Regional Development Plan

RDP01 Walpole GSP (EPN)

Planner: Peter Rye

Version: 2.0

Date: 20/03/2014

Document History

Version	Date	Revision Class	Originator	Section Update	Details
1.3	6/03/2014	Major	Peter Rye	1.2, Appendix D	Expenditure aligned to the 19th February 2014 NAMP version J less indirect costs.
1.3	6/03/2014	Major	Peter Rye	1,2,3,4,5	RDP narrative updated to reflect latest position
1.3	6/03/2014	Major	Peter Rye	1.2, Appendix E, Appendix F	LI and HI output measures updated in line with current NAMP plan and RIG tables
1.3	6/03/2014	Minor	Peter Rye	2.2	Network changes in progress updated to reflect interventions to date
1.3	6/03/2014	Major	Peter Rye	4	Recommended strategy reflects latest position
1.3	6/03/2014	Major	Peter Rye	Appendix G, Appendix I	Generation activity reflects latest position
1.3	20/03/2014	Minor	Steve Mould	All sections	Check all sections for consistent numbering, content etc.
2.0	27/03/2014	Minor	Regulation	All	Final publication

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

Contents

1 Executive Summary

This Regional Development Plan (RDP) reviews the UK Power Networks (UKPN) EPN HV and EHV network supplied from Walpole Grid Supply Point (GSP) with the exception of the area in the vicinity of Peterborough which is covered by RDP02.
The western part of the area is supplied via two grid substations (Walsoken and March) that are supplied from one of the dual circuit 132kV lines between Walpole and Peterborough. The eastern part of the area is supplied via four grid substations (Kings Lynn, Kings Lynn South, Hempton and Swaffham). The latter three are supplied by a dual circuit 132kV line from Kings Lynn Power Station, which connects back to Walpole GSP by two dual circuit 132kV lines, one with a tee connection to Kings Lynn Grid and the other with a tee connection to the 'Palm Paper' factory.

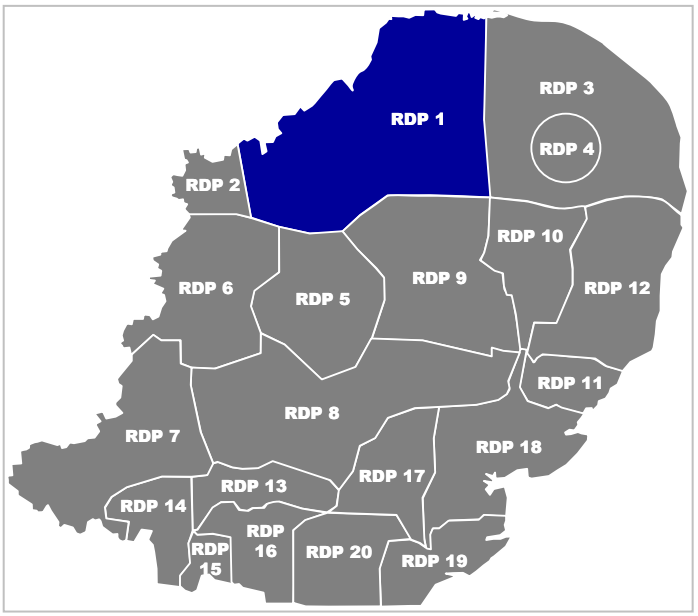


Figure 1 – Area covered by the RDP

This latter load is probably the most significant in this area, with a maximum demand of 60MVA. Their future plans include a doubling of capacity (timescale as yet indeterminate and dependent upon market demand) and a 162MW on-site generation station.

Kings Lynn Power Station is presently the most significant generator in the area with a capacity of 400MW, which is presently mothballed although the owners are investigating bringing it back on line. The owners also have permission for a 'B' station (980MW) and National Grid have recently received planning consent for a 400kV connection for this.

The area is also seeing a large volume of applications for generation connections. Historically these were mainly wind generators and were centred on the area between March and Peterborough, and connections in this area have been restricted for some time due to the limited 'reverse power' capability at March Grid. This area was therefore chosen as the trial area for the 'Flexible Plug & Play' project which is intended to facilitate the connection of embedded generation. However, requests are now biased towards solar farms and have a much wider spread, with many requests in the eastern and northern parts of the area.

At the time of writing there are 39 generation sites already connected to the 33kV and 11kV network with a total installed capacity of 190MW. In addition to this there are a further 24 sites holding 'accepted' connection offers totalling 255MW. As a result of this the 33kV network around Swaffham & Hempton Grid Substations and the 132kV network are both now 'saturated'. Further connection requests continue to be received although it is not anticipated that many of these will be viable due to the restrictions mentioned above.

1.1 Summary of issues addressed

The main issues addressed by this RDP are:

- Reinforcement requirements at individual substations
- 33kV network issues
- 132kV n-2 issues
- Generation effects

The main elements of this RDP are as follow:

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

- Carry out reinforcement works at individual primary substations as required by load growth
- Replace the 132/33kV transformers at March Grid with 90MVA units
- Install additional 33kV switchgear at Kings Lynn South Grid
- Source a remotely controllable pole mounted 33kV switch to enable the auto-changeover schemes at the single transformer primary substations to be reinstated

Investment Profile

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

Type	DPCR5 2013-15	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	2020 /2021	2021 /2022	2022 /2023	RIIO-ED1 Total
LRE	£4.6m	£3.2m	£3.7m	£3.1m	£2.0m	£2.3m	£1.5m	£2.4m	£6.7m	£24.9m
NLRE	£0.1m	£0.4m	£0.0m	£1.0m	£1.0m	£0.3m	£1.6m	£2.4m	£2.1m	£8.9m
TOTAL	£4.8m	£3.6m	£3.7m	£4.1m	£3.0m	£2.6m	£3.1m	£4.8m	£8.8m	£33.7m

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 the ED1 period (2022/23). Substations with a projected load index of LI4 and LI5 will be specifically targeted for improvement and are detailed in this document, with the resulting improvement also shown in the figure below.

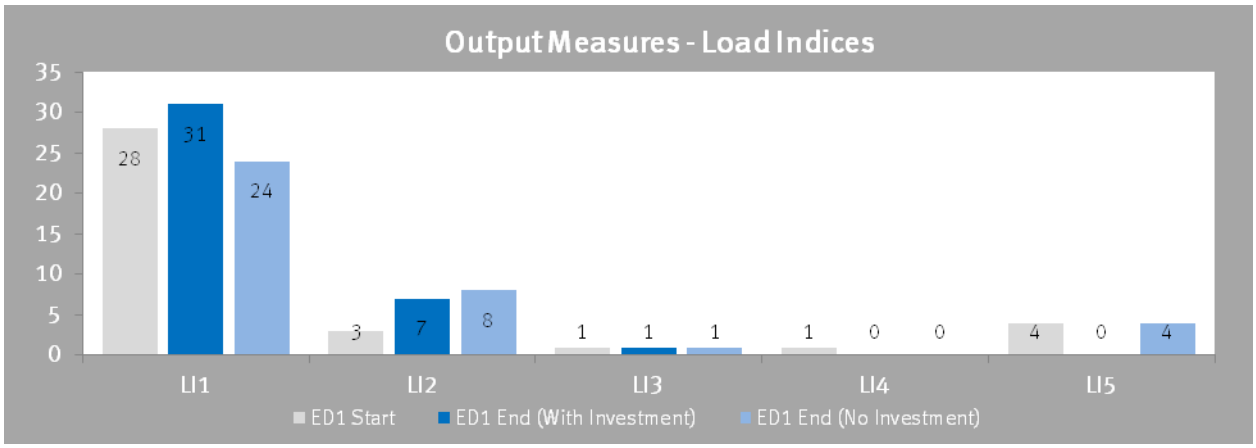
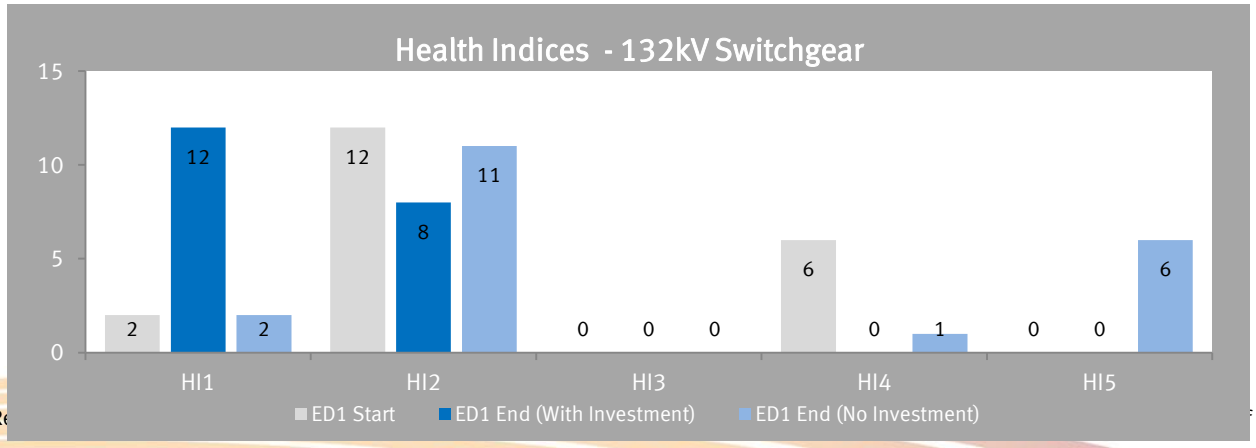
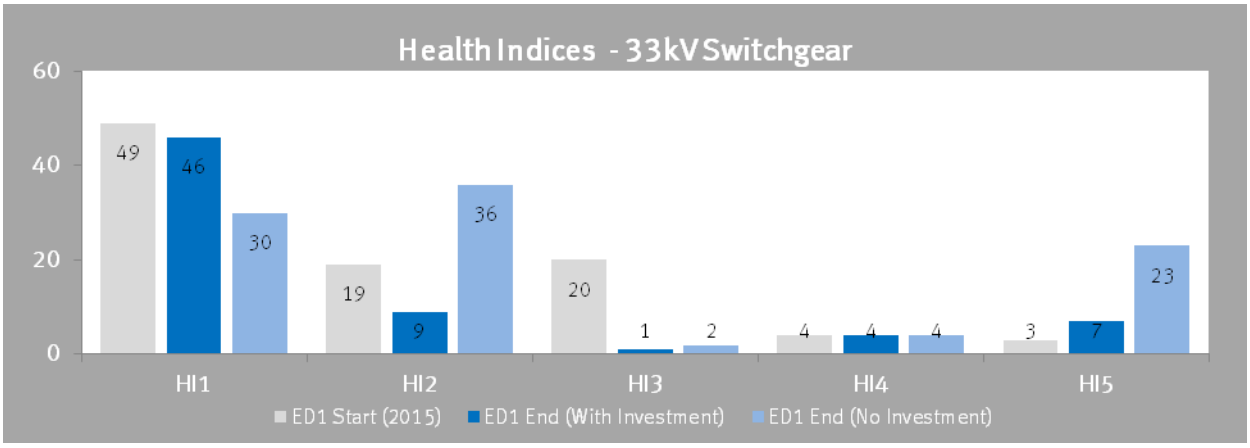


