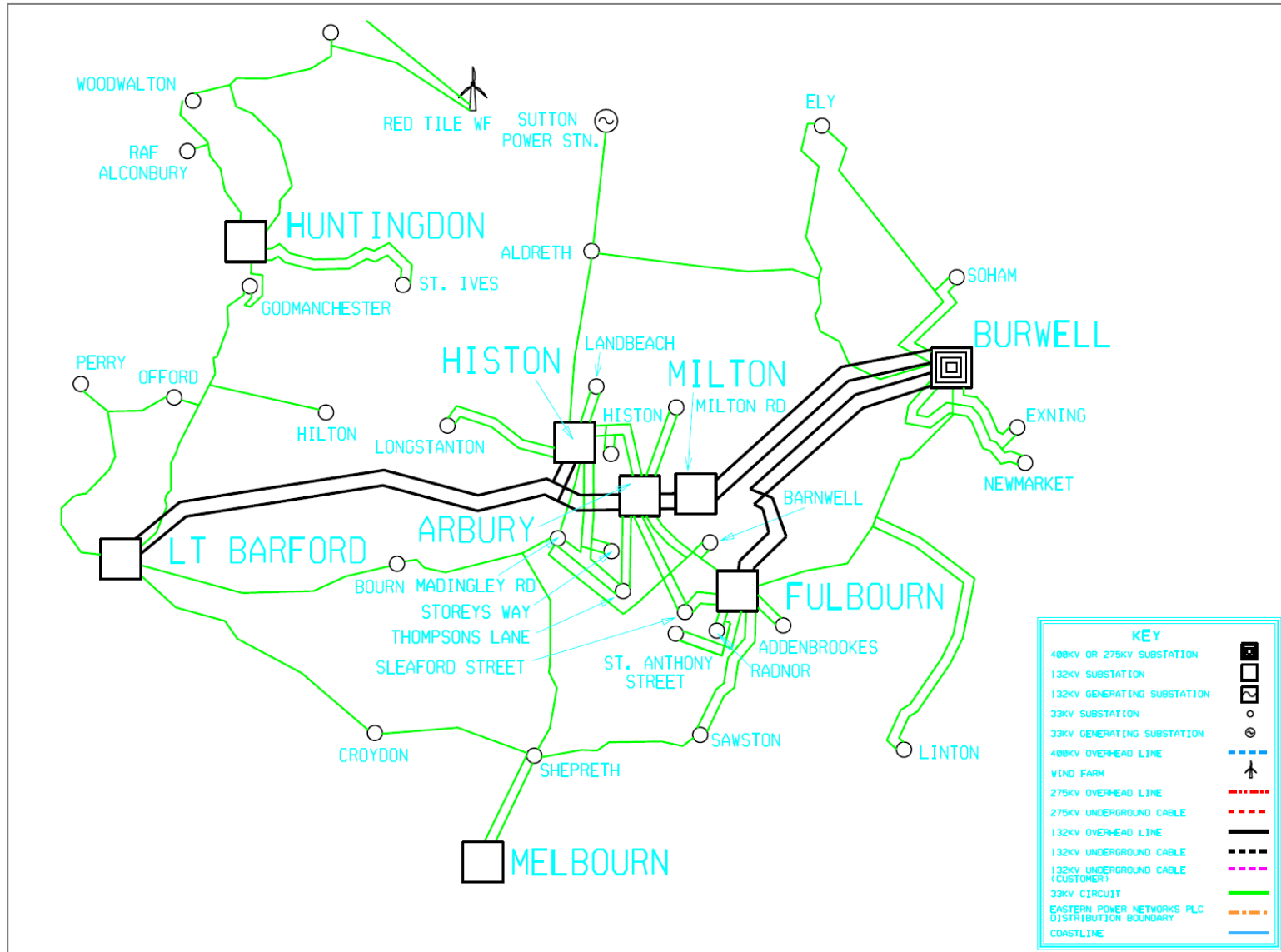
Approval by:

Name	Role	Signature	Date
Robert Kemp	Head of Asset Management		20/04/14
Barry Hatton	Director of Asset Management		

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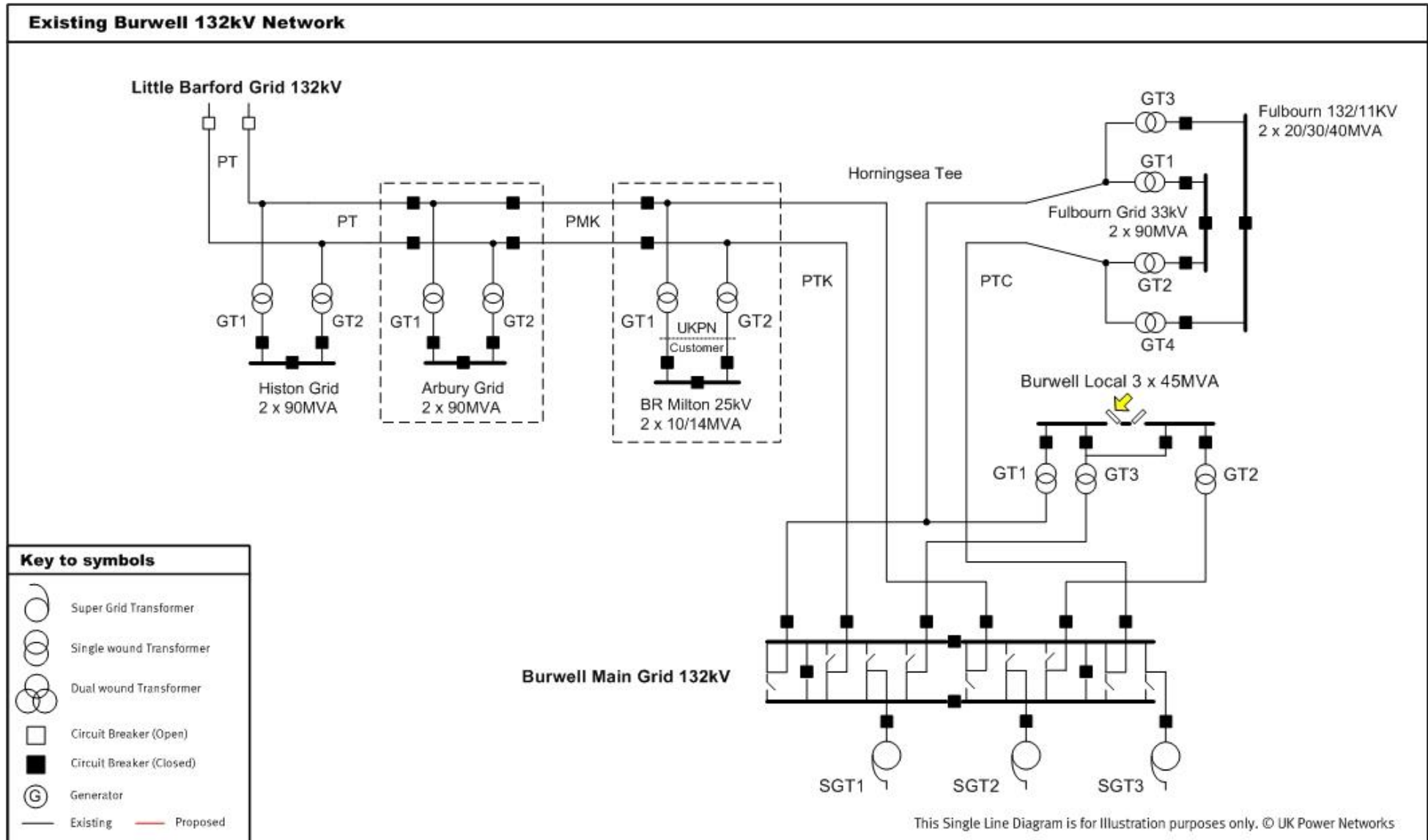
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APPENDIX A: GEOGRAPHICAL DIAGRAM

