Regional Development Plan - 19

Rayleigh & Tilbury GSP (EPN)

Planner	Howard Green
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Contents

1 Executive Summary

This Regional Development Plan (RDP) reviews UK Power Networks (UKPN) HV and EHV network supplied from the two Tilbury and the Rayleigh (part) Grid Supply Points (GSP).

The Rayleigh and Tilbury Exit Point Groups provide energy to the busy area of South East Essex incorporating much of the Thames Gateway Regeneration Area along the River Thames. The combined area has approximately 207,000 customers in a dense urban part of South East Essex with significant towns at Southend and Basildon both with a diverse industrial and commercial mix of large energy users and protected coastlines all with an approximate demand of 327MVA.

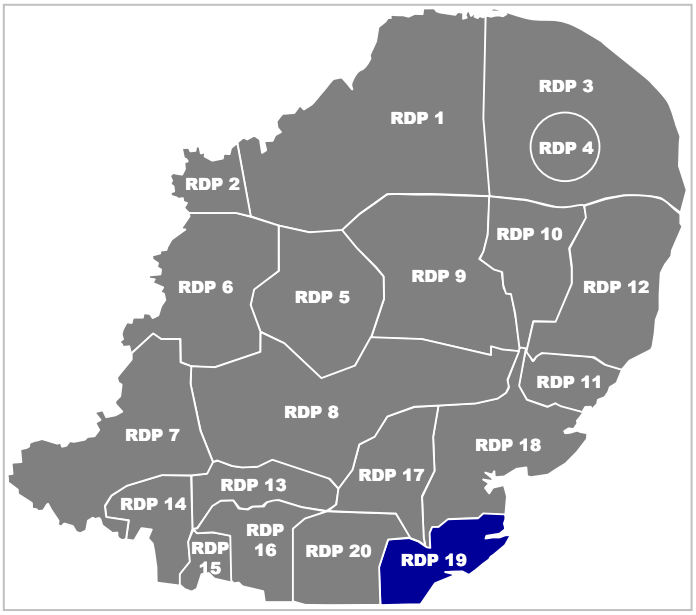


Figure 1 – Area covered by the RDP

Within the area there are key infrastructure sites at the London Gateway port development, on the ex Shell Refinery site on the banks of the River Thames, the adjacent Coryton Refinery, the Port of Tilbury and four coastal areas protected by the Ramsar (Wetlands of International Importance) Convention. The London Southend Airport has undergone extensive expansion including lengthening of the runway and redevelopment to promote itself as an alternative to the other London airports. Basildon has also attracted data centre developments into the town.

Development in the area is limited mainly to the brown-field sites spread across the area and the areas not already designated as protected. There are several areas of Green Belt between the urban areas. Both Basildon and Southend are identified within the East of England Spatial Strategy as key centres for development and change and have higher than average projected growth in jobs and housing. The total growth in jobs in this RDP area is 33500 with an additional 24500 new homes through to 2031, with approximately two thirds of this due to take place in the Basildon and Southend areas alone (sourced from Thames Gateway Essex Partnership & East of England Plan >2031, March 2010).

There are landfill generation sites in the area such as Pitsea and Mucking connected at 33kV as well as smaller sites connected at 11kV.

1.1 Summary of issues addressed

The combination of an expected higher than average level of natural growth in housing and provision of employment and large point load customers results in a potentially high increase in demands. There is a significant difference between the large customer maximum demands and the reserved capacity they are contracted for and often under utilise their agreed maximum power requirement. This drives reinforcement apparently in advance of need and before LI5 is reached in order to maintain the contracted supply limits to these few customers.

The Tilbury – Shell/Coryton Grid – South Benfleet 132kV tower line has the potential to become unfirm and then would require reinforcement. It is intended to manage demand at 33kV between adjoining Grid substations deferring this major reinforcement until necessary. At present the reinforcement and asset replacement projects at Rayleigh Local will enable the transfer of Hadleigh Primary from South Benfleet Grid onto Rayleigh Local sufficiently to defer the upstream reinforcement beyond the ED1 period.

Whilst no specific plans exist to reinforce Southend, future network developments need to be cognisant that the demand on the 132kV circuits is approaching 100MW. Therefore the possibility of managing the load via the

33kV network may be required to remain compliant with P2/6. The reinforcement of Fleethall Grid will enable load transfers to relieve Southend Grid and the 132kV circuits from Rayleigh and will further defer its reinforcement.

Investment Profile

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

RDP	Type	DPCR5 2013-15	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	2020 /2021	2021 /2022	2022 /2023	RIIO-ED1 Total
RDP19	LRE	£1.6m	£1.9m	£1.7m	£2.2m	£1.2m	£1.5m	£2.0m	£0.3m	£0.3m	£11.1m
	NLRE	£4.6m	£0.7m	£1.9m	£2.5m	£2.7m	£4.1m	£3.1m	£3.2m	£3.1m	£21.3m
	TOTAL	£6.1m	£2.6m	£3.6m	£4.7m	£3.9m	£5.6m	£5.1m	£3.6m	£3.4m	£32.4m

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 considered for improvement and are detailed in this document, with the resulting improvement also shown in figure 3.