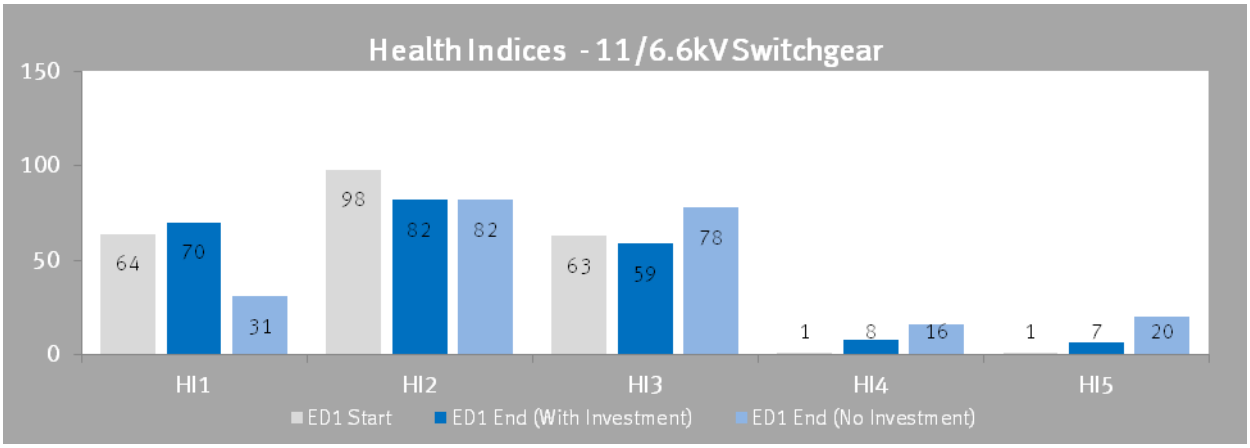
Figure 2. 2022/23 Load Indices with and without interventions

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



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





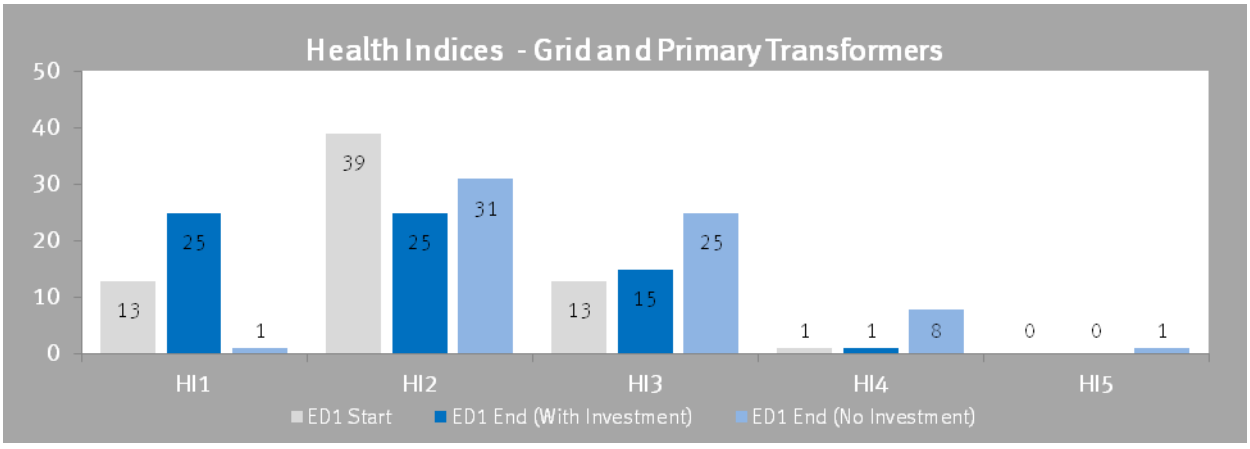


Figure 3. Health Indices by asset category

Scenarios considered

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

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

- Modifications to National Grid network
- Interconnection to other DNO

RDP Dependencies and Interactions

The interaction with Peterborough RDP has been considered.

2 Network configuration

2.1 Existing Network

The network considered by this document is supplied from the National Grid 400/132kV substation at Walpole. The network comprises 6 grid substations and 31 primary substations. A geographical diagram of the network is shown in Appendix A and single line diagrams of the network are shown in Appendix B. The main features of the network are:

- A 132kV double circuit overhead line from Walpole to West March, feeding March 132/33kV Grid Substation (2 x 45MVA transformers) and Walsoken 132/33kV Grid Substation (2 x 90MVA transformers). There are also further 132kV connections from West March to the Peterborough area.
- A double circuit 132kV overhead line from Walpole to Kings Lynn Power Station AIS raft, with a 132kV double circuit tee to Kings Lynn 132/33kV Grid Substation (2 x 60MVA transformers).
- A second double circuit 132kV overhead line from Walpole to Kings Lynn Power Station AIS raft, with a 132kV double circuit tee to the 'Palm Paper' factory.
- A 132kV double circuit overhead line from Kings Lynn Power Station AIS raft to Hempton Grid (2 x 45MVA transformers), with a double circuit tee to Swaffham Grid (1 x 45MVA + 1 x 60MVA transformers) and a single circuit tee to Kings Lynn South Grid (1 x 60MVA 132/33kV transformer + 1 x 10MVA 132/25kV transformer).
- An extensive mesh of 33kV overhead lines and cables connecting the grid substations to the 33/11kV primary substations.

Embedded Generation

There are two major power stations connected to the 132kV network:

- Peterborough Power Station - 3 x 160MVA CCGT units, 132kV connection, presently operating as a Short Term Operating Reserve (STOR) station
- Kings Lynn Power Station - 413MVA CCGT, 132kV connection, presently 'mothballed', but the owners are considering returning it to service.

There are a number of distributed generators connected to the 33kV network as listed below:

- Wissington Sugar Factory – CCGT with 54MVA export capacity
- Coldham Wind Farm – 18 MVA
- Ranson Moor Wind Farm – 10 MVA
- North Pickenham Wind Farm – 16 MVA
- Stags Holt Wind Farm – 20 MVA
- Red Tile 1 Wind Farm – 10MVA
- Coldham 2 Wind Farm – 16 MVA
- Glassmoor2 Wind Farm – 12.3 MVA
- Burnt House Wind Farm – 4.75 MVA
- Burnt House Solar – 6MVA
- Lexham Solar – 9.5MVA
- Fountaine Solar – 9.5MVA

There are also a significant number of 11kV connected generators, which have not been listed individually.

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

2.2 Network changes in progress

The following works are either under construction or expected to commence in the near future. The current planned expenditure profile for these projects can be found in Appendix D.

- Egmere Solar (20MVA). Planned completion 2014
- Meadow Farm Solar (5MVA). Planned completion 2014
- Downham Market Primary : Installation of 33kV switchboard and replacement of 3 x 5MVA transformers with 2 x 11/18/24 MVA transformers. Planned completion 2015.
- Walpole GSP – Replacement of 132kV switchgear. Planned completion 2016.

3 Summary of issues

Planning Load Estimate (PLE) data for the network winter loads is provided in the Appendices

It should be noted that the figures in the PLE for the Grid Substations are forecasts based on actual measured peak values at the individual sites. However, due to the interconnected nature of the 33kV network in this area, the critical value is the load that would appear at a Grid site under outage conditions, which can be higher or lower than the actual recorded peak demand, as the load distribution changes under outage conditions. Generation embedded in the network may also have been masking demand at the peak time.

The assessment of Grid substation reinforcement requirements contained in this strategy has therefore been undertaken by identifying the date & time of overall coincident peak demand on the network by analysis of load data from LIMES, populating the DIgSILENT network model with actual loads and generator outputs recorded at this time, and then utilising the DIgSILENT model to identify predicted Grid substation loadings.

The analysis for future years has then been undertaken by extracting the predicted load growth from the PLE forecasts and applying this to the coincident peak load data referred to above.

Analysis of historical data from LIMES has also identified that the weather conditions prevalent at the time of winter peak demand on the network often lead to limited output from the embedded generation. In addition, it is also known from operational experience that fault outages on this network can cause sufficient voltage disturbance to cause the embedded generators to trip.

The analysis has therefore been conducted assuming that none of the embedded generation will be functioning immediately post-fault.

3.1 Development areas

The main development areas are presently expected to be in the vicinity of Kings Lynn and Wisbech. The local authorities have proposals for developments in these areas, but in the main these take the form of relatively small disparate sites rather than large areas.

It is therefore anticipated that supplies to these sites will be provided by the existing primary substations and this has been factored into the reinforcement requirements identified in section 4.1.

3.2 Asset Replacement

A list of plant recommended for replacement has been included in the ED1 NAMP plan. Dates given are provisional and will change for operational or other reasons such as reinforcement. Costs are generic for the specific plant only and do not take account of any associated equipment which may need replacing at the same time (e.g. structures/bus/line isolators on outdoor CBs).

Walpole/Walsoken Grid 132kV Tower Line (PDC) - 132kV Tower Line Refurbishment

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

The condition assessment of the Walpole/Walsoken Grid 132kV Tower Line (PDC) has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 16 km of 132kV Tower Line refurbished.

March Grid/Walsoken 132kV Tower Line (POD) - 132kV Tower Line Refurbishment

The condition assessment of the March Grid/Walsoken 132kV Tower Line (POD) has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 31 km of 132kV Tower Line refurbished.

Hempton Grid/Swaffham 33kV OHL circuit - 33kV wood pole OHL replacement

The condition assessment of the Hempton Grid/Swaffham 33kV OHL circuit has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 30 km of 33kV OHL circuit replaced.

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

The condition assessment of the 1965/67 English Electric OKM4 outdoor oil insulated switchgear installed at Walsoken 132/33kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 5 circuit breakers replaced with 5 new circuit breakers.

Outwell Moors 33/11kV Primary Substation - replace 33kV CB

The condition assessment of the 1962 South Wales Switchgear E01 outdoor oil insulated circuit breaker at Outwell Moors Primary has shown that the probablility of failure due to degradation will become unacceptable. Completion of the project will see 1 circuit breaker replaced with 1 new circuit breaker.

Outwell Moors 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1962 SWS C4X/C8X indoor oil insulated switchgear installed at Outwell Moors 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 7 circuit breakers replaced with 7 new circuit breakers.

Downham Market 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1962 SWS C4X indoor oil insulated switchgear installed at Downham Market 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 8 circuit breakers replaced with 8 new circuit breakers.

Lt Massingham 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1963 SWS C4 indoor oil insulated switchgear installed at Lt Massingham 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 4 circuit breakers replaced with 4 new circuit breakers.

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

The condition assessment of the 1961 SWS C4X indoor oil insulated switchgear installed at Hardwick Rd 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 11 circuit breakers replaced with 11 new circuit breakers.

Swaffham Grid 33/11kV Primary Substation - Replace Primary Transformers (T1, T2, T3)

The condition assessment of the 1961 7.5MVA Ferranti Primary Transformers and 1964 7.5MVA Watford Primary Transformer installed at Swaffham Grid 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 3 Primary Transformers replaced with 2 new 11/18/24MVA Primary Transformers.

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

3.3 Security of supply analysis

Primary substation supply security

The load growth on this network is mainly due to natural growth in the demand of the existing customer base, with a relatively low level of new connection activity. The majority of development planned by the local council's is in the Kings Lynn area, but there has been little progress with this in recent years due to the economic situation.