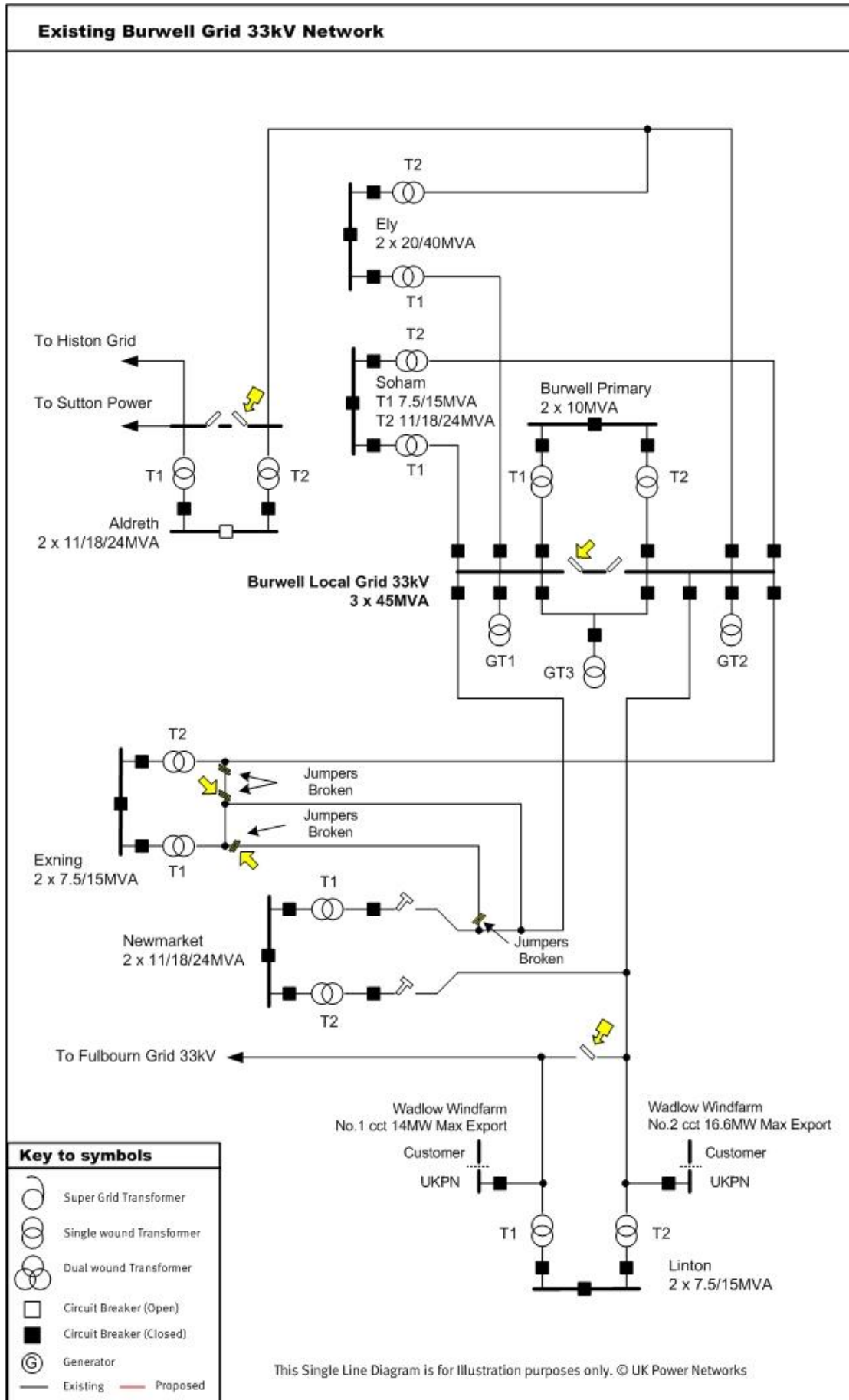


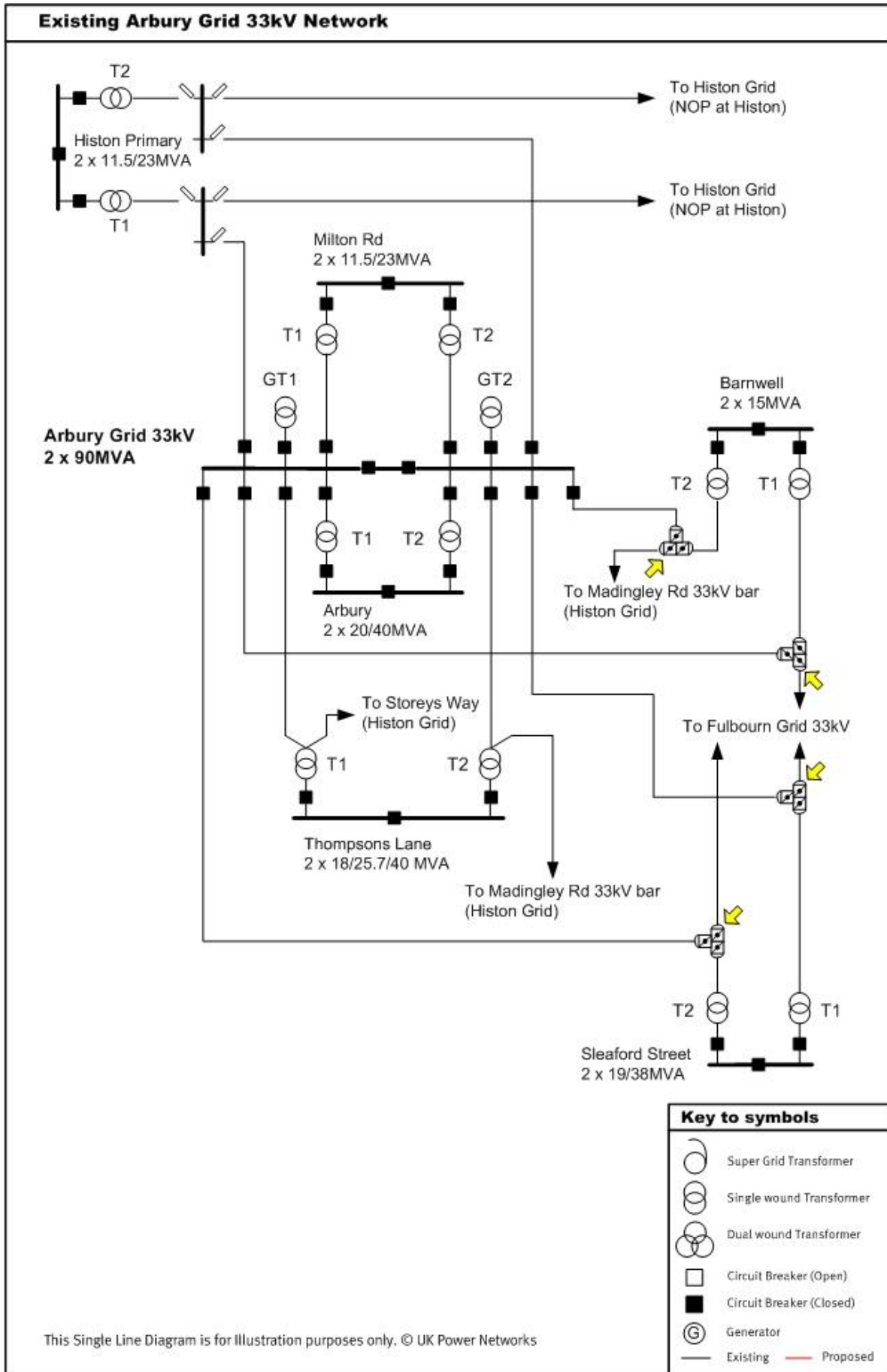
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APPENDIX B: SINGLE LINE DIAGRAM – EXISTING NETWORK