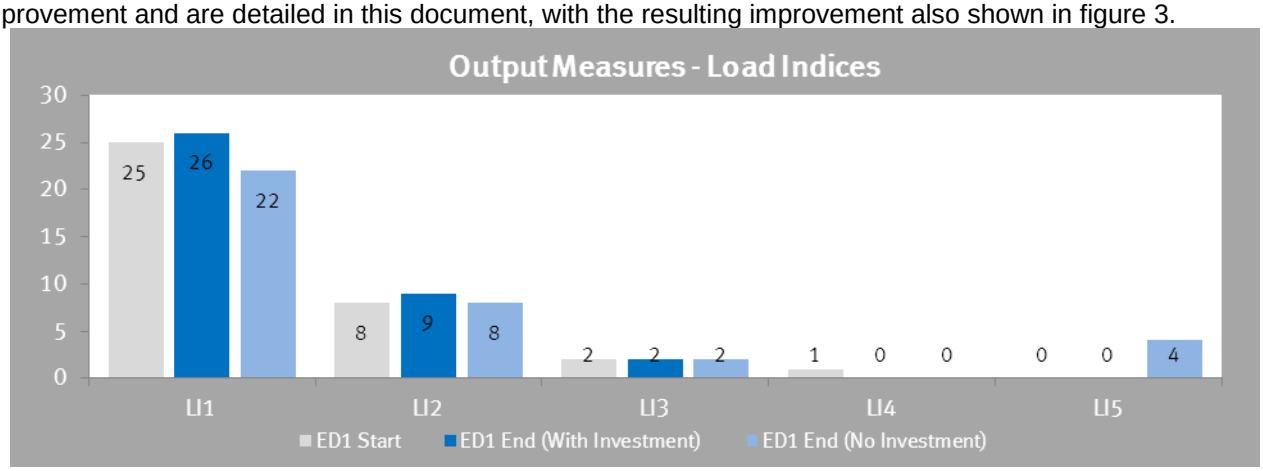
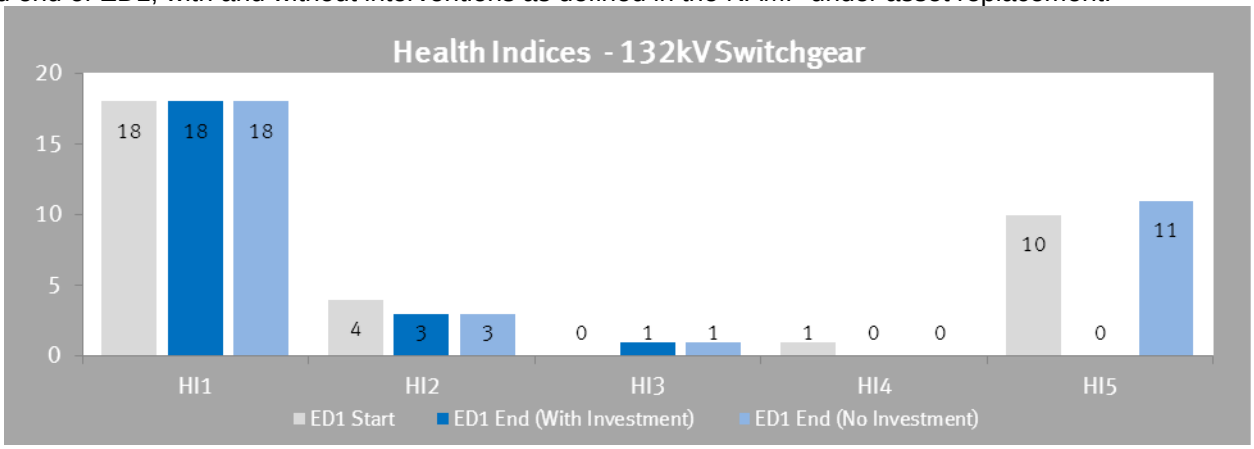
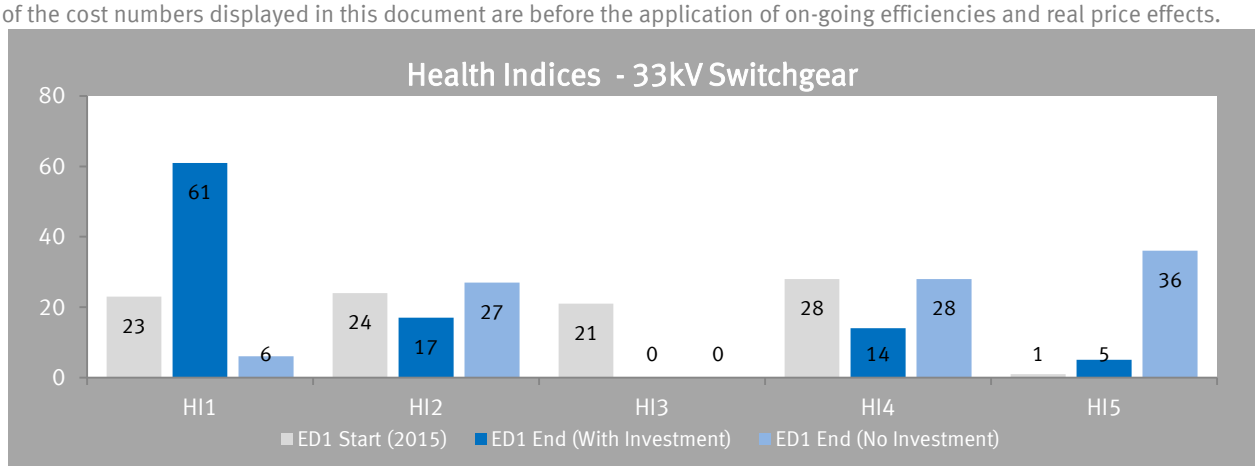


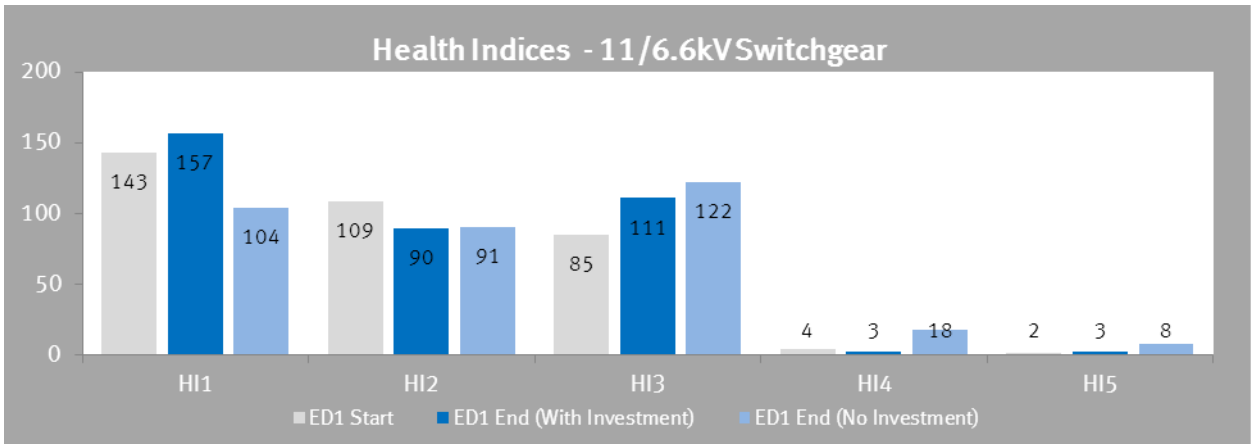
Figure 2. Load Indices (LI)

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



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





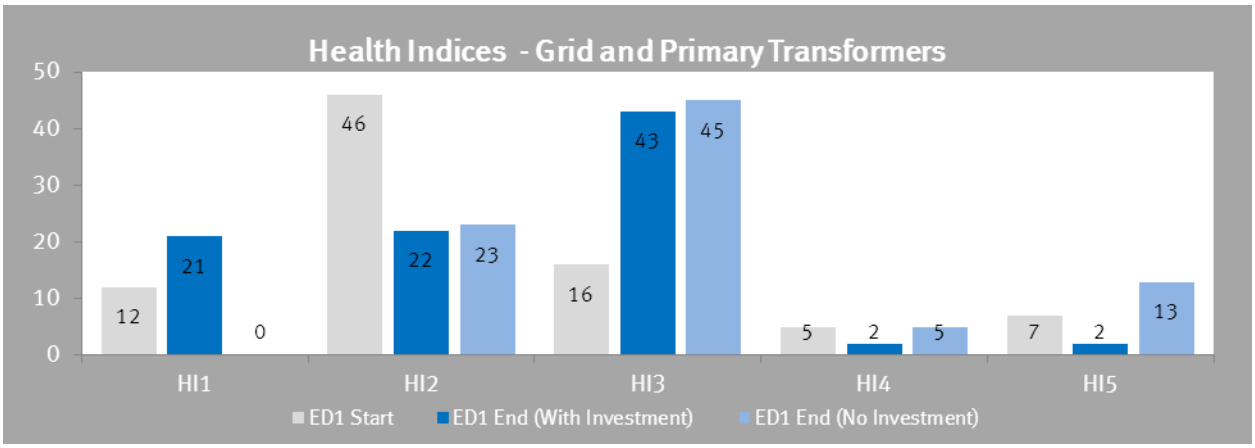


Figure 3. Health Indices by asset category

Scenarios Considered

- Demand growth from Planning Load Estimates (PLE's) up to 2023.
- Major Generation sites disconnected
- Compliance with P2/6 Standard for Security of Supply and operational flexibility of the 132kV and 33kV networks.

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

RDP Dependencies and Interactions

- Demand increase occurs at predicted rate.
- New Developments within reasonable demand parameters.
- Completion of the Rayleigh Main 132kV works.

2 Network configuration

2.1 Existing Network

The Rayleigh and Tilbury networks are interconnected at 132kV via the Basildon Grid (PAB & PSC) and Nevendon Grid (PD) routes. There is also 33kV interconnection between South Benfleet, Rayleigh and Nevendon Grids and. Additional 33kV interconnection exists to Purfleet Grid from Tilbury Local Grid.

Much of the current network was established in the 1950's and 60's. Most of the 132kV and 33kV circuits are operated as dual circuit with a few exceptions notably at Shell and Coryton Grid substations that each has a single 132/33kV transformer with paralleled 33kV. Much of the 132kV network is overhead circuits with cabled entries to the Grid substations. However Southend 132/33kV, 132/11kV and 132/25kV substations are all fed through approximately 12km of 132kV underground cable (FFC) from Rayleigh Grid. The demand on these circuits is approaching 100MW and as such the second circuit outage conditions for class D within P2/6 will become increasingly onerous beyond the ED1 review period.