Due to the 33kV network being run as a highly interconnected 'mesh' network, the substation peak load predictions can only be used to assess the P2/6 compliance of the individual primary substations in term of their transformer capacity and 11kV transfer capacity. The P2/6 compliance of Grid substations and the 33kV and 132kV network is assessed by network modelling as outages to the 132kV and 33kV circuits dynamically changes the load distribution.

The current Load Index information for all substations in the area can be found in Appendix E.

132kV network – N-1 security

This analysis has been carried out at winter peak loads with no 33kV embedded generation operating as a 'worst case' scenario. This is a viable scenario as experience has shown that the embedded generators are often making little contribution at the time of winter peak load, and also an outage to any of the 132kV circuits can create a voltage disturbance of sufficient magnitude to cause the 33kV connected embedded generators to trip.

2011/12 actual loads

Analysis of the network for a single circuit outage of any of the 132kV circuits that feed the network at 2011/12 actual loads with no embedded generation operating gives the following intact and post-fault loadings:

		Outage						
MVA	Firm	intact	Kings Lynn 1	Kings Lynn 2	Hempton/Swaffham/KLS 1	Hempton/Swaffham 2	Walsoken/March 1	Walsoken/March 2
Kings Lynn Grid	78	77.2	63.9	64	94.1	84	78.8	77.5
Kings Lynn South Grid	60	32.6	33.3	34.6	-	33.6	39.7	42.7
Hempton	58.5	34.6	39.5	39.7	31.1	30.8	35	36
Swaffham	58.5	43.1	47.6	48.4	40.1	36.9	46.1	48.1
Walsoken	114	76.3	79.3	77.2	96.8	78	67.1	63.5
March	58.5	63.5	63.9	63.4	66.7	64.4	59.5	59.7

This shows that for an outage to any of the 6 circuits, the resultant load on March Grid is predicted to be in excess of the present 'firm capacity' of the site. However, this is only an issue for outages to either of the Walpole – Walsoken / March circuits as March Grid would be expected to still have both transformers available for the other outage conditions.

If such a 132kV outage should correspond with an outage of the Wissington – Southery 33kV circuit, this loading condition is predicted to increase to 63MVA.

The above table also shows that under certain outage conditions, the load at Kings Lynn Grid exceeds the nominal 'firm capacity', but this is acceptable at present as both transformers would be expected to be in service under these conditions.

2021/22 predicted loads

Analysis of the network for a single circuit outage of any of the 132kV circuits that feed the network at 2011/22 predicted loads with no embedded generation operating gives the following intact and post-fault predicted loadings:

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

		Outage						
MVA	Firm	intact	Kings Lynn 1	Kings Lynn 2	Hempton/Swaffham/KLS 1	Hempton/Swaffham 2	Walsoken/March 1	Walsoken/March 2
Kings Lynn Grid	78	88.4	74.4	72.5	110.5	98.4	88.3	90.6
Kings Lynn South Grid	60	39	44	44.5	-	43.2	47.9	53.3
Hempton	58.5	44	48.3	48.8	41.3	40.9	42.9	43.7
Swaffham	58.5	56.3	63.6	64.2	53.2	46.2	61.2	64.3
Walsoken	114	84.9	86.3	85.9	112.8	87.3	77.5	71.3
March	58.5	68	68.2	68.1	72.9	69.8	70	68.3

This shows that by 2021/22 it is predicted that the load at March Grid will be in excess of the capacity of the existing transformers under any of the single circuit outage conditions.

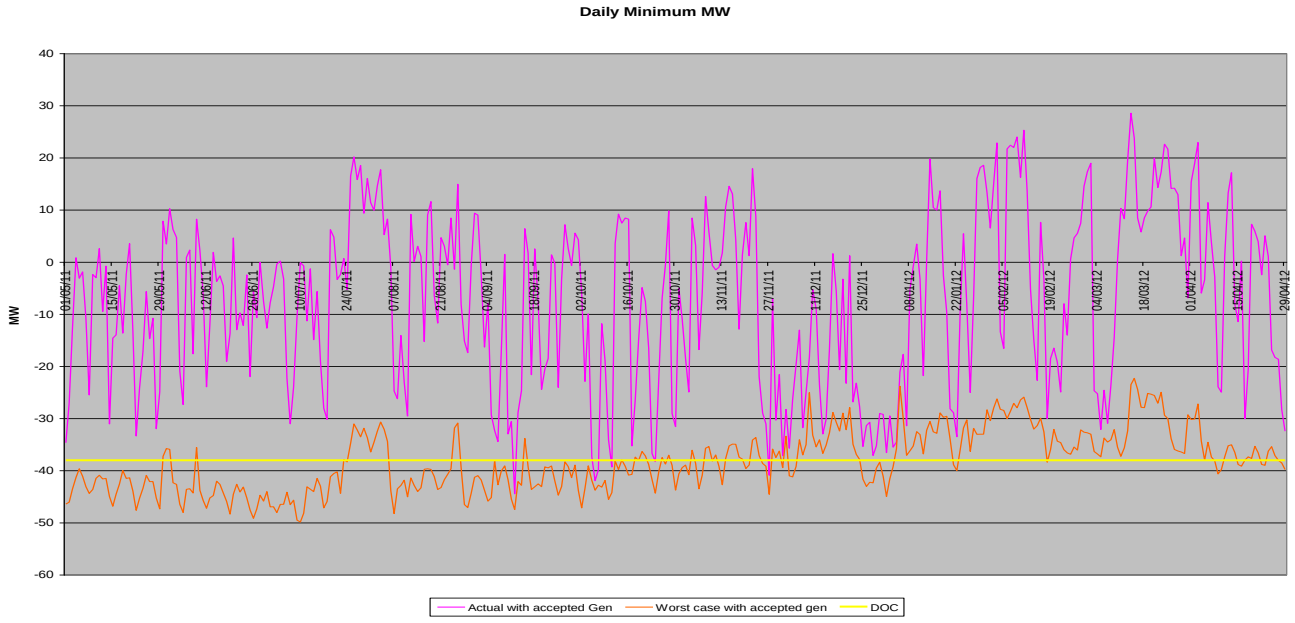
The loading at Kings Lynn Grid and Swaffham Grid under single circuit outage conditions will also be approaching the limits of the transformers.

3.4 Operational & Technical restrictions

Generation effects

March Grid presently has four windfarms with a peak combined output of 47MW, and a Solar generation site with a peak output of 6MW connected to the 33kV network. There are also a number of smaller wind and solar installations both installed and with 'accepted' connection offers at lower voltages.

If all the existing generation and 'accepted' new connections are superimposed upon the actual load and generation data for March Grid, the results are as follows:



The issue is that when the generation exceeds the load, then power is fed back through the Grid Transformers into the 132kV network. In itself this is not a problem, but the Grid Transformers utilise 'directional overcurrent' protection as a backup to the 'intertrip' system to ensure that a 132kV fault is not kept energised from the 33kV network. If the generation should cause a power flow back into the 132kV network that is greater than the protection setting then this could cause loss of the Grid Site. The maximum protection setting that can be applied is shown by the yellow line on the chart above.

The orange line on the chart shows the 'worst case' position, which assumes all the generation is running flat out all the time. As the majority of the generation is wind and solar which are both intermittent by nature, this will obviously not happen in practice.

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

For the pink line, the wind generation has been 'profiled' to the output pattern that has been observed at the sites that have been in commission for a number of years. The solar generation has been assumed to be 'always on' at this time, as we do not yet have sufficient experience with this type of generation to assign a profile to it. This line shows that once all the 'accepted' schemes have been built, we can expect the critical level to be exceeded for a short time on a few occasions during the year.

On this basis, March Grid has been deemed to have reached 'saturation point' in terms of generation connections. For any further connections to be made (and applications are still being received for this area), the network will either have to be modified to remove the limitation of the protection or the schemes would have to be installed with control systems that ensured the network capacity was not exceeded.

Funding has been secured through the Ofgem 'Low Carbon Networks Fund' to implement a project in this area called 'Flexible Plug & Play' (FPP). The backbone of this project is a radio communications system that is designed to allow remotely connected generators to communicate with the Grid Substations so that the generation output can be controlled within the network limitations.

A similar situation has now also occurred at the eastern end of the RDP area, where there is now sufficient 'accepted' generation connection offers to also bring Swaffham Grid and Hempton Grid to 'saturation' point. As a result, further generation connections in this area can now only be achieved by means of constrained connections. A list of generation enquiries as at the time of writing is included as Appendix F.

The volume of generation applications has been such that the 132kV network in this area has also now reached 'saturation point', with any further applications therefore being given a connection point at Walpole GSP.

Network Constraints

Auto-Isolation at Single Transformer Primary Substations

There are number of single transformer Primary substations in this network, which are teed from the 33kV 'ring' circuits. These substations are therefore vulnerable to faults on these circuits, and as a result the majority have been equipped with auto-changeover schemes that are designed to auto-isolate the faulty section of network during the auto-reclose 'dead time'.

The majority of these schemes utilise standard 33kV overhead line switches fitted with a variety of motorised or gas operated actuators to perform this isolation. These actuators have proved to be unreliable, and few of the schemes are still working.

Network Analysis Results

No 33kV circuit reinforcement requirements have been identified by network analysis at 2012 Winter Peak loads for n-1 outage conditions.

Connection of Generation - Heat Map

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

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

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

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

3.5 National Grid

The 400/132kV supergrid substation at Walpole which supplies the West Norfolk network also feeds the Peterborough Network and part of the adjacent DNO 'WPD East Midlands'. Since load estimates for the WPD network are not readily available in a form to enable an assessment of the total load on the GSP to be determined, it was not possible to assess the ability of the existing capacity at Walpole to meet the load demand up to 2022.

However this aspect would be discussed as appropriate at the Joint Technical Liaison Meeting held with National Grid on a regular basis.

4 Recommended strategy

4.1 Description

Primary & Grid Reinforcement

Wisbech Railway 33/11kV Primary Substation - ITC (2 x 18/30/40MVA) and 11kV switchgear
The predicted load at Wisbech Railway Primary Substation will exceed the existing firm capacity, including the transfer capacity to adjacent substations and it is therefore proposed to replace the existing transformers with larger units. As there are some access issues affecting the existing substation site it is proposed to establish the new equipment on an adjacent site. The existing circuits supplying the transformers are fully rated for the larger units. Completion of this project will see the 2 existing transformers replaced with 2 new transformers and the existing switchboard replaced with a new switchboard comprising 10 circuit breakers.

Southery 33/11kV Primary Substation - Replace Primary Transformer (T1)
The predicted load at Southery Primary Substation will exceed the existing firm capacity, including the transfer capacity to the adjacent Primary Substations. It is therefore proposed to replace the 33/11kV transformer.

Lt Massingham 33/11kV Primary Substation - Replace Primary Transformer (T1)
The predicted load at Little Massingham Primary Substation will exceed the existing firm capacity, including the transfer capacity to adjacent primary substations. It is therefore proposed to replace the existing transformer with a larger unit. The existing 11kV switchgear is not rated for the full capacity of the larger transformer, but is proposed to be replaced on a separate non-load related project. Completion of this project will see the existing transformer replaced with 1 new transformer.