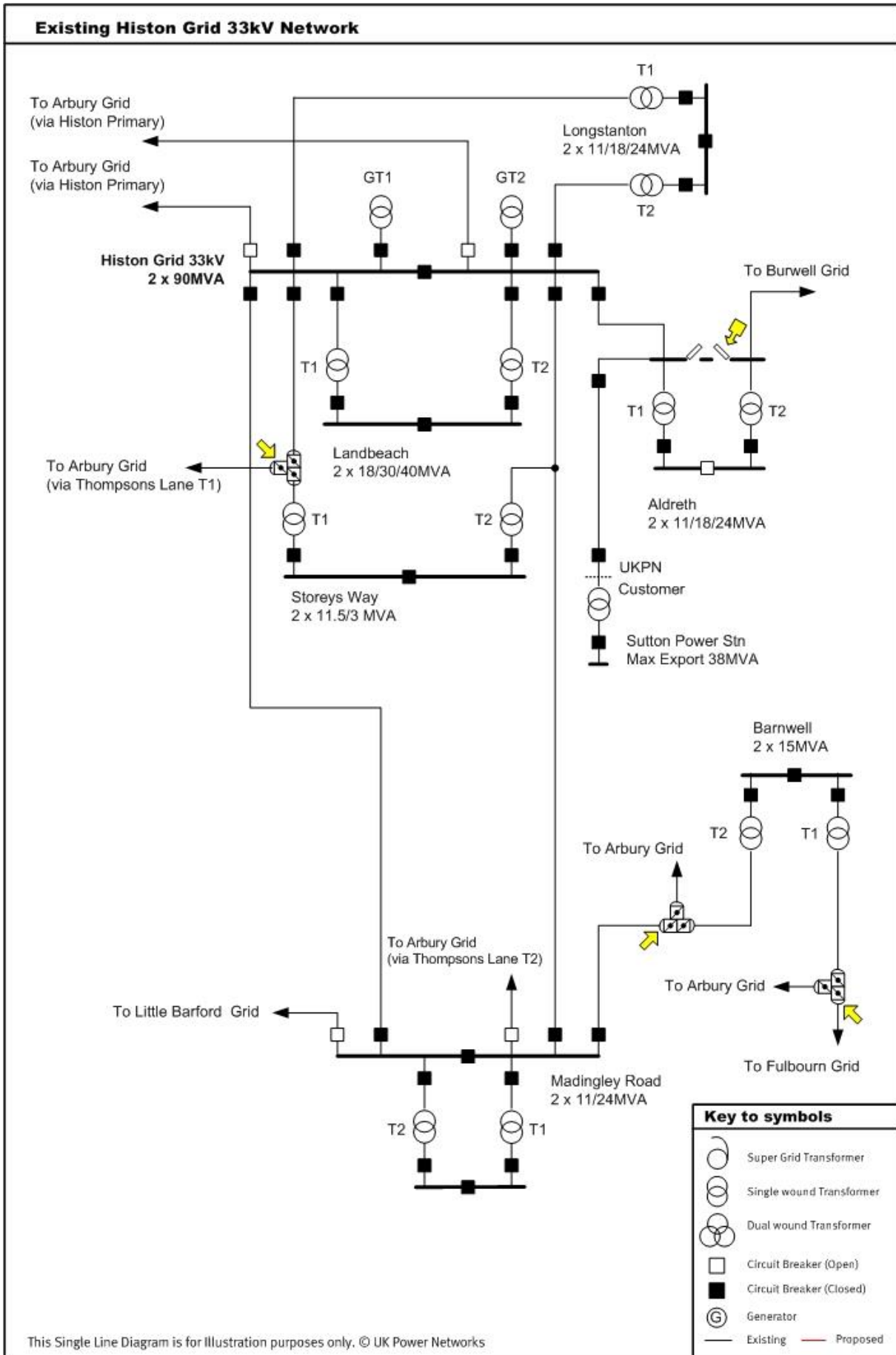


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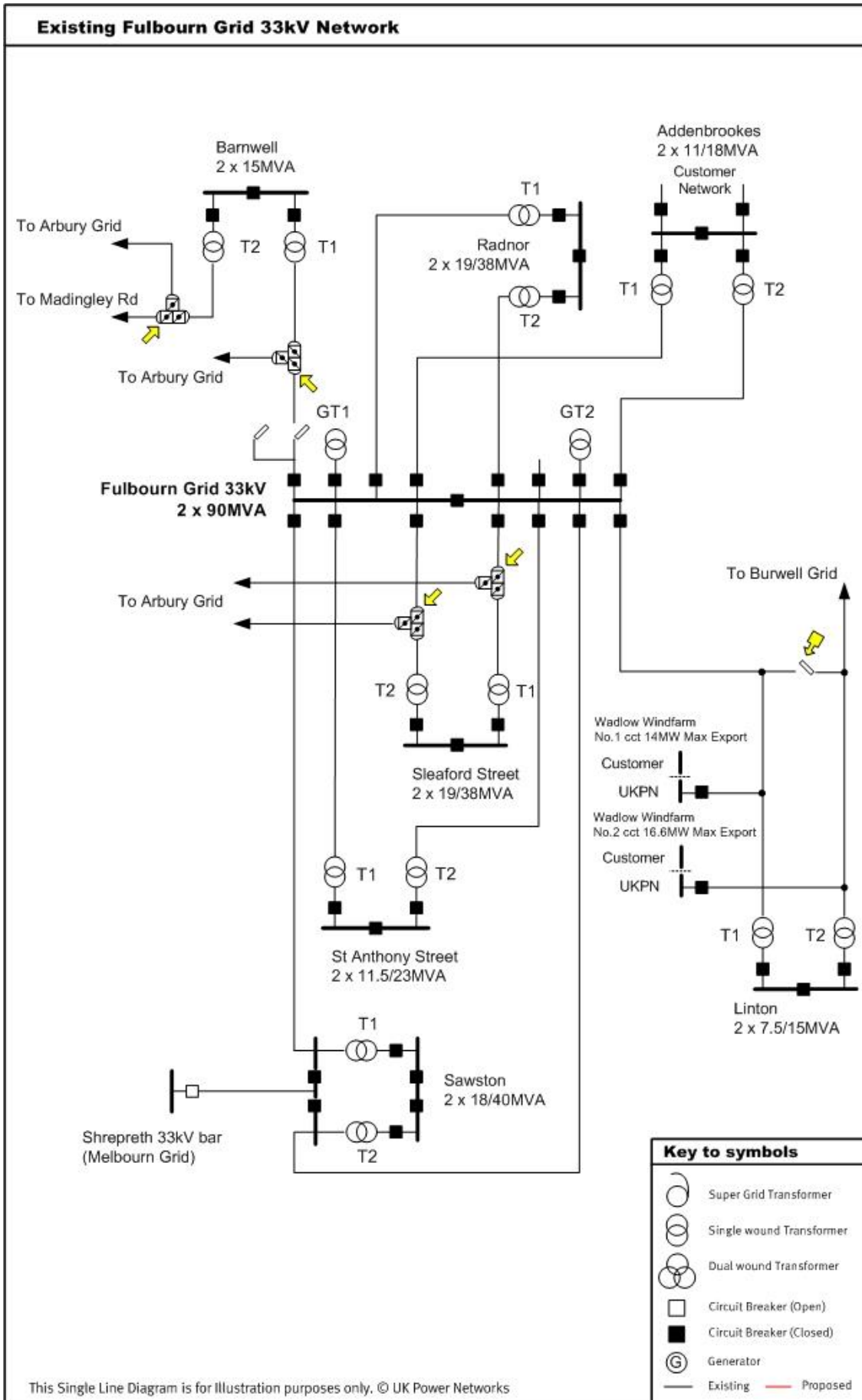