The network is expected to remain compliant through the ED1 by the transfer of demand at 33kV between Sth Benfleet Grid to Rayleigh Grid, (once Rayleigh has been reinforced) with the transfer of Hadleigh Primary (approximately 18MVA). A second transfer of Little Belhus Primary to secure Tilbury Local can be made to Purfleet Grid. Both of these can be made without major investment as circuits and switchgear already exist.

The network has several embedded generation connections at 33kV and the rural areas are attracting fresh enquiries for large scale PV installation and wind farms. This may drive reinforcement predominately of some 33kV circuits on a proportional basis.

2.2 Network changes in progress

Rayleigh Main 132kV GIS – Asset Replacement of 132kV AIS switchgear

Rayleigh Local 132/33kV Grid Substation - Replace 33kV switchgear (2000A)

Rayleigh Local 132/33kV Grid Substation – Reinforcement 132/33kV ITC (2 x 90MVA)

Tilbury local 33/11kV Primary substation – Reinforcement 11kV Interconnection to Selwyn Road

Nevendon 132/33kV Grid Substation - Replace 33kV Switchgear (Fault Level)

Rebuild Fleethall - Burnham 33kV OHL P1 - P49 – Rebuild OHL (completed 2013)

Basildon Local 33/11kV Primary Substation – Asset Replacement of 11kV Switchgear (2000amp) (completed 2013)

Wickford 33/11kV Primary Substation – Asset Replacement of 11kV switchgear (2000amp) (completed 2013)

3 Summary of Issues

3.1 Development areas

The Sub Regional Growth Area forms part of the Thames Gateway South Essex Development Partnership (TGSEP), formally the Thames Gateway. This stretches from Barking in east London and reaches as far along the Thames estuary as Southend on Sea. The Thames Gateway redevelopment has been driving regeneration and new developments over the last 10 years and will continue for the foreseeable future in the new TGSEP.

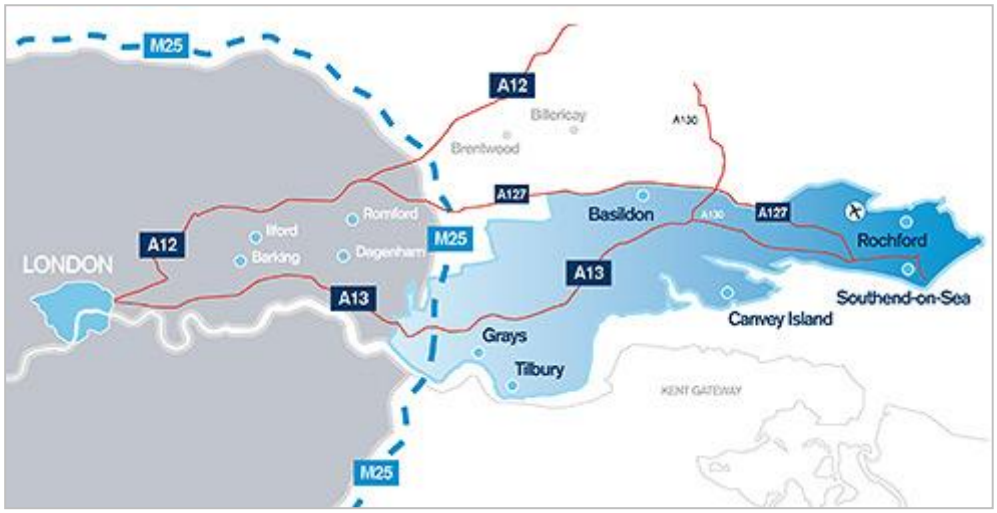


Figure 4. Sub Regional Growth area of Thames Gateway

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

Authority	Job Growth	New Housing	
		Total	per annum
Basildon	12000	10700	535
Castle Point	4500	4000	200
Rochford	7000	4600	230
Southend	12000	6500	325
Tilbury		18500	925

(Extracts from East of England Regional Spatial Strategy & Thames Gateway South Essex Area Partnership)

The development of a deep water port (London Gateway) near Corringham that opened it's first phase open in quarter 4 2013 will provide additional employment opportunities with an total estimated 12000 jobs directly, plus many more indirectly. The port is to take its primary supply directly from the transmission system. However a 30MVA 'back up' reserve capacity supply will be retained form the local 33kV network at Shell Grid. The refinery at Coryton has ceased oil production and is expected to become a distribution depot under its new owners. This may lead to a reduction in their agreed MPR and release of capacity back into the network. The site is expected to be re-developed with commercial/industrial loads and an energy park for green embedded generation technologies.

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).

Tilbury/Basildon 132kV Tower Line (PAB) - 132kV Tower Line Refurbishment

The condition assessment of the Tilbury/Basildon 132kV Tower Line (PAB) has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising CI and CML performance, therefore this project recommends the refurbishment. Completion of the project will see 26 km of 132kV Tower Line refurbished.

Rayleigh/Fleethall 132kV Tower Line (PY) – Tower Line Refurbishment

The condition assessment of the Rayleigh/Fleethall 132kV Tower Line (PY) has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising CI and CML performance, therefore this project recommends the refurbishment. Completion of the project will see 28km of 132kV Tower Line replaced.

Shell Tee/South Benfleet (PBD) Refurbishment

This is a 132 kV double circuit line which runs for 9.6km between Shell Tee and South Benfleet. It consists of 35 towers built in 1968, predominantly to the PL16 design. It has Zebra phase conductors (400mm2 ACSR) and Lynx earth wire (175mm2 ACSR), neither of which have any record of being reconductored.

During a line patrol, it was recorded that the fittings and insulators were in poor condition on the entire route. A scheme was raised to replace the fittings and insulators on the entire route. It was decided that instead of this, only 10% of the fittings and insulators would be replaced and these would be sent to EA Technology for testing.

The report has been returned from EA Technology and it shows that the insulators are near their end of life, and replacement should be considered in the near future.

It is planned to do some work on this line for BT21 in 2015. It is not yet confirmed what will be used. This may come forward to align with this scheme in 2013. If it is, and no matter the solution chosen, the opportunity to align outages and mobilisation costs shall be taken to reduce costs.

Tilbury 132kV/Tilbury Local 132kV Tower Line (PP) - 132kV Tower Line Refurbishment

The condition assessment of the Tilbury 132kV/Tilbury Local 132kV Tower Line (PP) has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising CI and CML performance therefore this project recommends the replacement. Completion of the project will see 2 km of 132kV Tower Line refurbished, though a possible diversion may require undergrounding of this section.

Tilbury/Shell/Coryton 33kV OHL circuit - 33kV wood pole OHL replacement

The condition assessment of the Tilbury/Shell/Coryton 33kV OHL circuit has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising CI and CML performance, therefore this project recommends the replacement. Completion of the project will see 14 km of 33kV OHL circuit replaced.

Tilbury Compact Grid/Mucking Generator/Shell Grid 33kV OHL circuit - 33kV wood pole OHL replacement

The condition assessment of the Tilbury Compact Grid/Mucking Generator/Shell Grid 33kV OHL circuit has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising CI and CML performance, therefore this project recommends the replacement. Completion of the project will see 6 km of 33kV OHL circuit replaced.

Bata / Leemans 33kV OHL circuit - 33kV wood pole OHL replacement

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

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

The condition assessment of the 1963 SWS UE1 indoor oil insulated switchgear installed at Southend 132/33kV Grid 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.

UK Pipelines 132/33kV Grid Substation - Replace 33kV Switchgear

The condition assessment of the 1956 SWS EO1 outdoor oil insulated switchgear installed at UK Pipelines 132/33kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 2 circuit breakers replaced with 2 new circuit breakers.

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

The condition assessment of the 1966 SWS ET indoor oil insulated switchgear installed at Coryton 132/33kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 9 circuit breakers replaced with 9 new circuit breakers.