Upwell (Lakes End) 33/11kV Primary Substation - ITC (2 x 7/11/15MVA)
The predicted load at Upwell Primary Substation will exceed the existing firm capacity, including the transfer capacity to adjacent substations. It is therefore proposed to replace the existing transformer with a pair of larger units. The existing switchgear is not fully rated for this increased load. The existing circuits supplying the transformers are fully rated for the larger units. Completion of this project will see the existing transformer replaced with 2 new transformers a new 33kV bus-section circuit breaker and a new 11kV switchboard comprising 7 circuit breakers.

Tilney Proposed 33/11kV Primary Substation – New Substation (1 x 7/11/18MVA Unit)
The predicted load at Stickfast Lane Substation will exceed the existing firm capacity, including the transfer capacity to adjacent substations. As the firm capacity at Stickfast Lane is limited by the 11kV transfer capacity, installing a larger transformer will not resolve the issue. It is therefore proposed to construct a new Primary Substation on an existing reserved site to enhance the transfer capacity. This proposed Substation will be supplied from Kings Lynn Grid.

Fairstead Primary - ITC (2 x 18/25.4/40 MVA)

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

The predicted summer load at Fairstead Primary Substation will exceed the existing firm capacity, including the transfer capacity to adjacent primary substations. It is therefore proposed to replace the existing transformers with larger units. The existing switchgear and 33kV circuits supplying the transformers are not rated for the full capacity of the larger transformers, but are not proposed for replacement at this time as they have a higher capacity than the summer rating of the existing transformers. Completion of this project will see the 2 existing transformers replaced with 2 new transformers.

March Grid Proposed Local 33/11kV Primary Substation - (1 x 11/18/24MVA)

The predicted load at March Primary Substation will exceed the existing firm capacity, including transfer capacity to adjacent substations. An ITC of the existing site is not possible due to the capacity of the 33kV circuits. It is therefore proposed to install a new Primary Substation at March Grid. Completion of this project will see the installation of 1 new transformer and a new 11kV switchboard compromising 7 circuit breakers.

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

The predicted load at March Grid Substation will exceed the existing firm capacity. It is therefore proposed to replace the existing transformers with larger units. The existing switchgear is not fully rated for the capacity of the larger transformers, and it is therefore also proposed to replace the transformer and bus-section CBs. Completion of this project will see the 2 existing transformers replaced with 2 new transformers, and 3 existing CBs replaced with 3 new CBs.

Kings Lynn South 132/33kV Grid Substations - Replace Switchboard (2000A)

The 33kV switchboard at Kings Lynn South Grid is South Wales Switchgear type HG36 which is no longer available. It has no bus-section CB, which creates an operational issue as any scenario that requires the busbar to be isolated would isolate the single 132/33kV transformer and also sever the interconnection between Walsoken Grid and Kings Lynn Grid. This would have the effect of leaving the Kings Lynn 33kV network vulnerable to a fault during such an outage. It is also proposed to install a second 132/33kV transformer in ED2 which will require the switchboard to be extended.

It is therefore proposed to replace the Kings Lynn South switchgear to resolve the operational issue, make provision for the installation of the second transformer and provide spare panels to allow other sites with this type of switchgear to be extended.

DG - Proposed new Grid Substation Between March and Peterborough

It is anticipated that the demand for generation connections on the 33kV network fed from March Grid will exceed the maximum capacity that can be provided by the site. Once the maximum capacity of March Grid has been reached it will then be necessary to install a new 132/33kV substation in the area to provide further capacity.

This area is seeing significant renewable generation developments. Our Cost-Benefit analysis of this programme shows that the expected overall societal benefit (largely from abated CO2 and losses) of allowing the earlier connection of renewable generation outweighs the costs of the enabling investment (please refer to Annex 13c Cost Benefit Analysis - 4. CBA Results).

33kV circuit reinforcement

March Grid/Chatteris Primary 33kV Circuits - Rebuild (575A)

The 33kV circuits from March Grid to Chatteris Primary are predominantly 200ACSR construction but also include a section of 150ACSR, which totals 21km of circuit. Network modelling has shown that statutory voltage on the 11kV busbar at Chatteris can only be maintained under n-1 conditions up to a maximum demand of 20MVA.

However, modelling has also shown that this issue can be resolved by rebuilding the 150ACSR section to 200ACSR. It is therefore proposed to rebuild this section of line to enable the full 23MVA winter capacity of Chatteris Primary to be utilised.

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

DG - Rebuild Funtham"s Lane - Chatteris Tee No2 - 200SCA

The section of the March – Chatteris / Whittlesey no 2 33kV circuit between the 'Chatteris tee' and Funtham's Lane is presently constructed of 0.1Cu conductor, which is posing a constraint to the connection of embedded generation to the 33kV network, and limiting transfer capacity between March Grid and Peterborough Central Grid. It is therefore proposed to rebuild this section of line to 200SCA conductor.

Other 33kV Network Issues

It is recommended that a remotely controllable pole-mounted enclosed switch is sourced to replace the actuated ABSDs that no longer work in order to restore the functionality of these auto-isolation schemes. The affected sites are:

- Egmere
- Little Massingham
- Kempstone
- Southery
- Upwell Lakes End

It is also recommended to install new auto-isolation schemes at Watlington and Wiggenhall Primaries.

132kV Network Issues

N-1 Security

It was identified in section 3.3.1 that the residual load on March Grid for a single circuit outage to one of the Walpole – Walsoken/March 132kV circuits whilst the Wissington generator was off-line would be in excess of the transformer rating at winter 2011/12 peak load.

At predicted winter peak loads for 2021/22, the residual load on March Grid for a single circuit outage to any of the 132kV circuits feeding the interconnected network would be in excess of the transformer rating if the Wissington generator was off-line. Even with the generator on-line, an outage to either of the Walsoken / March circuits would overload the remaining transformer at March.

It is therefore proposed to replace the March Grid Transformers. Once the reverse powerflow issues have been resolved, this will also provide additional capacity to connect embedded generation in this area.

Innovation: Demand Side Response

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

Innovation: Flexible Plug and Play

The vision of Flexible Plug and Play is to provide a faster and cheaper method for connecting generators of renewable energy to the electricity distribution network. If UK Power Networks were to connect large amounts of distributed generation, which includes renewable generation, using the traditional approach, where the network already has a high concentration of connections, then network upgrading/reinforcement would be needed. This is expensive and takes time (sometimes years). Flexible Plug and Play will provide an alternative connection choice to renewable generation developers.

The trial area is a rural area of around 700sqkm between Peterborough and March in Cambridgeshire in the East of England. This area has been chosen because in recent years UK Power Networks has seen an increase

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

in the renewable generation connection requests and this area has favourable characteristics for wind generation.

The trial area is within the EPN region of RDP01 (Walpole GSP).

4.2 Financial Appraisal and Benefits

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

5 Rejected Strategies

No alternative strategies have been identified at this time.

6 References

References	Description
Reference 1	Planning Load Estimates EPN Area 2011 - 2023
Reference 2	132kV Network HV Schematic Operating Diagrams East of England
Reference 3	33kV Network HV Schematic Operating Diagrams East of England
Reference 4	Engineering Recommendation P2/6 Security of Supply, July 2006

6.1 Appendices

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

7 Document sign off

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

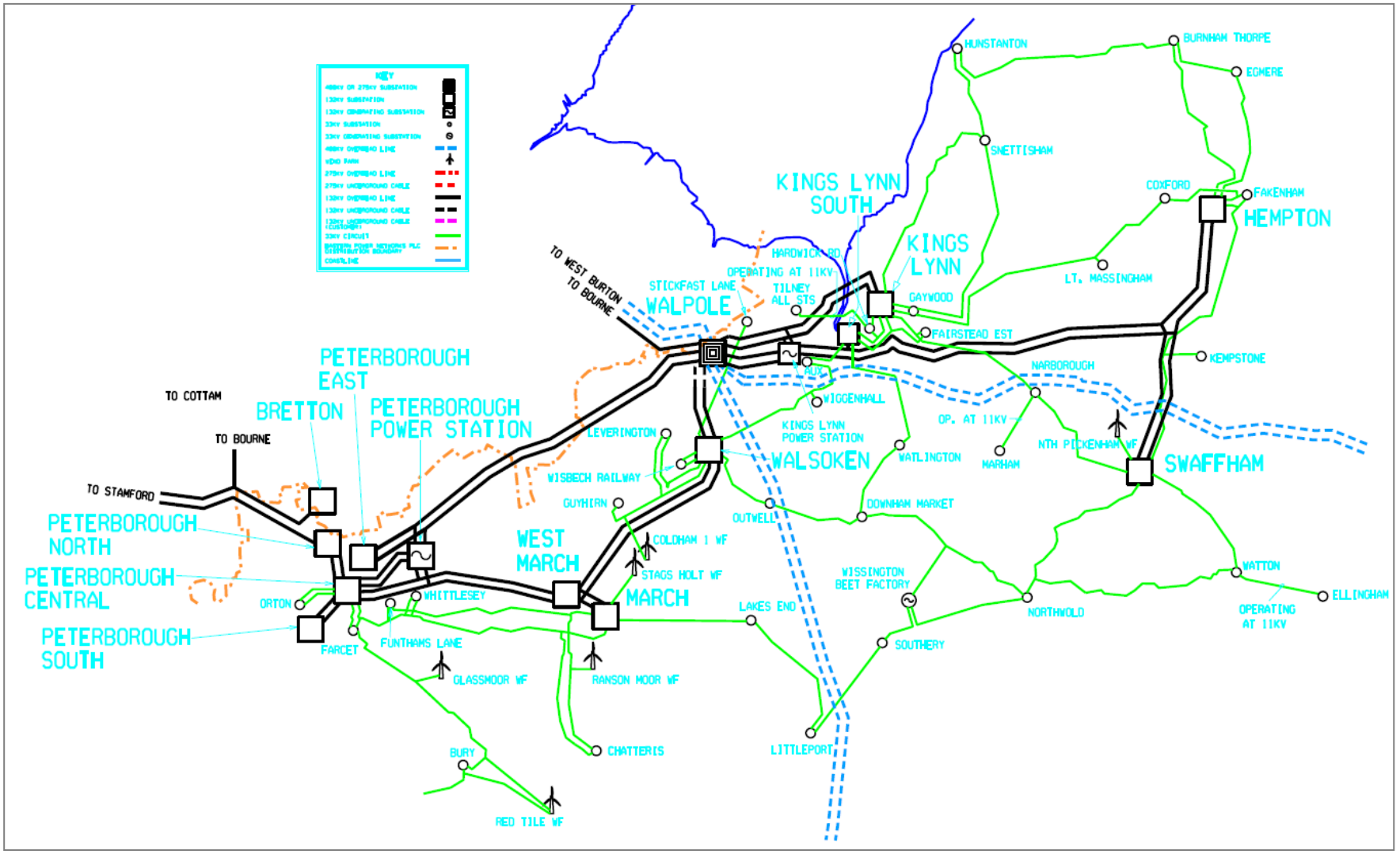
Recommended by:

Name	Role	Signature	Date
Peter Rye	Infrastructure Planning Engineer		
Nuno Da Fonseca	Infrastructure Planning Manager (EPN)		