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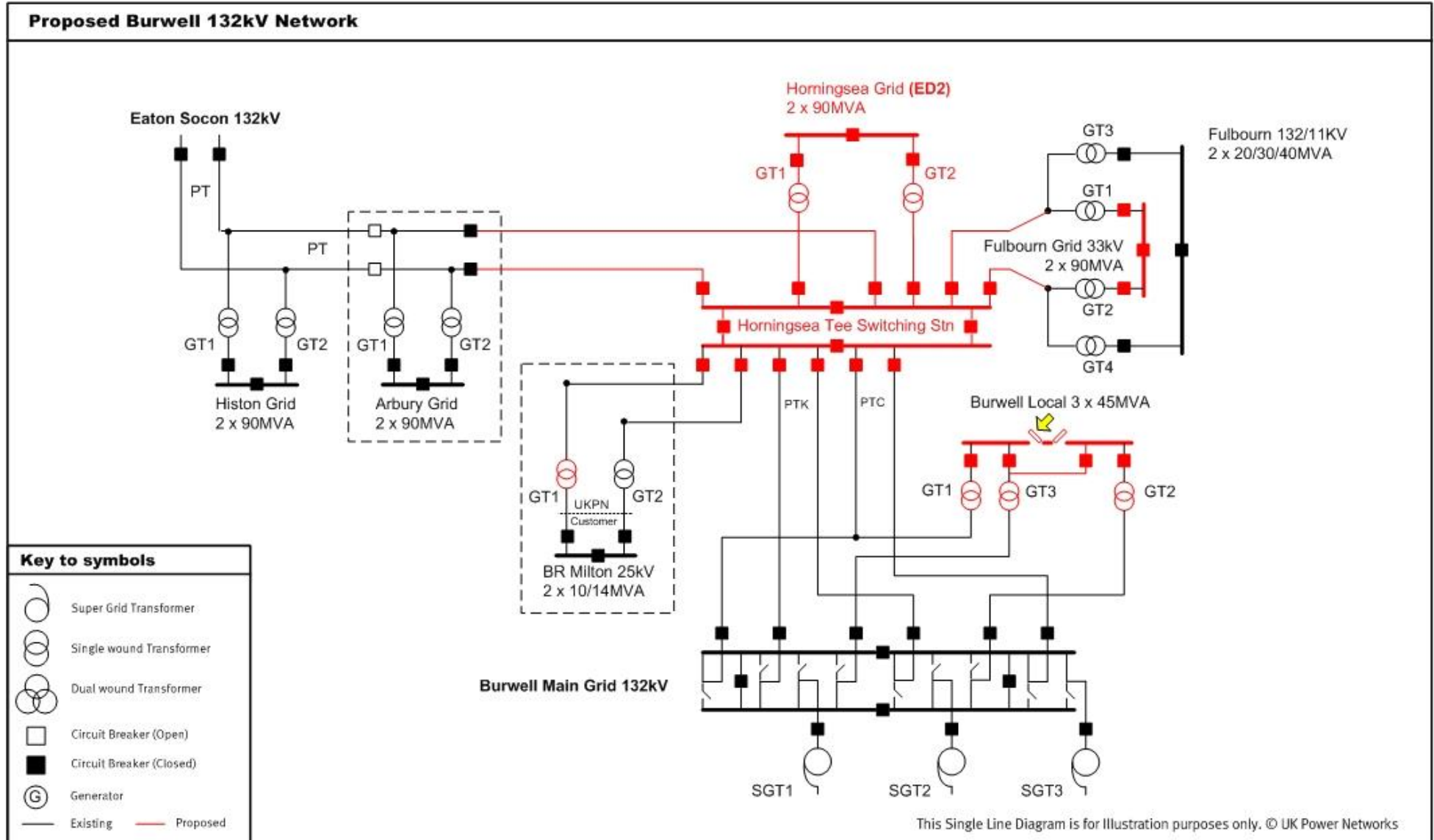
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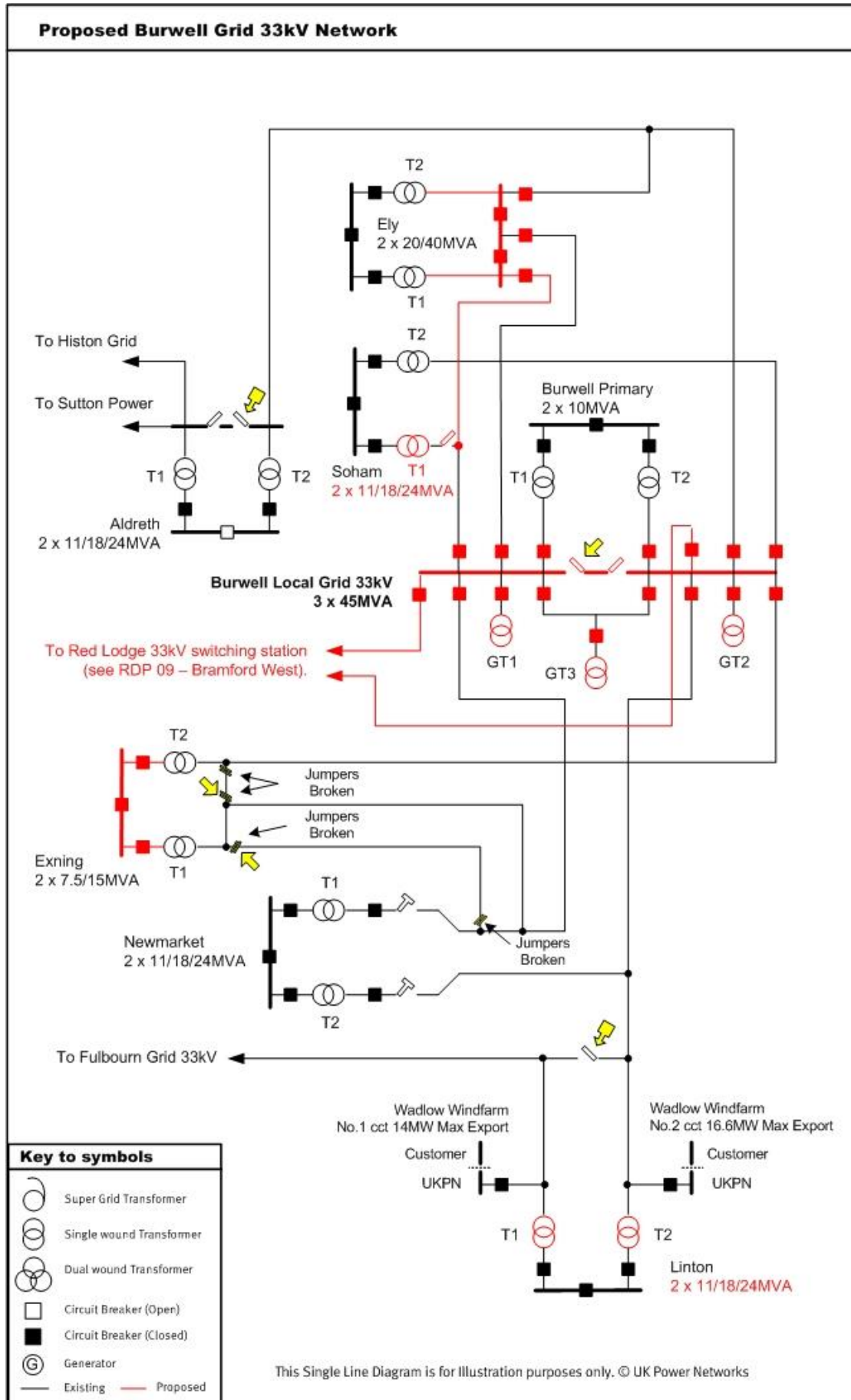