Gardiners Lane 33/11kV Primary Substation – Replace 11kV Switchgear

The condition assessment of the 1964 SWS C4X indoor oil insulated switchgear (No R/C) installed at Gardiners Lane 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. It is not possible to keep these assets in use without compromising operational requirements, therefore this project recommends its replacement. Completion of the project will see 11 circuit breakers replaced.

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

The condition assessment of the 1963 REY LM23T indoor oil insulated switchgear installed at Canvey 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 12 circuit breakers replaced with 12 new circuit breakers. Consideration of refurbishment will be also considered.

Rayleigh 132/33kV Grid Substation – Replace Grid Transformers (GT1b, GT2B)

The existing transformer capacity is constrained due to their poor condition which has affected the oil ducts around the transformer cores, limiting their ability to effectively maintain working temperatures. Both transformers have a discharge condition and are susceptible to further damage should a close-up fault occur and cause passage of high levels of fault current, they are also condition 5 for PCB levels. The transformers are fitted with slow speed tap-changers requiring regular maintenance. The transformers also emit an elevated level of background noise that is exasperated by the use of pumps and fans during first circuit outages. Local residents have reported this to the local Environmental Health Officer who accepts that the issue will be resolved by replacement of the transformers and does not propose to take any formal action at present. Operation of the replacement circulation pumps on occasion initiates a Buchholz trip due to the oil surge.

Southend 132/33kV Grid Substation - Replace Grid Transformers (GT1B, GT2B)

The condition assessment of the 1958/66 BET Grid Transformers installed at Southend 132/33kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 2 Grid Transformers replaced with 2 new Grid Transformers.

Tilbury Local 132/33kV Grid Substation - Replace Grid Transformers (GT5, GT7)

The condition assessment of the 1956 BET Grid Transformers installed at Tilbury Local 132/33kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 2 Grid Transformers replaced with 2 new Grid Transformers. The 132/33kV Grid Transformers have been identified as part of ED1 reinforcement strategy.

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

The condition assessment of the two 1955 Hackbridge Hewittick transformers at Selwyn Road Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 2 Primary Transformers replaced with 2 new Primary Transformers.

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

The condition assessment of the 1966 FUL Primary Transformer installed at Durham Rd 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 2 Primary Transformers replaced with 2 new Primary Transformers.

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

The condition assessment of the 1967 FUL Primary Transformer installed at Thundersley 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 2 Primary Transformers replaced with 2 new Primary Transformers.

Coryton 132/33kV Grid Substation - Refurbish Grid Transformers (GT2)

The condition assessment of the 1966 GEC Grid Transformer installed at Coryton 132/33kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 1 Grid Transformer refurbished.

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

The condition assessment of the 1972 HSP Primary Transformer installed at Marshfoot Road 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 1 Primary Transformer refurbished.

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

The condition assessment of the 1969 EEC Primary Transformer installed at Southend West 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 2 Primary Transformers refurbished.

3.3 Security of supply analysis

Substation	Demand (MW)	Supply Class	Demand (MVA)			P2/6	Comments
			2015	2018	2022		
Tilbury 132KV 2/3	108	D	107	153	159	Compliant	
Tilbury 132kV 1/7	113	D	127	164	174	Compliant	
Rayleigh 132kV	540	E	570	610	620	Compliant	

Table 2. P2/6 Assessment table

3.4 Operational and technical constraints

At Tilbury the National Grid provide two Bulk Supply Points each with two SGT's with no interconnection between them at 132kV. This arrangement avoids the creation of a Class E group in terms of P2/6 and therefore the added obligation to meet outage requirements.

The 132kV overhead lines in the group cross Network Rail tracks in two places both over the Fenchurch St – South-end lines. A further diamond crossing on the PEA line exists under the National Grid 400kV connection to the generation plant at Coryton.

Within the Tilbury group the new London Gateway Deep Water Port is under construction and has a 30MVA supply connection directly from Shell Grid. This connection is an alternative to the main supply that has been secured from the transmission system at the Coryton Generation site. The 30MVA will need to be reserved for the port under normal operating conditions.

The Coryton Refinery went into receivership in 2012 and changed ownership. The site still has a multiple 33kV connection arrangement albeit with a much reduced MPR. Redevelopment of the site including an energy park is being considered with an increased MPR and generation export.

The network fed from this Supply Point Group interconnects at Low Voltage between the Supply points with some Super Grid parallels at 33kV 11kV and LV.

3.5 National Grid

National Grid have recently established a 400kV GIS substation at Tilbury and in the process of replacing their 275/132kV exit point transformers to 400/132kV. Their current proposals are to replace on a like for like basis all four SGT's and retaining the two Bulk Supply Point arrangement. Other National Grid reinforcement is taking place to their OHL circuits in preparation for increased generation connection.

The Tilbury power station operated by RWE was decommissioned in 2013 and is due to be disconnected from the 132kV and 275kV networks. National Grid is considering the number of 400/132kV SGT's at Tilbury that will directly impact the 132kV connection arrangement to the UKPN connected networks. This may require 132kV reconfiguration to maintain supplies to a reduced number of SGT's Meetings are expected to take place during 2014 to resolve this.

4 Recommended strategy

With the completion of the reinforcement and asset replacement works at Rayleigh main and the asset replacement at Tilbury by National Grid this ensures the Grid Supply Points have more than adequate capacity for the foreseeable future. The increasing load on the Shell/Coryton and Sth Benfleet 132kV (PEA) will be managed through the ED1 period with transfers to adjacent Grid substations fed from other Grid Supply Points. This approach will avoid major expenditure for additional 132kV circuits. The future 132kV network operating arrangements at Tilbury will depend on discussions with National Grid later in 2014.

The 33kV network can be retained with relatively minor reinforcement works whilst also benefitting from additional capacity created during asset replacement of transformers and switchgear that can facilitate demand transfers.

The projects detailed in Appendix D will maintain adequate capacity to meet predicted growth.

<u>Bellhouse Lane 33/11kV Primary Substation - ITC (2 x 12/18/24MVA) and 11kV switchboard</u>

The predicted load at Bellhouse Primary Substation will exceed the existing firm capacity, including the transfer capacity to Leigh Substation (due in 2022). It is therefore proposed to replace the existing 15MVA ONAN 33/11kV transformers with larger 12/24MVA OFAF units. The existing (800amp) 11kV switchgear is not fully rated for this increased load. The existing circuits supplying the transformers are not fully rated for the full capacity of larger units. However they will provide at least 21MVA and hence it is not proposed to replace these

circuits at this time. The 11kV switchboard HI rating is 4 at the start of ED1 rising to 5 by the end and will need replacement.
Completion of this project will see the 2 existing transformers replaced with 2 new transformers and the 11kV switchboard replaced.

Mucking Creek Proposed 33/11kV Primary Substation - (2 x 18/30/40MVA)
The demand on Rainbow Lane is increasing as new demands are introduced and the existing networks will require reinforcement in the form of a new primary substation. The demand on Rainbow lane is predicted to exceed firm capacity within the ED1 period (2018).
On completion of this project a two 33/11kV transformer new primary substation will be established to relieve Rainbow Lane with a permanent demand transfer.

Leigh 33/11kV Primary Substation - 11kV Transfer scheme to Hadleigh Road and Bellhouse Ln
The predicted demand at Leigh Primary is expected to exceed the site firm capacity. An 11kV transfer scheme to move demand onto Hadleigh and/or Bellhouse Lane is proposed.

11kV Transfer from Hainault Ave Prim to Fleethall Local
The predicted demand at Hainault Avenue Primary is expected to exceed the site firm capacity. An 11kV transfer scheme to move demand onto Fleethall Local is proposed.

11kV Demand Transfer from Basildon Local to Langdon Primary
The predicted demand at Basildon Local is expected to reach the site firm capacity. It is proposed to provide additional 11kV transfer to Langdon Primary.