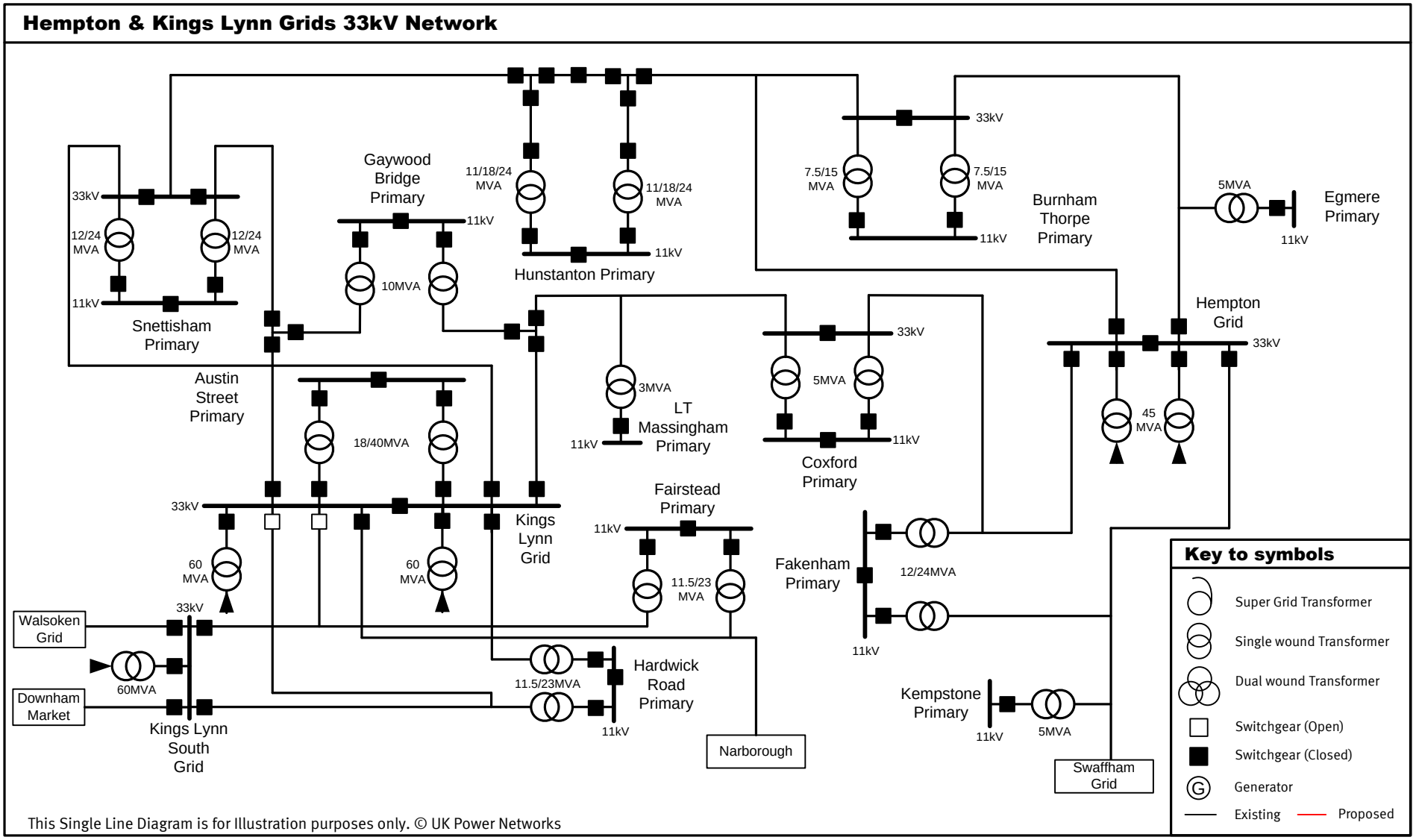
Approval by:

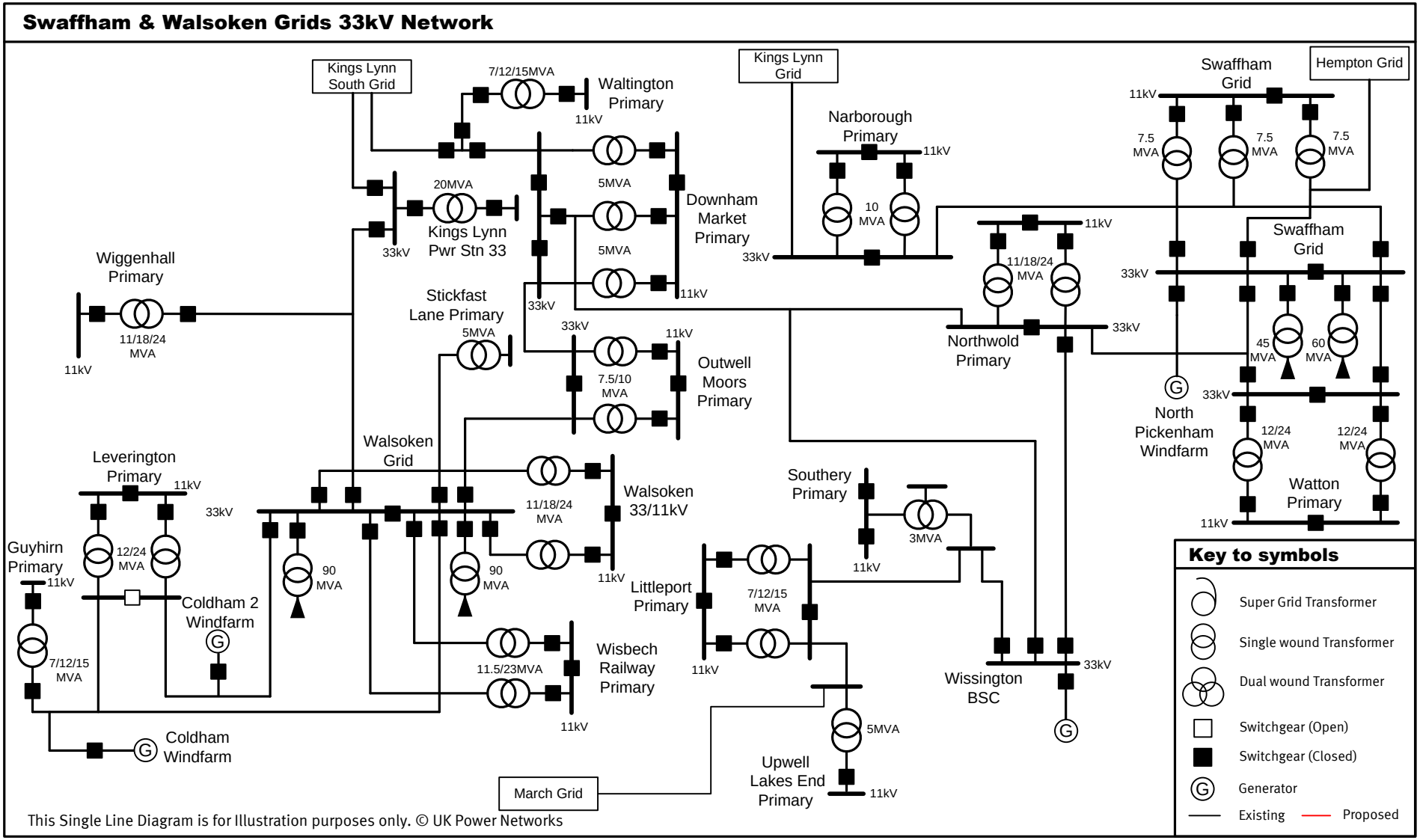
Name	Role	Signature	Date
Robert Kemp	Head of System Development		
Barry Hatton	Director of Asset Management		