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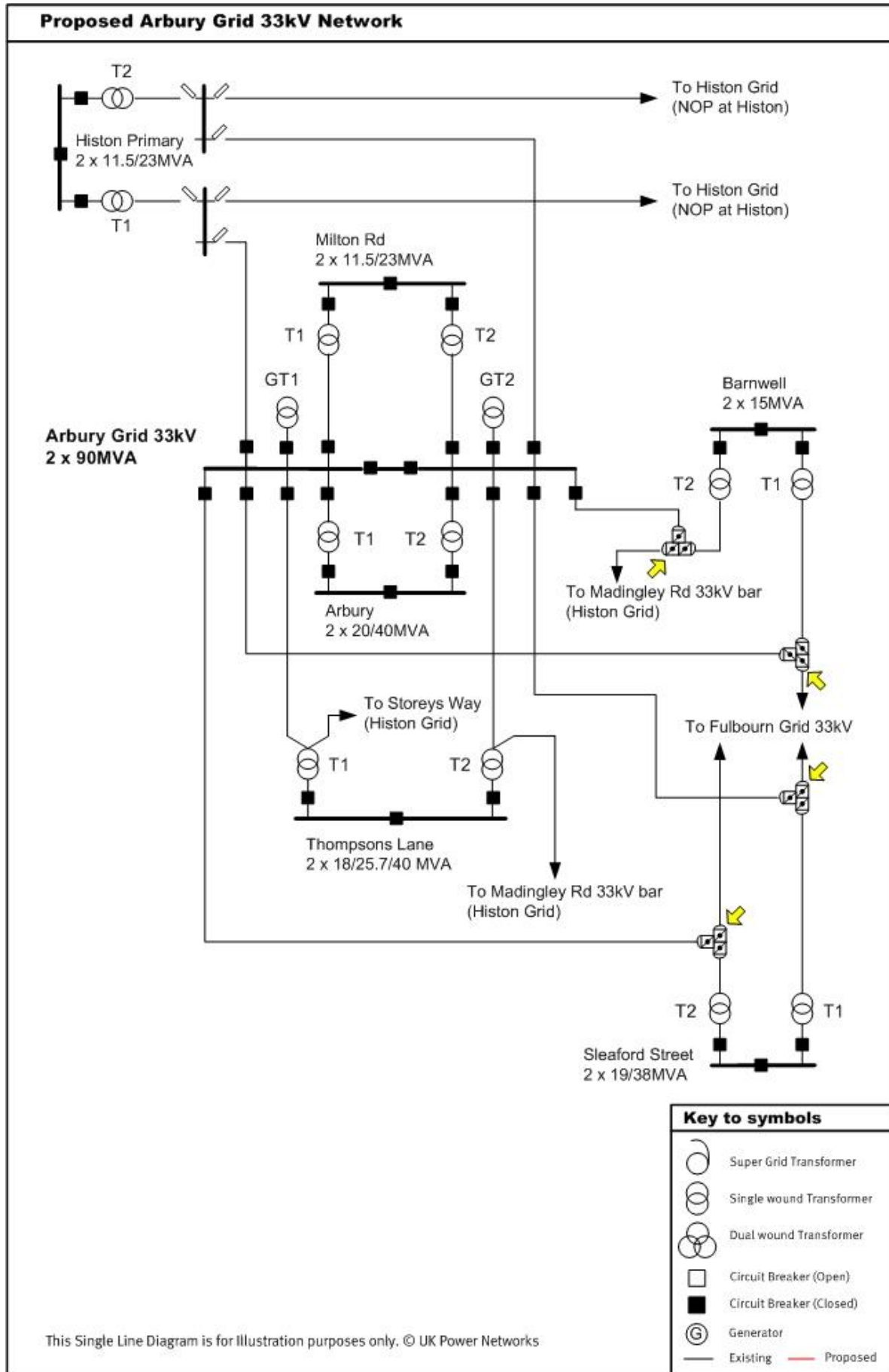
APPENDIX C: SINGLE LINE DIAGRAM – RECOMMENDED STRATEGY