11kV Demand Transfer from Canvey to South Benfleet Local Primary
The predicted demand at Canvey Primary is expected to reach the site firm capacity. It is proposed to provide additional 11kV transfer to South Benfleet Primary.

(RDP - Fleethall/Southend) Fleethall 132/33kV Grid Substation - ITC (2 x 90MVA)
The predicted load at Fleethall Grid will exceed the existing firm capacity, including the transfer capacity to Rayleigh Grid within the ED1 period (2019). It is therefore proposed to install new larger capacity transformers (90MVA), 33kV switchgear (2000amp) and bus-bars. The existing 132kV 175mm ACSR circuits from Rayleigh are fully rated for the larger capacity transformers.

Completion of this project will see the 2 new transformers installed and the associated existing 33kV AIS switchgear replaced.

Rayleigh Local 132/33kV Grid substation – ITC (2 x 90MVA)
The predicted load at Rayleigh S/S will exceed the existing firm capacity, including the transfer capacity to Nevendon and South Benfleet S/Ss. The existing switchgear is not fully rated for this increased load. It is therefore proposed to replace this switchgear. The existing circuits supplying the transformers are fully rated for the larger units. The 132/33kV transformers are to be replaced as part of the asset replacement works.

Rayleigh Local/Uplands Park 33kV FFC Circuits - reinforce circuits (600A)
In order to release the transformer capacity from the Uplands Primary transformers the 33kV cables are to be over laid and replacement CT's installed in the 11kV switchgear at Uplands primary. It is therefore proposed to replace both of these circuits removing the FFC's from service.
Completion of this project will see two 2km underground replacement circuits and new CT's installed.

Nevendon 132/33kV Grid substation – 33kV Switchgear reinforcement.
The predicted fault level at Nevendon Grid Substation will exceed the 1000MVA rating of the existing switchgear following completion of the Rayleigh 132kV GIS and Exit Point works. It is not possible to lower the fault level without compromising operational and planning requirements. It is therefore proposed to replace the existing switchgear with a new installation comprising 15 circuit breakers.

5 Rejected Strategies

5.1 Rejected Strategy 1 – Reduction of SGT's at Tilbury

During the National Grid planning of their asset replacement of the four 275/132kV consideration was given to reducing the number of SGT's and provision of a 132kV bus-bar arrangement. However combining the demand of the two Tilbury groups would potentially create a Class E group. As a Class E group the second circuit outage requirements would require a double bus-bar switchgear configuration, additional SGT's or increased 132kV interconnection. These alternatives have not been taken up by National Grid due to their high cost.

5.2 Rejected Strategy 2 -132kV interconnection to Rayleigh Main

Additional 132kV interconnection between the Tilbury and Rayleigh groups has been considered and may be a future option once reinforcement is necessary in the Sth Benfleet 132kV network. This is not anticipated until beyond the ED1 period.

6 References

References	Description
Reference 1	Planning Load Estimates EPN Area 2011 – 2023 (DNE)
Reference 2	132kV Network HV Schematic Operating Diagrams East of England (date)
Reference 3	33kV Network HV Schematic Operating Diagrams East of England (date)
Reference 4	Council Masterplans, East of England Plan >2031. Thames Gateway South Essex Partnership.

6.1 Appendices

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

6.2 Document History

Version	Date of Issue	Author	Details
1.2	17/5/2013	Howard Green	Update with revised LI data

1.3	24/06/2013	Nuno da Fonseca	Reviewed Final version
1.4	20/3/14	Howard Green	Aligned to ED1

7 Document sign off

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

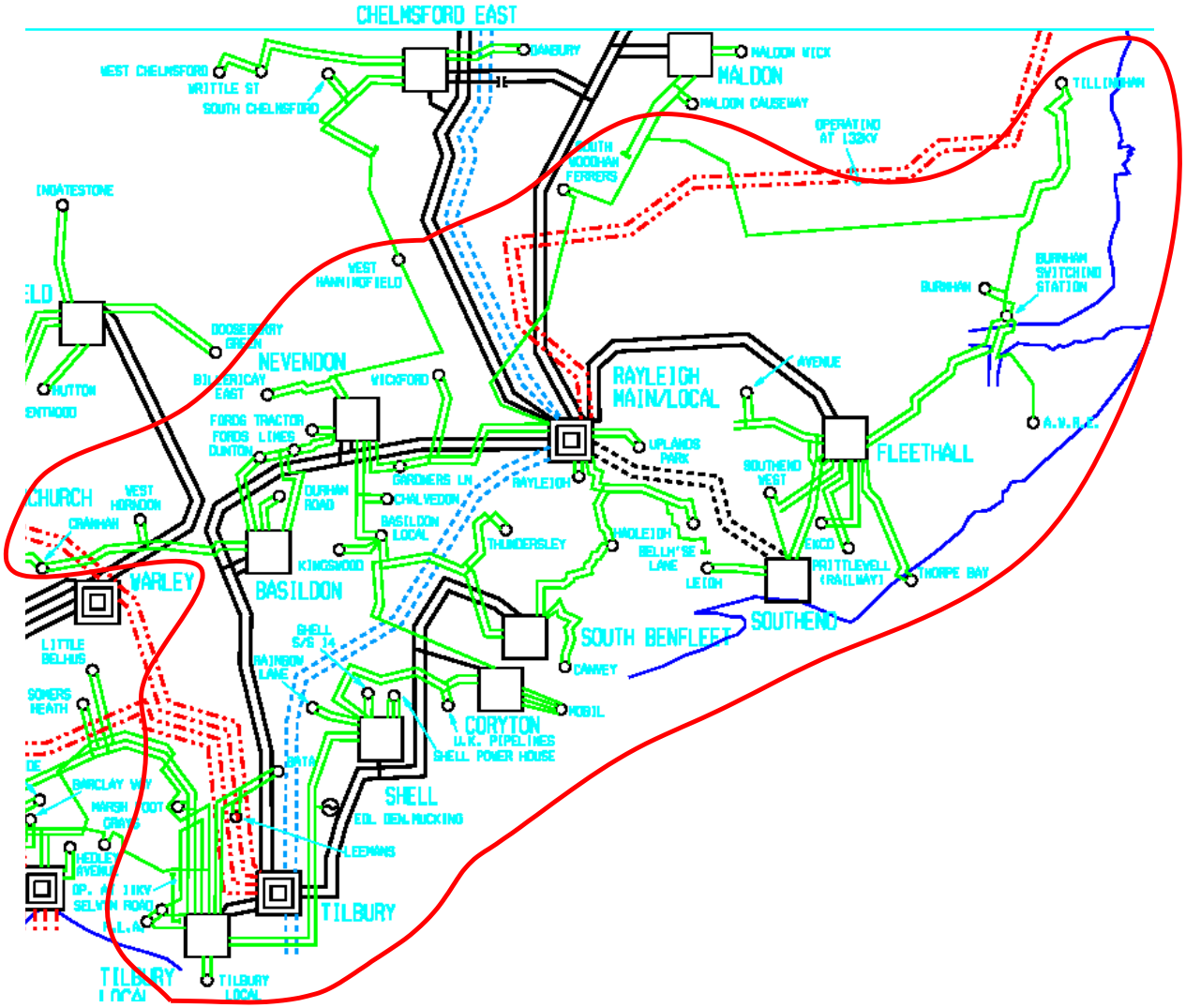
Recommended by:

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

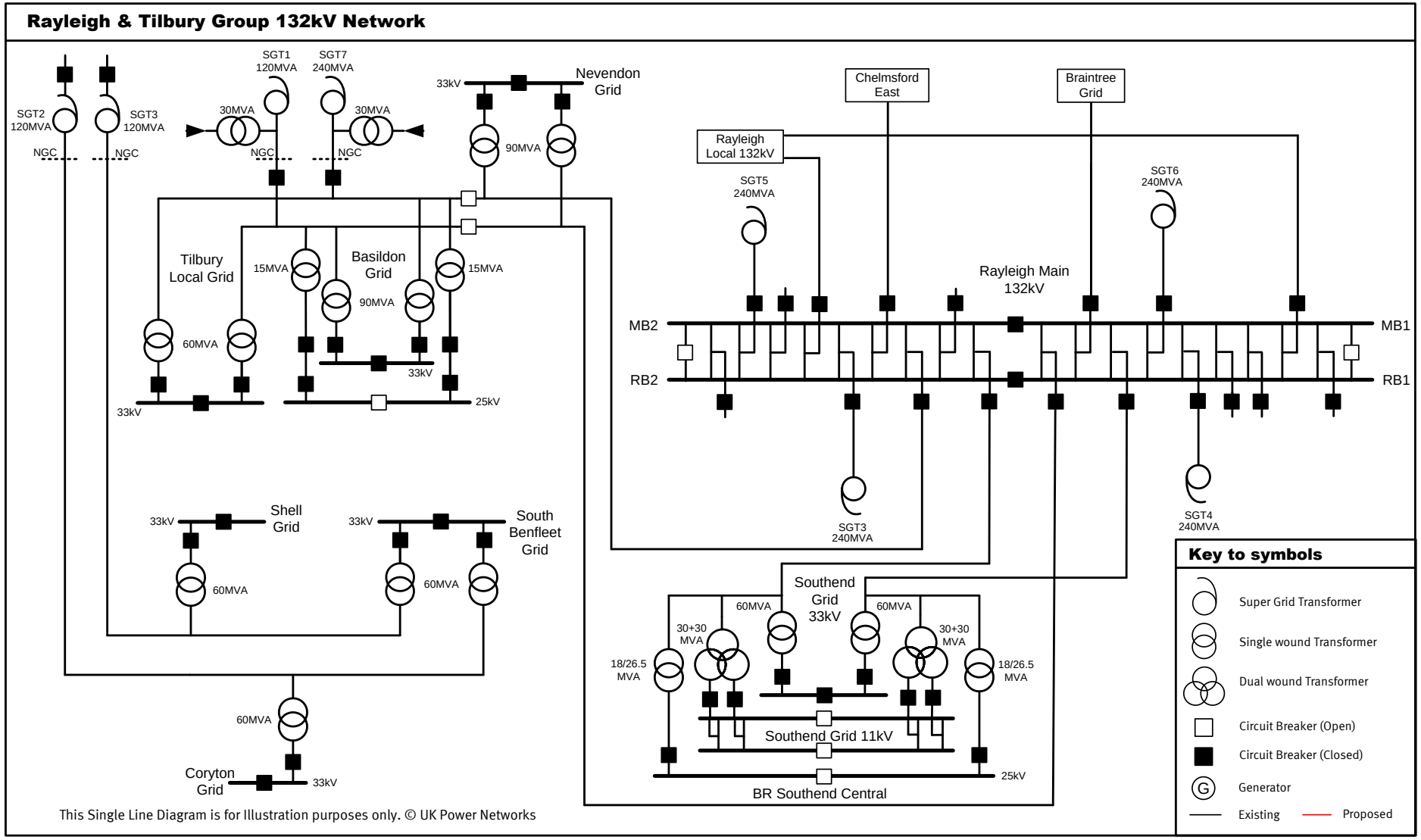
Approval by:

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

APPENDIX A: GEOGRAPHICAL DIAGRAM



APPENDIX B: SINGLE LINE DIAGRAM – EXISTING NETWORK



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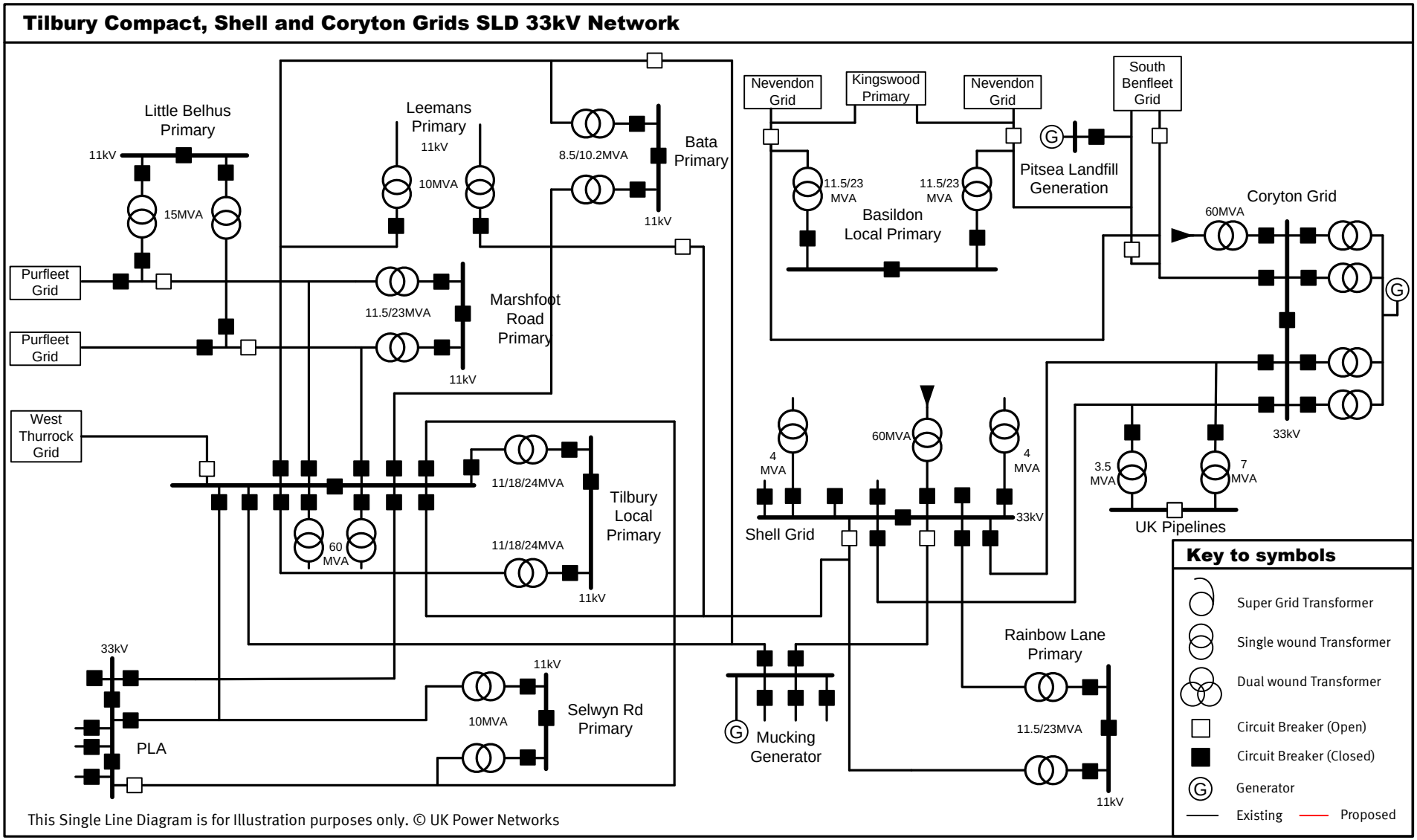
Tilbury Compact, Shell and Coryton Grids SLD 33kV Network