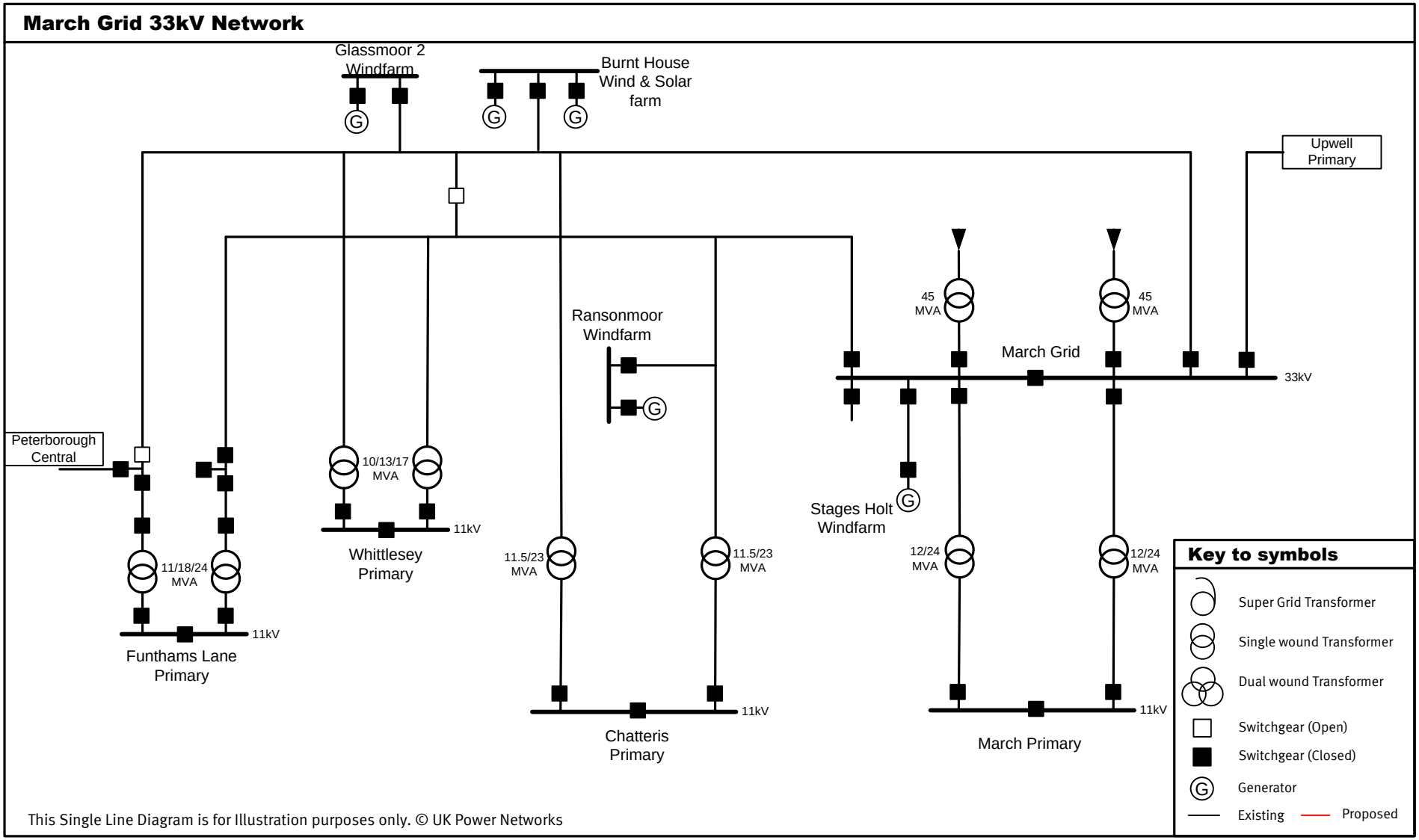
APPENDIX A: GEOGRAPHICAL DIAGRAM



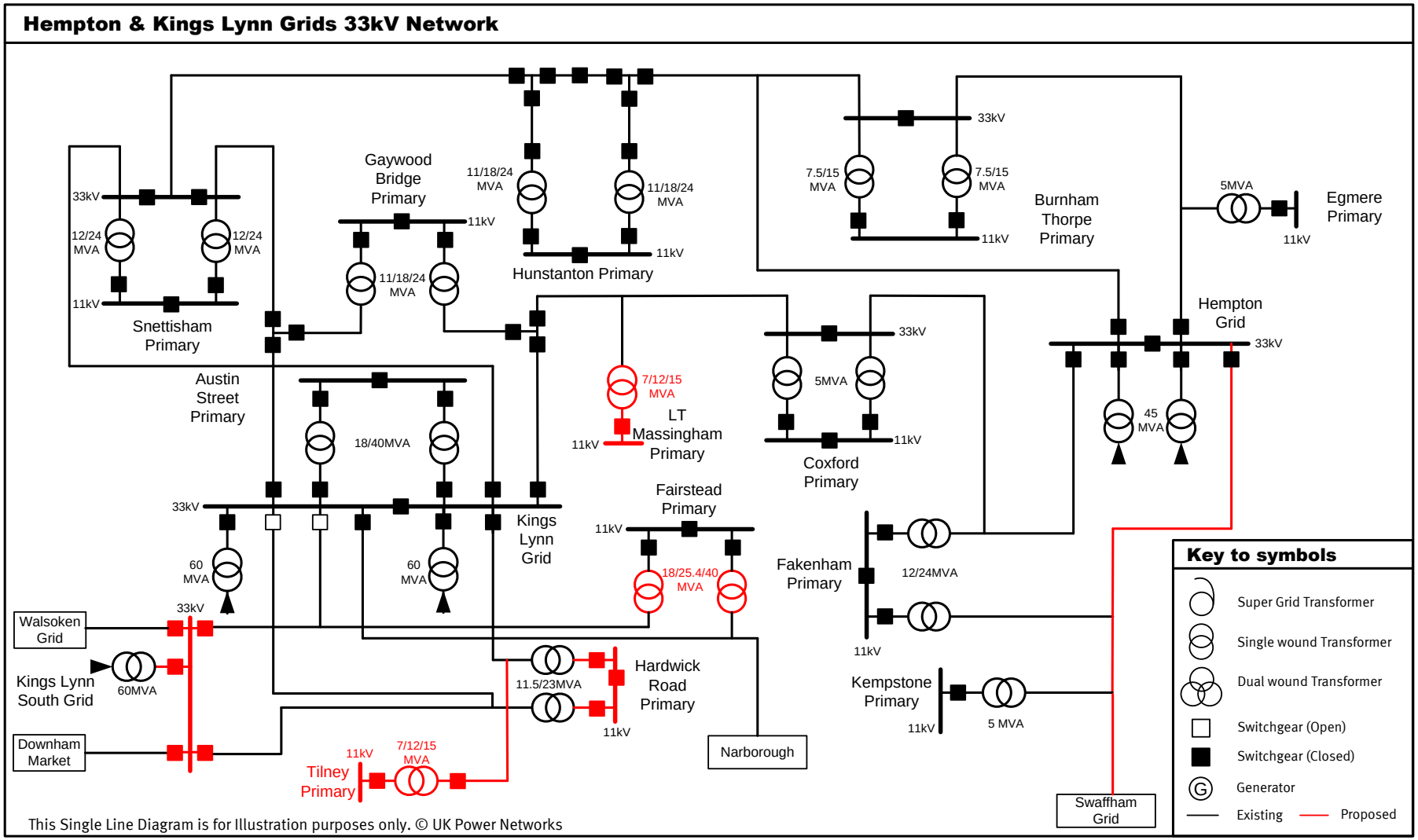
APPENDIX B: SINGLE LINE DIAGRAM – EXISTING NETWORK



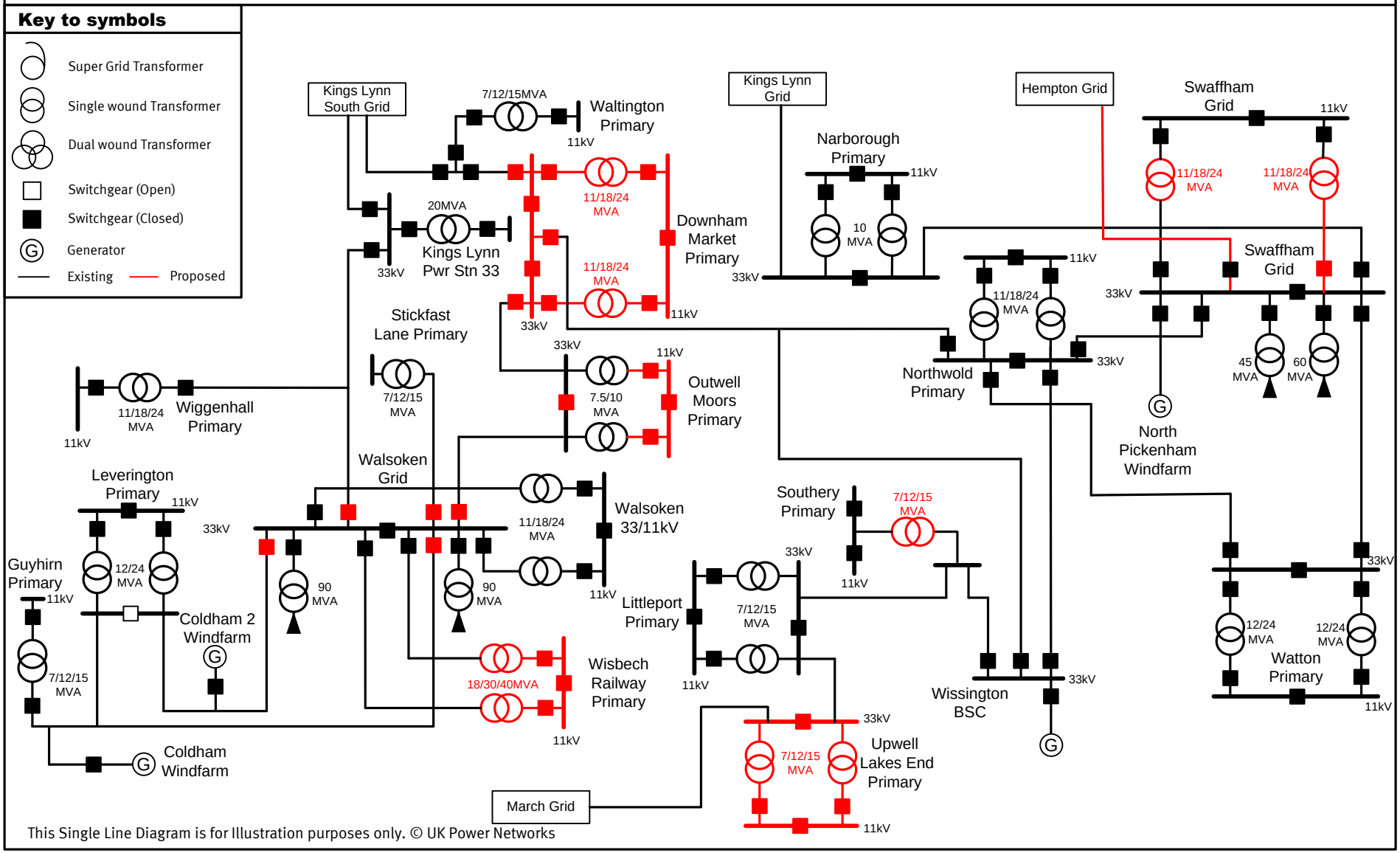

Swaffham & Walsoken Grids 33kV Network
Kings Lynn South Grid
7/12/15MVA
Waltington Primary
11kV
20MVA
Kings Lynn Pwr Stn 33
33kV
5MVA
5MVA
Downham Market Primary
11kV
Kings Lynn Grid
Narborough Primary
11kV
10 MVA
33kV
Swaffham Grid
Hempton Grid
11kV
7.5 MVA
7.5 MVA
7.5 MVA
11kV
11/18/24 MVA
33kV
Swaffham Grid
Wiggenhall Primary
11/18/24 MVA
11kV
Stickfast Lane Primary
5MVA
33kV
11kV
7.5/10 MVA
Outwell Moors Primary
Northwold Primary
33kV
45 MVA
60 MVA
33kV
North Pickenham Windfarm
12/24 MVA
12/24 MVA
Watton Primary
11kV
Walsoken Grid
11/18/24 MVA
Walsoken 33/11kV
11kV
Leverington Primary
11kV
33kV
12/24 MVA
Guyhirn Primary
11kV
Coldham 2 Windfarm
90 MVA
90 MVA
7/12/15 MVA
Southery Primary
3MVA
11kV
Littleport Primary
7/12/15 MVA
11kV
11.5/23MVA
Wisbech Railway Primary
11kV
Wissington BSC
33kV
5MVA
Upwell Lakes End Primary
11kV
March Grid
Coldham Windfarm
Key to symbols
Super Grid Transformer
Single wound Transformer
Dual wound Transformer
Switchgear (Open)
Switchgear (Closed)
Generator
Existing
Proposed
This Single Line Diagram is for Illustration purposes only. © UK Power Networks