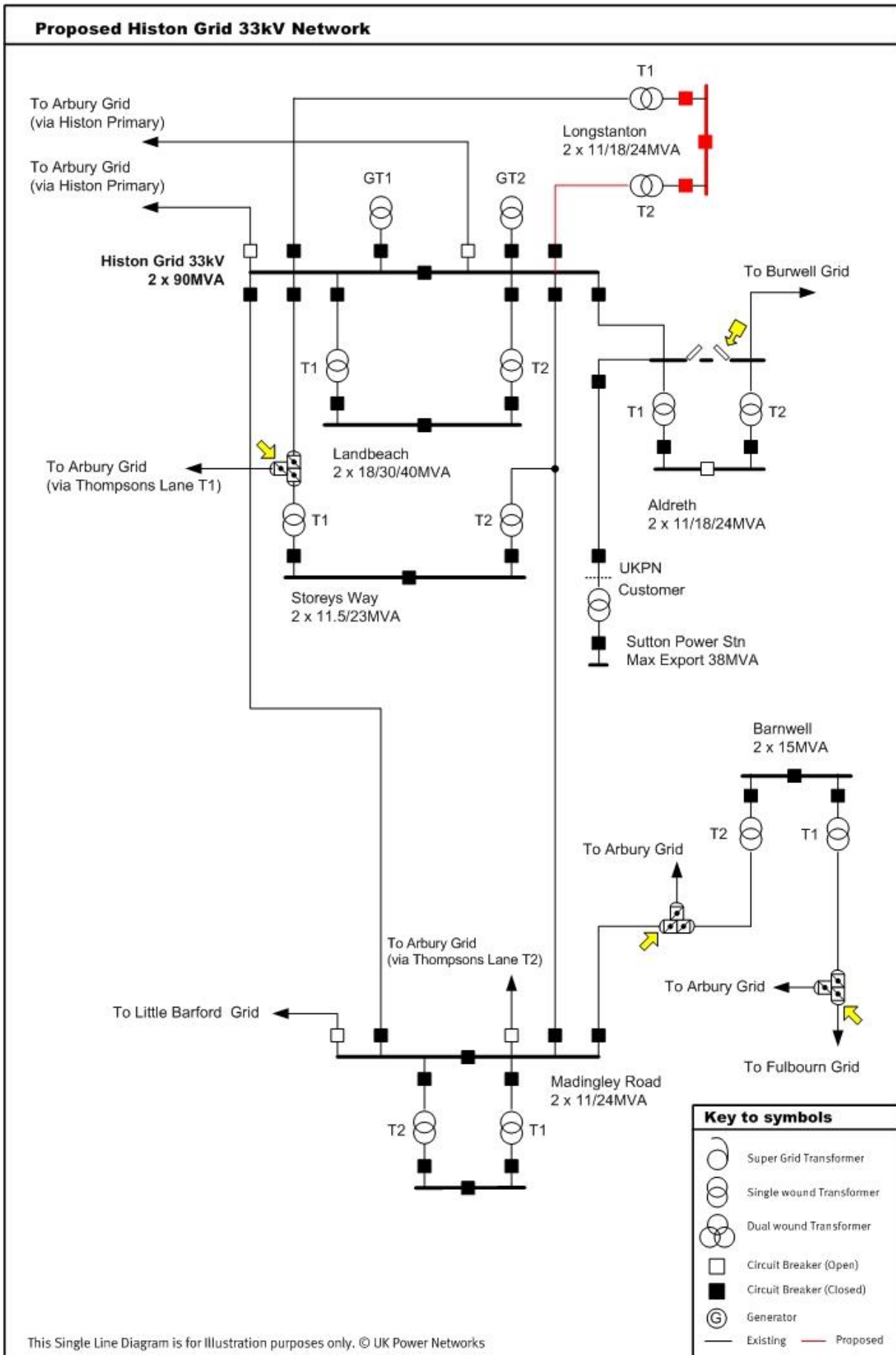
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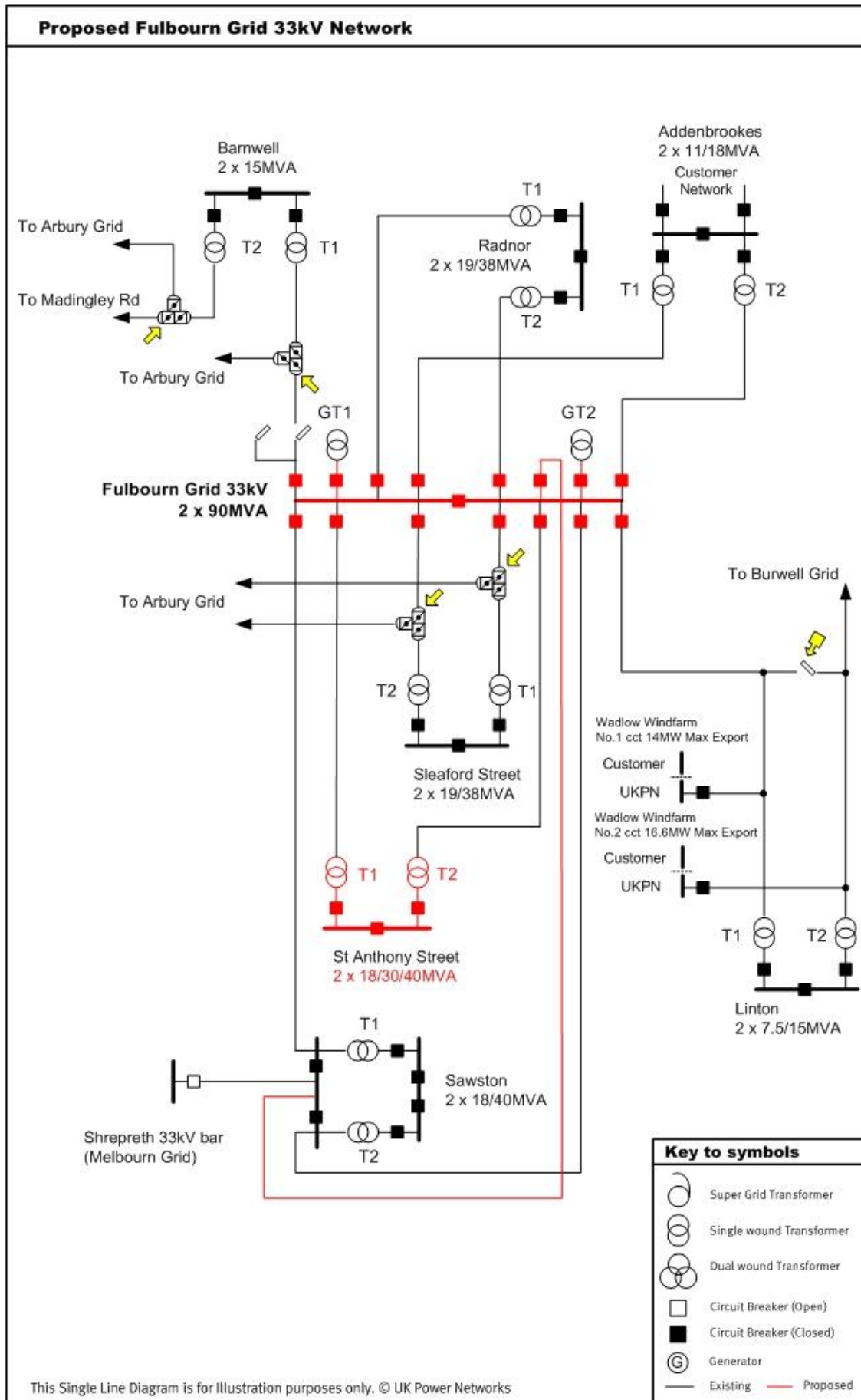
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APPENDIX D: DETAILED COSTS FOR RECOMMENDED STRATEGY