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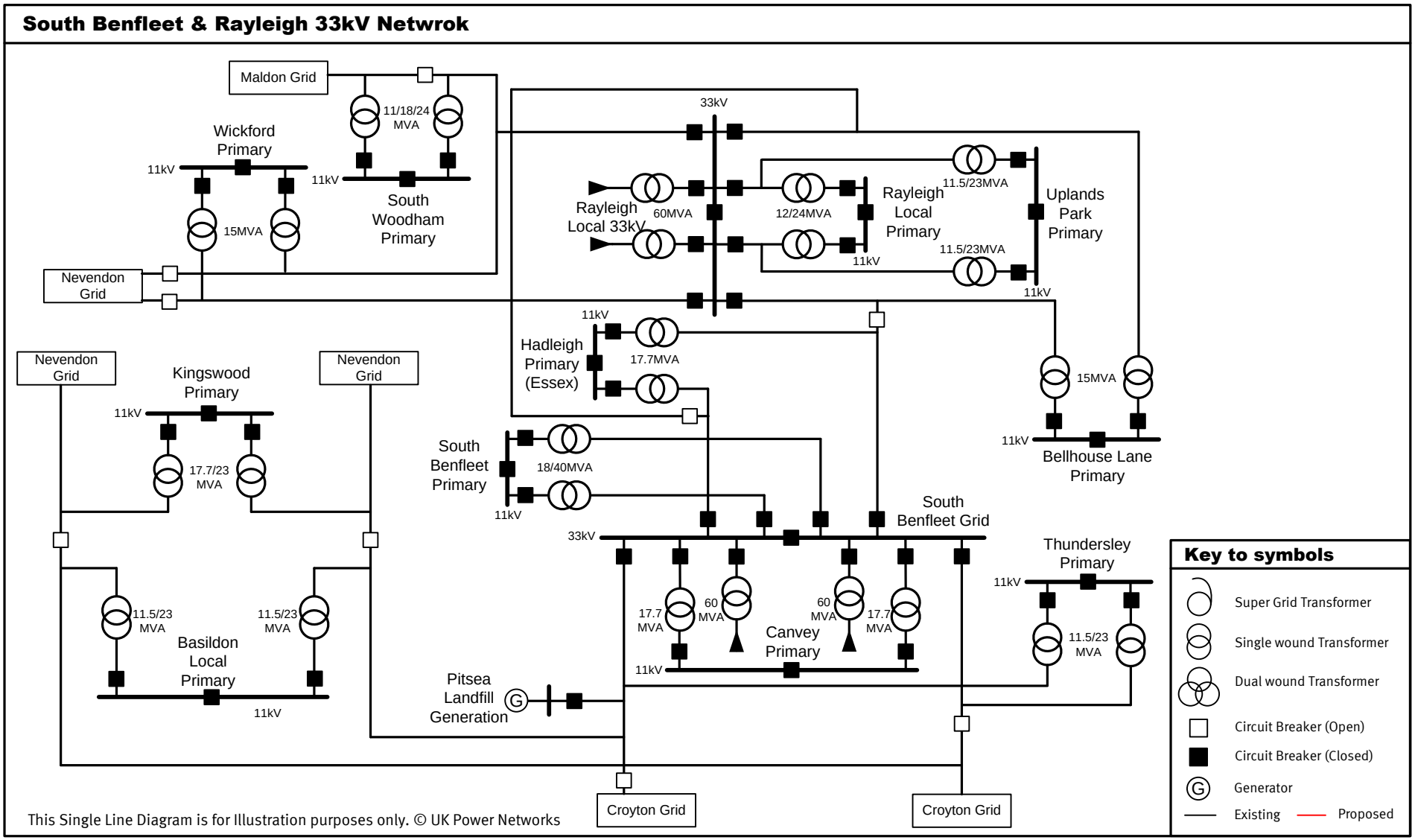
South Benfleet & Rayleigh 33kV Netwrok



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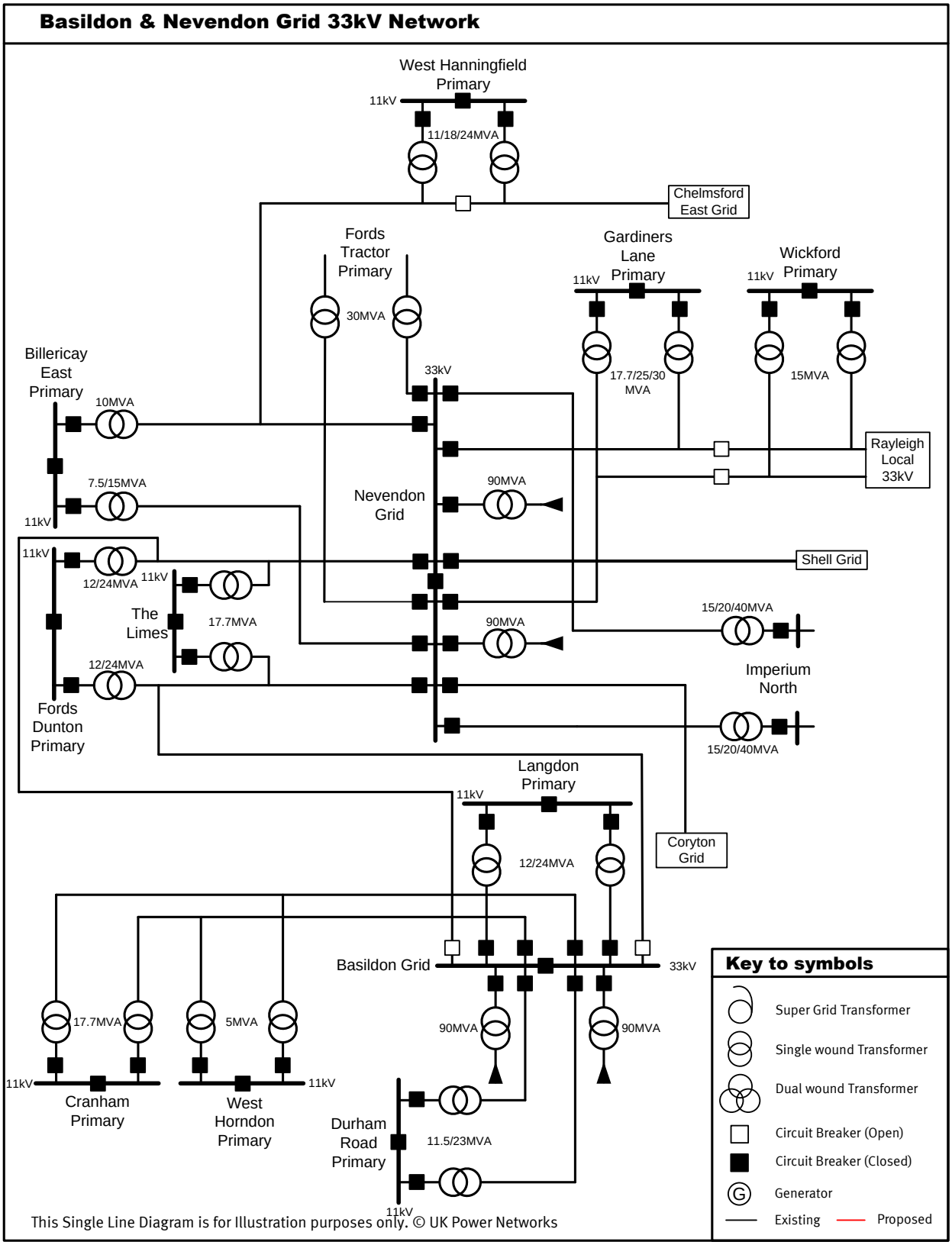
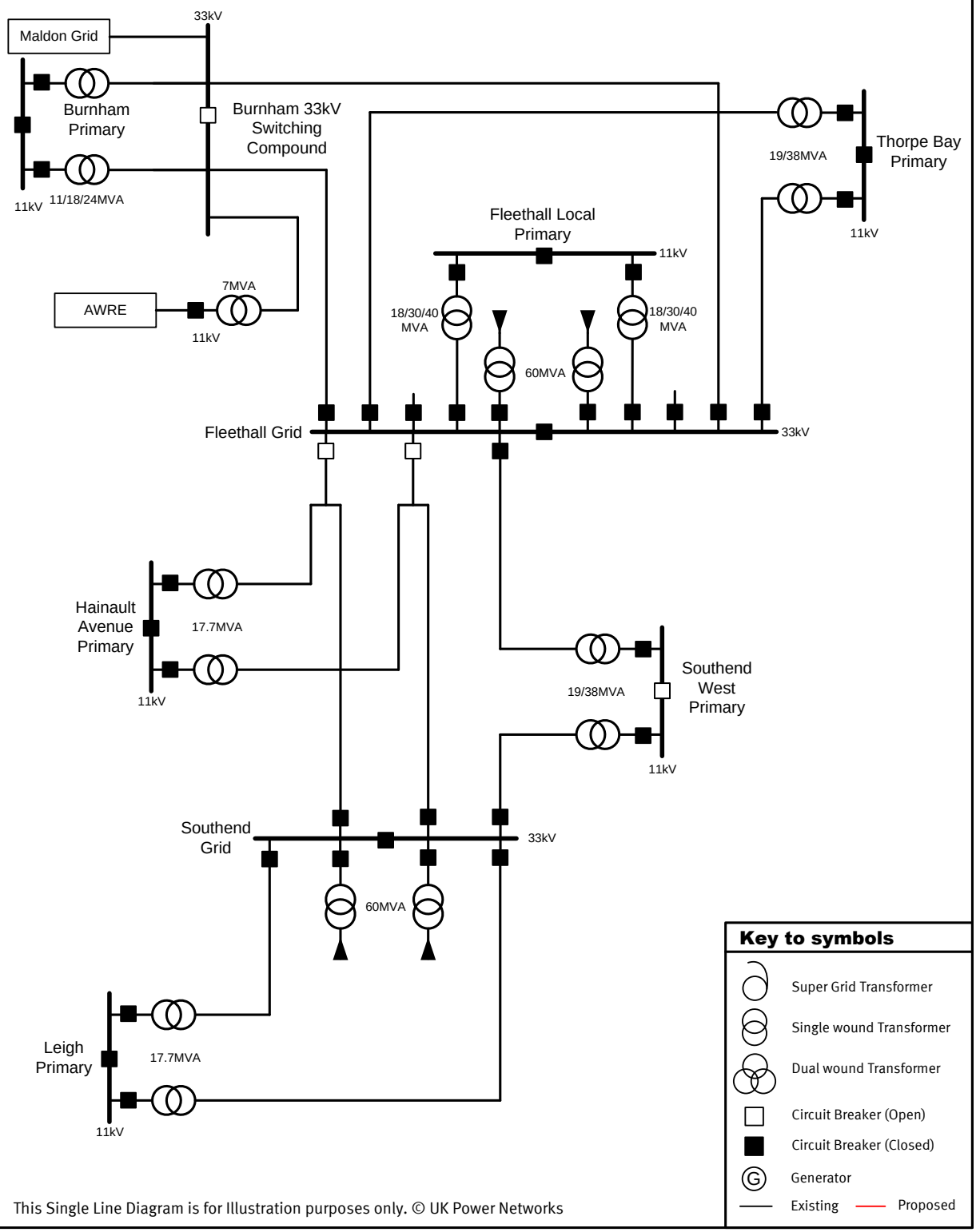