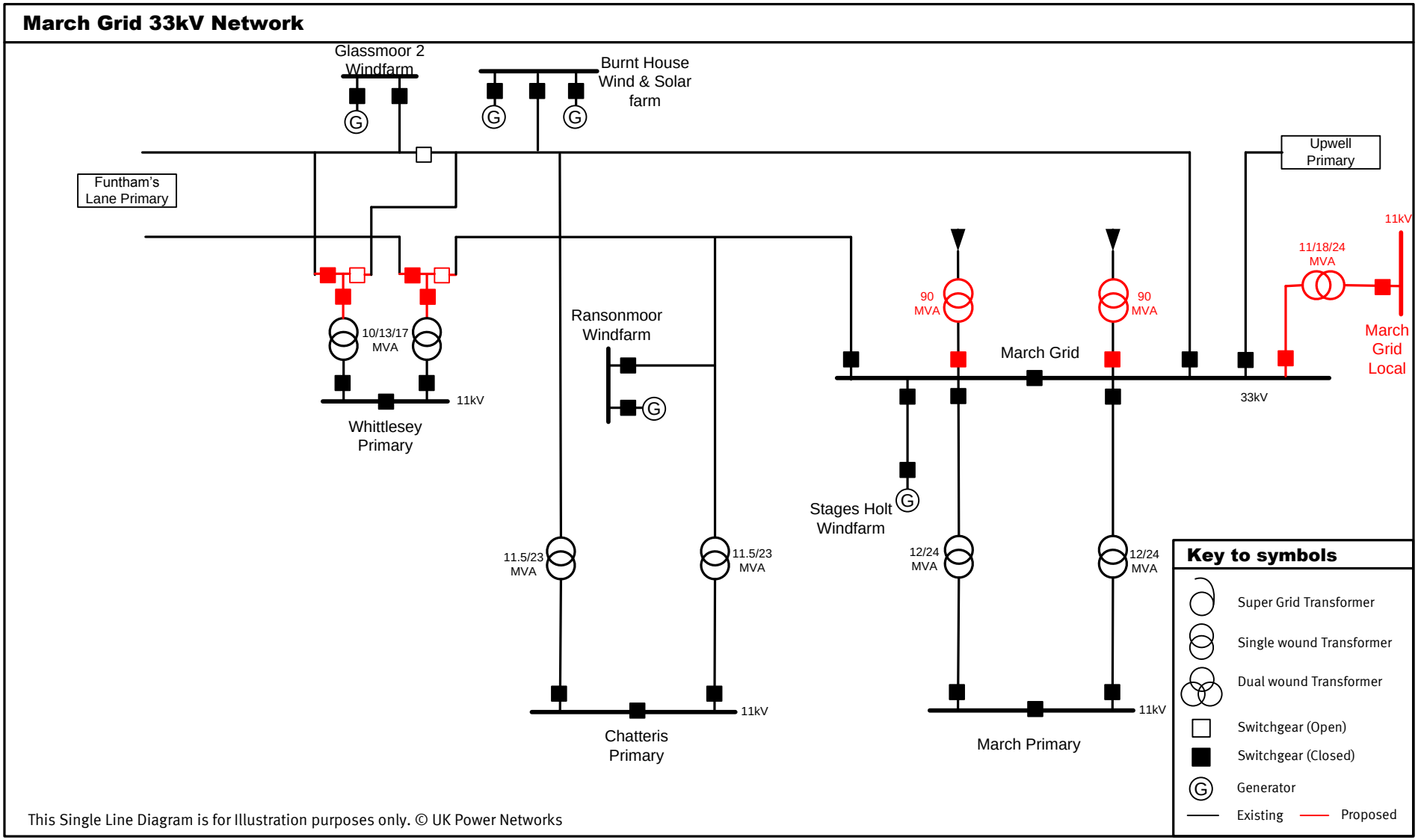

March Grid 33kV Network
Glassmoor 2 Windfarm
Burnt House Wind & Solar farm
Upwell Primary
Peterborough Central
10/13/17 MVA
11kV
Whittlesey Primary
Ransonmoor Windfarm
45 MVA
45 MVA
March Grid
33kV
Stages Holt Windfarm
11/18/24 MVA
11kV
Funthams Lane Primary
11.5/23 MVA
11.5/23 MVA
11kV
Chatteris Primary
12/24 MVA
12/24 MVA
11kV
March Primary
Key to symbols
Super Grid Transformer
Single wound Transformer
Dual wound Transformer
Switchgear (Open)
Switchgear (Closed)
Generator
Existing
Proposed
This Single Line Diagram is for Illustration purposes only. © UK Power Networks

APPENDIX C: SINGLE LINE DIAGRAM – RECOMMENDED STRATEGY



Swaffham & Walsoken Grids 33kV Network




March Grid 33kV Network
Glassmoor 2 Windfarm
Burnt House Wind & Solar farm
Funtham's Lane Primary
Upwell Primary
10/13/17 MVA
11kV
Whittlesey Primary
Ransonmoor Windfarm
90 MVA
90 MVA
March Grid
33kV
11/18/24 MVA
11kV
March Grid Local
Stages Holt Windfarm
11.5/23 MVA
11.5/23 MVA
12/24 MVA
12/24 MVA
11kV
Chatteris Primary
11kV
March Primary
Key to symbols
Super Grid Transformer
Single wound Transformer
Dual wound Transformer
Switchgear (Open)
Switchgear (Closed)
Generator
Existing
Proposed
This Single Line Diagram is for Illustration purposes only. © UK Power Networks

APPENDIX D: DETAILED COSTS FOR RECOMMENDED STRATEGY

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

Cat	Project ID	Description	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
A	4048	PDC - Walpole - Walsoken Grid - Conductor Replacment									247,260	741,779
A	7545	POD - March Grid - Walsoken - Conductor Replacement								510,200	1,406,064	
A	7573	3G71A - Swaffham Grid Local T2 - Hempton Grid - 33kV Wood Pole OHL Replacement									439,476	1,350,411
A	2390	Walsoken 132/33kV Grid Substation - Replace 33kV Switchgear					540,841					
A	3937	Outwell 33/11kV Primary Substation - Replace 33kV CB	79,870									
A	5811	Downham Market 33/11kV Primary Substation - Replace 11kV Switchgear					234,119	539,771				
A	7655	Lt Massingham 33/11kV Primary Substation - Replace 11kV Switchgear		47,711	358,528							
A	7691	Hardwick Rd 33/11kV Primary Substation - Replace 11kV Switchgear								241,527	318,469	
A	7701	Outwell Moors 33/11kV Primary Substation - Replace 11kV Switchgear					232,605	509,141				
A	7771	Swaffham Grid 33/11kV Primary Substation - Replace Primary Transformers (T1, T2, T3)							334,729	848,186		
R	6352	Underground HB & PLG 132kV Routes at Walpole GSP (Kings Lynn Circuits)			1,174,142	1,127,315	1,127,315					
R	2363	(RDP - West Norfolk) Downham Market 33/11kV Primary Substation - ITC (2 x 11/18/24MVA)	1,007,775	1,012,904								
R	2963	Gaywood Bridge 33/11kV Primary Substation - ITC (2 x 11/18MVA) - Transformer Work	337,500									
R	3328	Kempstone 33/11kV Primary Substation - Demand Side Response (DSR)						10,000	35,000	35,000	35,000	35,000
R	3560	Wisbech Railway 33/11kV Primary Substation - ITC (2 x 18/30/40MVA) and 11kV Switchgear				10,161	274,359	975,497	801,084			
R	3588	Southery 33/11kV Primary Substation - Replace Primary Transformer (T1)										174,618
R	3589	Lt Massingham 33/11kV Primary Substation - Replace Primary Transformer (T1)			174,011	395,203						

Walpole GSP (excluding Peterborough)

Cat	Project ID	Description	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
R	4173	Upwell (Lakes End) 33/11kV Primary Substation - ITC (2 x 7/11/15MVA)								353,695	1,045,239	
R	4271	Tilney Proposed 33/11kV Primary Substation – New Substation (1 x 7/11/18MVA)					9,542	419,074	1,096,591			
R	5730	Fairstead 33/11kV Primary - ITC (2 x 18/25.4/40 MVA)								12,068	374,109	940,227
R	5731	Orton 33/11kV Primary Substation - Demand Side Response (DSR)									30,000	30,000
R	4091	March Grid Proposed Local 33/11kV Primary Substation - (1 x 11/18/24MVA)			9,678	231,459	805,670	585,502				
R	2365	March Grid 132/33kV Grid Substation - ITC (2 x 90MVA Units)	10,357	451,651	1,682,319	1,261,739						
R	8529	DG - Proposed new Grid Substation Between March and Peterborough								21,254	488,832	5,525,926
R	2378	Walpole GSP 132kV Exit Point - Replace CBs (NG*)	852,243	962,052								
R	3997	Walsoken/March 132kV Tower Line (POD) Circuits - Install 132kV CB''s		11,674	151,758	443,600	236,594					
R	3840	Kings Lynn South 132/33kV Grid Substations - Replace Switchboard (2000A)							9,853	165,749	408,568	
R	2177	Feltwell/Southery Proposed 33kV OHL Circuit- (770A(W))										
R	2360	Gaywood/Snettisham 33kV OHL - Rebuild (575A(W))										
R	3924	March Grid/Chatteris Primary 33kV Circuits - Rebuild (575A)							327,959	899,704		
R	8530	DG - Rebuild Funtham's Lane - Chatteris Tee No2 - 200SCA			22,942	247,375	630,408					

APPENDIX E: 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**
Austin Street	S	Transformer	30.0		30.0	23.9	24.8	LI1	LI2		30.0	LI2	C	Yes
Burnham Thorpe	W	Switchgear	12.0		12.0	6.7	6.6	LI1	LI1		12.0	LI1	B	Yes
Chatteris	W	Voltage	20.0		20.0	17.3	18.6	LI2	LI2	3924	22.8	LI2	C	Yes
Coxford	W	Aux equipment	5.0		5.0	3.7	3.7	LI1	LI1		5.0	LI1	B	Yes
Downham Market	W	Aux equipment	15.2	2363	15.2	10.3	11.2	LI1	LI1		15.2	LI1	B	Yes
Egmere	W	Backfeed	2.6		2.6	2.1	2.1	LI1	LI2		2.6	LI2	B	Yes
Fairstead Total	S	Transformer	17.3		17.3	16.1	16.4	LI2	LI2	5730	22.8	LI1	C	Yes
Fakenham	S	Transformer	18.0		18.0	13.8	14.4	LI1	LI2		18.0	LI2	C	Yes
Gaywood Bridge	W	Transformer	13.0		22.8	15.6	16.7	LI1	LI1		22.8	LI1	C	Yes
Guyhirn	W	Backfeed	3.1		3.1	2.5	2.5	LI1	LI1		3.1	LI1	B	Yes
Hardwick Road total	S	Transformer	17.3		17.3	10.6	10.9	LI1	LI1		17.3	LI1	B	Yes
Hempton Grid 33	S	Transformer	48.2		48.2	22.9	23.8	LI1	LI1		48.2	LI1	C	Yes
Hunstanton	W	Aux equipment	15.2		15.2	8.9	9.8	LI1	LI1		15.2	LI1	B	Yes
Kempstone	W	Backfeed	4.4		4.4	3.8	3.9	LI2	LI1	3328	5.0	LI1	B	Yes
Kings Lynn Grid 33	S	Transformer	71.0		75.3	47.0	49.4	LI1	LI1		75.3	LI1	C	Yes
Kings Lynn South Grid	S	Backfeed	31.3		38.6	21.8	23.1	LI1	LI1		38.6	LI1	C	Yes
Leverington	S	Transformer	18.0		18.0	14.3	14.6	LI1	LI2		18.0	LI2	C	Yes

				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**
Littleport	S	Transformer	12.0		12.0	6.4	6.9	LI1	LI1		12.0	LI1	B	Yes
Lt Massingham	W	Backfeed	3.0		3.0	3.4	3.6	LI5	LI5	3589	5.6	LI1	B	Yes
March Grid 33	W	Transformer	60.1		61.0	47.9	50.8	LI1	LI2	2365	114.3	LI1	C	Yes
March Primary	S	Transformer	18.0		18.0	19.3	14.2	LI4	LI1	4091	18.0	LI1	C	Yes
Narborough	W	Transformer	13.0		13.0	10.3	10.1	LI1	LI1		13.0	LI1	B	Yes
Northwold	W	Transformer	24.0		24.0	10.1	9.9	LI1	LI1		24.0	LI1	B	Yes
Outwell Moors	S	Transformer	7.5		7.5	5.0	5.0	LI1	LI1		7.5	LI1	B	Yes
Snettisham total	W	Circuit Rating	20.0		20.0	9.6	10.5	LI1	LI1		20.0	LI1	B	Yes
Southery	W	Backfeed	2.6		2.6	2.5	2.5	LI3	LI3	3589	2.6	LI3	B	Yes
Stickfast Lane	W	Backfeed	3.8		3.8	4.2	4.1	LI5	LI5	4271	5.0	LI2	B	Yes
Swaffham Grid	W	Transformer	18.0		18.0	8.5	9.0	LI1	LI1		18.0	LI1	B	Yes
Swaffham Grid 33	W	Transformer	62.6		79.2	45.3	46.3	LI1	LI1		79.2	LI1	C	Yes
Upwell Lakes End	W	Backfeed	2.3		2.3	2.9	2.9	LI5	LI5	4173	15.0	LI1	B	Yes
Walsoken	W	Transformer	24.0		24.0	16.5	16.9	LI1	LI1		24.0	LI1	C	Yes
Walsoken Grid 33	W	Switchgear	126.9		128.4	60.5	62.0	LI1	LI1		128.4	LI1	D	Yes
Watlington	W	Transformer	15.0		15.0	4.4	4.8	LI1	LI1		15.0	LI1	B	Yes
Watton	S	Transformer	18.0		18.0	13.9	14.7	LI1	LI2		18.0	LI1	C	Yes
Whittlesey	W	Transformer	17.0		17.0	13.0	14.3	LI1	LI1	3900	19.1	LI1	C	Yes
Wiggenhall	W	Backfeed	4.3		4.3	2.8	2.9	LI1	LI1		4.3	LI1	B	Yes
Wisbech Railway	S	Transformer	17.3		17.3	19.4	20.2	LI5	LI5	3560	30.0	LI1	C	Yes
Tilney					0.0	0.0	5.2			4271	7.0	LI2	B	Yes