NAMP version: Table J Less Indirect Baseline 19th February 2014 ED1 resubmission (£)

Cat	Namp Line	Project ID		2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
A	1.50.01	7654	Longstanton 33/11kV Primary Substation - Replace 11kV Switchgear			232,605	509,141						
A	1.50.01	7686	Exning 33/11kV Primary Substation - Replace 11kV Switchgear									234,119	539,771
A	1.51.01	7713	Burwell Local Grid - Replace Grid Transformers (GT1, GT2, GT3)					964,569	2,883,790	867,521			
A	1.51.01	7715	Milton 132/25kV Grid Substation - Replace Grid Transformers (GT1: 132/25kV)								46,757	1,431,232	
R	1.33.01	3448	Soham Primary 33/11kV Substation - ITC (1 x 12/18/24MVA)	455,598									
R	1.33.01	5566	St Anthony Steet 33/11kV Primary Substation - ITC (2 x 18/30/40MVA) and 11kV Switchboard							16,199	332,081	1,676,436	
R	1.34.02	5004	Exning 33/11kV Primary Substation - Improved 11kV Interconnection	223,461									
R	1.35.05	5490	Ely Primary 33/11kV Primary Substation - Establish a New 33kV Switchboard	111,211	304,156								
R	1.36.01	2240	Horningsea T/Fulbourn - Reinforce 132kV Capacity						10,701	113,257	2,559,433	4,128,090	3,148,014
R	1.36.03	2169	Burwell 132/33kV Grid Substation - Replace 33kV Switchboard (Fault Level)				257,586	1,491,660					
R	1.36.03	6342	Fulbourn 132/33kV Grid Substation - Replace 33kV Switchboard (Fault Level)									258,858	1,637,550
R	1.37.01	2234	Horningsea T/Arbury/Histon 132kV OHL (PTK/PMK) Circuits - Reinforce (925A(W))		44,407	4,501,392	2,272,899						
R	1.37.09	5488	Hornigsea T/Fulbourn 132kV OHL (PTC) Circuits - Reinforce (770A(W))	1,447,657									

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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)	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
Addenbrookes	S	Transformer	18.0		18.0	10.2	10.2	LI1	LI1		18.0	LI1	B	Yes
Aldreth. Total	W	Switchgear	15.2		15.2	12.3	13.0	LI2	LI2		15.2	LI2	C	Yes
Barnwell	W	Transformer	19.5		19.5	12.4	13.6	LI1	LI1		19.5	LI1	C	Yes
Burwell Local Grid 33	W	Transformer	108.0		108.0	78.3	84.2	LI1	LI1		108.0	LI1	D	Yes
Burwell Primary	S	Transformer	10.0		10.0	5.6	6.2	LI1	LI1		10.0	LI1	B	Yes
Ely	W	Circuit Rating	25.0	5490	25.0	21.1	23.1	LI2	LI2	3902	38.1	LI1	C	Yes
Exning	S	Transformer	11.5	5004	11.5	7.6	8.1	LI1	LI1		11.5	LI1	B	Yes
Fulbourn Grid 33	S	Transformer	90.0	3367	90.0	68.0	76.9	LI1	LI2		90.0	LI2	D	Yes
Histon Grid 33.	S	Transformer	90.0		116.0	76.5	85.5	LI1	LI1		116.0	LI1	D	Yes
Histon Primary.	S	Transformer	17.3		17.3	9.6	10.4	LI1	LI1		17.3	LI1	B	Yes
Landbeach.	W	Switchgear	23.9		23.9	8.6	9.4	LI1	LI1		23.9	LI1	B	Yes
Linton total	W	Transformer	15.0		15.0	12.2	13.1	LI2	LI2		15.0	LI1	C	Yes
Longstanton.	W	Circuit Rating	15.7		15.7	12.7	13.8	LI2	LI2		15.7	LI1	C	Yes
Madingley Road	S	Transformer	18.0		18.0	6.2	6.5	LI1	LI1		18.0	LI1	B	Yes
Milton Road	S	Transformer	17.3		17.3	9.6	10.9	LI1	LI1		17.3	LI1	B	Yes
Newmarket	W	Circuit Rating	22.3		22.3	17.3	18.3	LI1	LI2		22.3	LI2	C	Yes
Radnor	S	Transformer	28.5		28.5	22.2	23.2	LI1	LI2		28.5	LI2	C	Yes
Sawston	S	Circuit Rating	26.5		26.5	21.4	22.6	LI2	LI2		30.0	LI1	C	Yes
Sleaford St	S	Transformer	28.5		28.5	19.5	21.0	LI1	LI1		28.5	LI1	C	Yes