				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**
March Grid Local										4091	10.0	LI1		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
KINGS LYNN PWR STN 132		8					8					8			
PALM PAPER INTAKE	2					2					2				
WALPOLE GRID		2		6			1		1	6	10				
WEST MARCH 132		2					2								
TOTAL	**2**	**12**		**6**		**2**	**11**		**1**	**6**	**12**	**8**			

	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
BURNHAM THORPE PRIMARY			1							1					1
COLDHAM 2 WINDFARM	1					1									
COLDHAM WINDFARM	1					1									
COXFORD PRIMARY	1					1					1				
DOWNHAM MARKET PRIMARY		3					3					3			
GLASSMOOR WINDFARM S/S	1					1									
GUYHIRN PRIMARY	1					1					1				
HARDWICK RD PRIMARY											2				
HEMPTON GRID			7							7					
HUNSTANTON PRIMARY	5					5					5				
KEMPSTONE PRIMARY											5				
KINGS LYNN GRID	14						14								
KINGS LYNN PWR STN 33		3					3								
KINGS LYNN SOUTH GRID		6					5	1			6				
LITTLEPORT PRIMARY	1					1					1				
MARCH GRID	1		6	2			1			8	3	1			5
NARBOROUGH PRIMARY	1					1					1				
NORTHWOLD PRIMARY	2					1	1				1	1			
OUTWELL MOORS PRIMARY				1						1	1				
RANSONMOOR WINDFARM	1						1								
SNETTISHAM PRIMARY	2					2					2				
STAGS HOLT WINDFARM PRIMARY	1					1									
SWAFFHAM GRID	1	3	5			1	2	1	4	1	1	2	1	4	1
WALSOKEN GRID	7		1	1	3	5	2			5	10	2			
WATLINGTON PRIMARY	2					2									
WATTON PRIMARY	5					5					5				
WIGGENHALL PRIMARY	1					1					1				
WISSINGTON BSC		4					4								
TOTAL	**49**	**19**	**20**	**4**	**3**	**30**	**36**	**2**	**4**	**23**	**46**	**9**	**1**	**4**	**7**

	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
AUSTIN STREET PRIMARY	12	1					13					13			
BURNHAM THORPE PRIMARY		5					2	3				2	3		
CHATTERIS PRIMARY		5	5					8	2				8	2	
COXFORD PRIMARY		7					3	4				3	4		
DOWNHAM MARKET PRIMARY			7	1				2	2	4	8				
EGMERE PRIMARY		1					1					1			
FAIRSTEAD PRIMARY		8	2				4	6				4	6		
FAKENHAM PRIMARY		10					10					10			
GAYWOOD BRIDGE PRIMARY		10						10					10		
GUYHIRN PRIMARY		1	3						3	1				3	1
HARDWICK RD PRIMARY			11					7	2	2	11				
HUNSTANTON PRIMARY			7						3	4				3	4
KEMPSTONE PRIMARY		5						5					5		
LEVERINGTON PRIMARY	12					12					12				
LITTLEPORT PRIMARY		2	7					9					9		
LT MASSINGHAM PRIMARY			4						2	2	4				
MARCH PRIMARY	12						12					12			
NARBOROUGH PRIMARY	9					9					9				
NORTHWOLD PRIMARY	9						9					9			
OUTWELL MOORS PRIMARY			7					1	2	4	7				
SNETTISHAM PRIMARY		9					9					9			
SWAFFHAM GRID		9					1	8				1	8		
UPWELL LAKES END PRIMARY		1					1					1			
WALSOKEN GRID		4					1	3			4	1	3		
WATLINGTON PRIMARY	5					5									
WATTON PRIMARY		9			1		9			1		9			1
WEST MARCH 132															
WHITTLESEY PRIMARY		9	2				7	3		1		7	3		1
WIGGENHALL PRIMARY	5					5					5				
WISBECH RAILWAY PRIMARY		2	8					9		1	10				
TOTAL	**64**	**98**	**63**	**1**	**1**	**31**	**82**	**78**	**16**	**20**	**70**	**82**	**59**	**8**	**7**

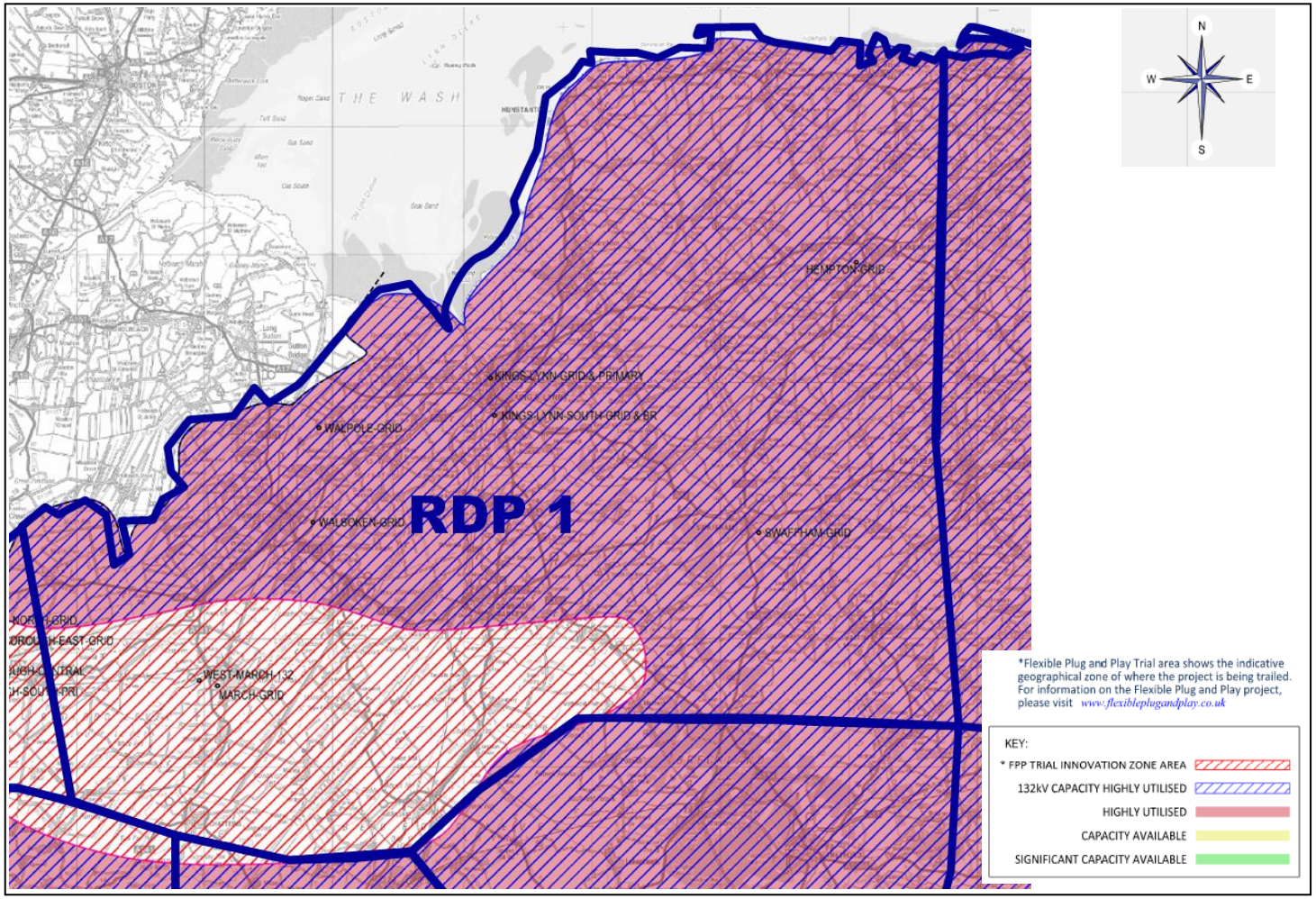
	Grid and Primary Transformers														
	ED1 Start (2015)					End of ED1 (2023) No Investment					End of ED1 (2023) With Investment				
Substation	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
AUSTIN STREET PRIMARY		2					2					2			
BURNHAM THORPE PRIMARY		2					2					2			
CHATTERIS PRIMARY		2					2					2			
COXFORD PRIMARY			2					1	1				1	1	
DOWNHAM MARKET PRIMARY		3						3			2				
EGMERE PRIMARY			1					1					1		
FAIRSTEAD PRIMARY		2						2			2				
FAKENHAM PRIMARY		2					1	1				1	1		
GAYWOOD BRIDGE PRIMARY			2						2		2				
GUYHIRN PRIMARY	1						1					1			
HARDWICK RD PRIMARY		2						2					2		
HEMPTON GRID		2					1	1							
HUNSTANTON PRIMARY	2						2					2			
KEMPSTONE PRIMARY			1					1			2				
KINGS LYNN GRID			2						2						
KINGS LYNN SOUTH GRID		2					1	1				1	1		
LEVERINGTON PRIMARY	2						2					2			
LEXHAM SOLAR FARM															
LITTLEPORT PRIMARY	2						2					2			
LT MASSINGHAM PRIMARY			1						1		1				
MARCH GRID		2					1	1			2				
MARCH PRIMARY		2					2					2			
NARBOROUGH PRIMARY		2						2					2		
NORTHWOLD PRIMARY	2						2					2			
OUTWELL MOORS PRIMARY		2					2					2			
SNETTISHAM PRIMARY		2						2					2		
SOUTHERY PRIMARY			1						1		1				
STICKFAST LN PRIMARY		1						1							
SWAFFHAM GRID		3	1	1			2	1	1	1	2	1	1		
UPWELL LAKES END PRIMARY		1					1				2				
WALSOKEN GRID	2	1					2	1			1	2	1		
WATLINGTON PRIMARY	1						1								
WATTON PRIMARY		2					1	1				1	1		
WHITTLESEY PRIMARY			2					2			2		2		
WIGGENHALL PRIMARY	1					1					2				
WISBECH RAILWAY PRIMARY		2					1	1			2				
TILNEY PRIMARY											1				

Walpole GSP (excluding Peterborough)

	Grid and Primary Transformers													
	ED1 Start (2015)				End of ED1 (2023) No Investment					End of ED1 (2023) With Investment				
MARCH GRID LOCAL										1				
TOTAL	**13**	**39**	**13**	**1**	**1**	**31**	**25**	**8**	**1**	**25**	**25**	**15**	**1**	

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.



Eastern Power Networks Generation Capacity Map 14-01-2014