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Soham	W	Transformer	15.0	3448	22.8	12.3	13.5	LI1	LI1		22.8	LI1	C	Yes
St Anthony St	S	Transformer	17.3		17.3	17.8	18.2	LI4	LI5	5566	30.0	LI1	C	Yes
Storeys Way.	W	Transformer	23.0		23.0	15.9	17.0	LI1	LI1		23.0	LI1	C	Yes
Thompsons Lane	S	Aux equipment	25.7		25.7	14.1	14.7	LI1	LI1		25.7	LI1	C	Yes
Fulbourn Grid 132/11	W	Switchgear	38.1		38.1	22.1	23.6	LI1	LI1		38.1	LI1	C	Yes
Arbury	S	Aux equipment	25.7		25.7	14.6	15.2	LI1	LI1		25.7	LI1	C	Yes
Arbury Grid	S	Transformer	90.0		90.0	90.7	97.8	LI1	LI2		90.0	LI4	D	Yes

Burwell GSP (EPN)

APPENDIX F: OUTPUT MEASURES - HEALTH INDICES (HI)

132kV Switchgear (2013 information)

Substation	132kV Switchgear														
	ED1 Start (2015)					ED1 End (2023) No Investment					End of ED1 (2023) With Investment				
	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
ARBURY GRID	4					4					4				
BURWELL MAIN GRID		10					10					10			
HORNINGSEA GRID												16			
MILTON 132		2					2					2			
TOTAL	4	12				4	12				20	12			

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OUTPUT MEASURES - HEALTH INDICES (HI)

33kV Switchgear (2013 information)

Substation	33kV Switchgear														
	ED1 Start (2015)					ED1 End (2023) No Investment					End of ED1 (2023) With Investment				
	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
ALDRETH PRIMARY		1					1					1			
ARBURY GRID	16					6	10				6	10			
BARNWELL PRIMARY	2					2					2				
BURWELL LOCAL GRID		11		1	1		11			2	16				
ELY PRIMARY											5				
FULBOURN GRID	3	2	2	8	1	3	2		2	9	16				
HISTON GRID		3		5	5		3			10		3			10
MADINGLEY RD PRIMARY	9						9					9			
NEWMARKET PRIMARY	2					2					2				
SAWSTON PRIMARY			2							2					2
SLEAFORD ST PRIMARY	2					2					2				
STOREYS WAY PRIMARY	1						1					1			
TOTAL	35	17	4	14	7	15	37		2	23	49	24			12

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OUTPUT MEASURES - HEALTH INDICES (HI)

11/6.6kV Switchgear (2013 information)

Substation	11/6.6kV Switchgear														
	ED1 Start (2015)					ED1 End (2023) No Investment					End of ED1 (2023) With Investment				
	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
ADDENBROOKES PRIMARY	3	2				5					5				
ALDRETH PRIMARY	1	5	2			1	3	2	2		1	3	2	2	
ARBURY GRID	11					11					11				
BARNWELL PRIMARY	9					9					9				
BURWELL PRIMARY		10				5	5				5	5			
ELY PRIMARY	9	4				13					13				
EXNING PRIMARY		3	4	1			7			1	8				
FULBOURN GRID		9	4			1	8	3	1		1	8	3	1	
HISTON PRIMARY		11				11					11				
LANDBEACH PRIMARY	9	1				10					10				
LINTON PRIMARY		10				10					10				
LONGSTANTON PRIMARY		2	5				3	3	1		7				
MADINGLEY RD PRIMARY	9					1	8				1	8			
MILTON RD PRIMARY		4	8				12					12			
NEWMARKET PRIMARY	11					11					11				
RADNOR PRIMARY	14					14					14				
SAWSTON PRIMARY	16					16					16				
SLEAFORD ST PRIMARY	2	10				2	6	4			2	6	4		
SOHAM PRIMARY		7				7					7				
ST ANTHONY ST PRIMARY	1	12				7	6				13				

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Substation	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
STOREYS WAY PRIMARY		8	2				7	3				7	3		
THOMPSONS LN PRIMARY	15					15					15				
TOTAL	110	98	25	1		41	132	50	8	3	69	125	34	5	1

Burwell GSP

OUTPUT MEASURES - HEALTH INDICES (HI)

Grid and Primary Transformers (2013 information)

Substation	Grid and Primary Transformers														
	ED1 Start (2015)					End of ED1 (2023) No Investment					End of ED1 (2023) With Investment				
	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
ADDENBROOKES PRIMARY	1	1				2					2				
ALDRETH PRIMARY	2					2					2				
ARBURY GRID	4					4					4				
BARNWELL PRIMARY		2				2					2				
BURWELL LOCAL GRID				2	1				1	2	3				
BURWELL PRIMARY		2				1	1				1	1			
ELY PRIMARY		2				2					2				
EXNING PRIMARY	1	1				1	1				1	1			
FULBOURN GRID		4				3	1				3	1			
HISTON GRID		2				1	1				1	1			
HISTON PRIMARY		2					2					2			
LANDBEACH PRIMARY	2					2					2				
LINTON PRIMARY		2				1	1				2				
LONGSTANTON PRIMARY	2					2					2				
MADINGLEY RD PRIMARY	2					1	1				1	1			
MILTON 132	1				1	1			1		1	1			
MILTON RD PRIMARY		1	1			1	1				1	1			
NEWMARKET PRIMARY	2					2					2				
RADNOR PRIMARY		2					2					2			
SAWSTON PRIMARY	2					2					2				
SLEAFORD ST PRIMARY		2				2					2				

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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
SOHAM PRIMARY	1	1				1	1				1	1			
ST ANTHONY ST PRIMARY		1	1					1	1		2				
STOREYS WAY PRIMARY		2						2					2		
THOMPSONS LN PRIMARY	2					2					2				
TOTAL	22	27	2	2	2	1	35	14	2	3	10	34	11		

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.