Basildon & Nevendon Grid 33kV Network
West Hanningfield Primary
11kV
11/18/24MVA
Chelmsford East Grid
Fords Tractor Primary
30MVA
Gardiners Lane Primary
11kV
17.7/25/30 MVA
Wickford Primary
11kV
15MVA
Billericay East Primary
10MVA
33kV
Rayleigh Local 33kV
7.5/15MVA
11kV
Nevendon Grid
90MVA
11kV
12/24MVA
11kV
Shell Grid
The Limes
17.7MVA
90MVA
15/20/40MVA
12/24MVA
Imperium North
Fords Dunton Primary
15/20/40MVA
Langdon Primary
11kV
12/24MVA
Coryton Grid
Basildon Grid
33kV
17.7MVA
5MVA
90MVA
90MVA
11kV
11kV
Cranham Primary
West Horndon Primary
Durham Road Primary
11.5/23MVA
11kV
This Single Line Diagram is for Illustration purposes only. © UK Power Networks
Key to symbols
Super Grid Transformer
Single wound Transformer
Dual wound Transformer
Circuit Breaker (Open)
Circuit Breaker (Closed)
Generator
Existing
Proposed

Fleethall & Southend Grid 33kV Network



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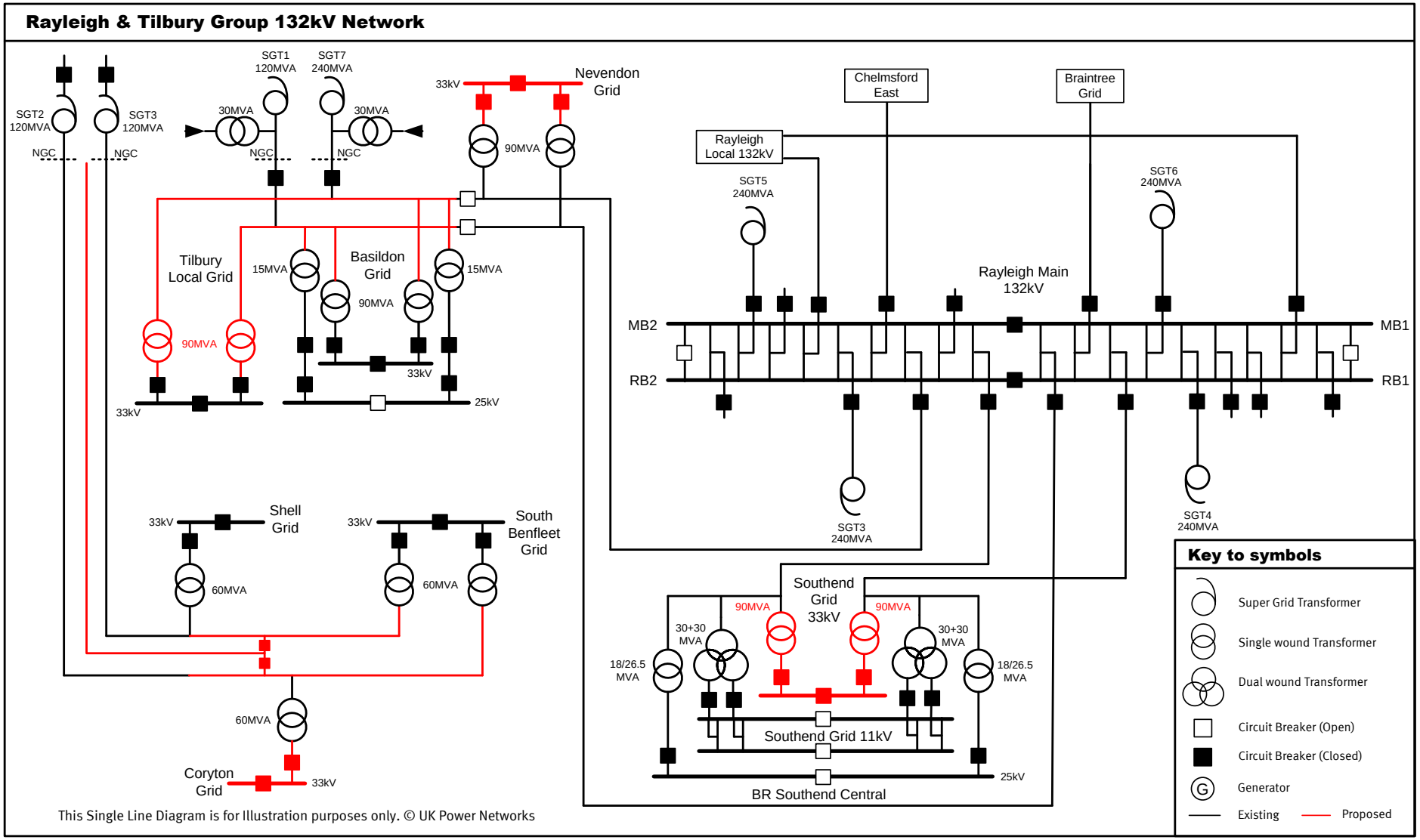
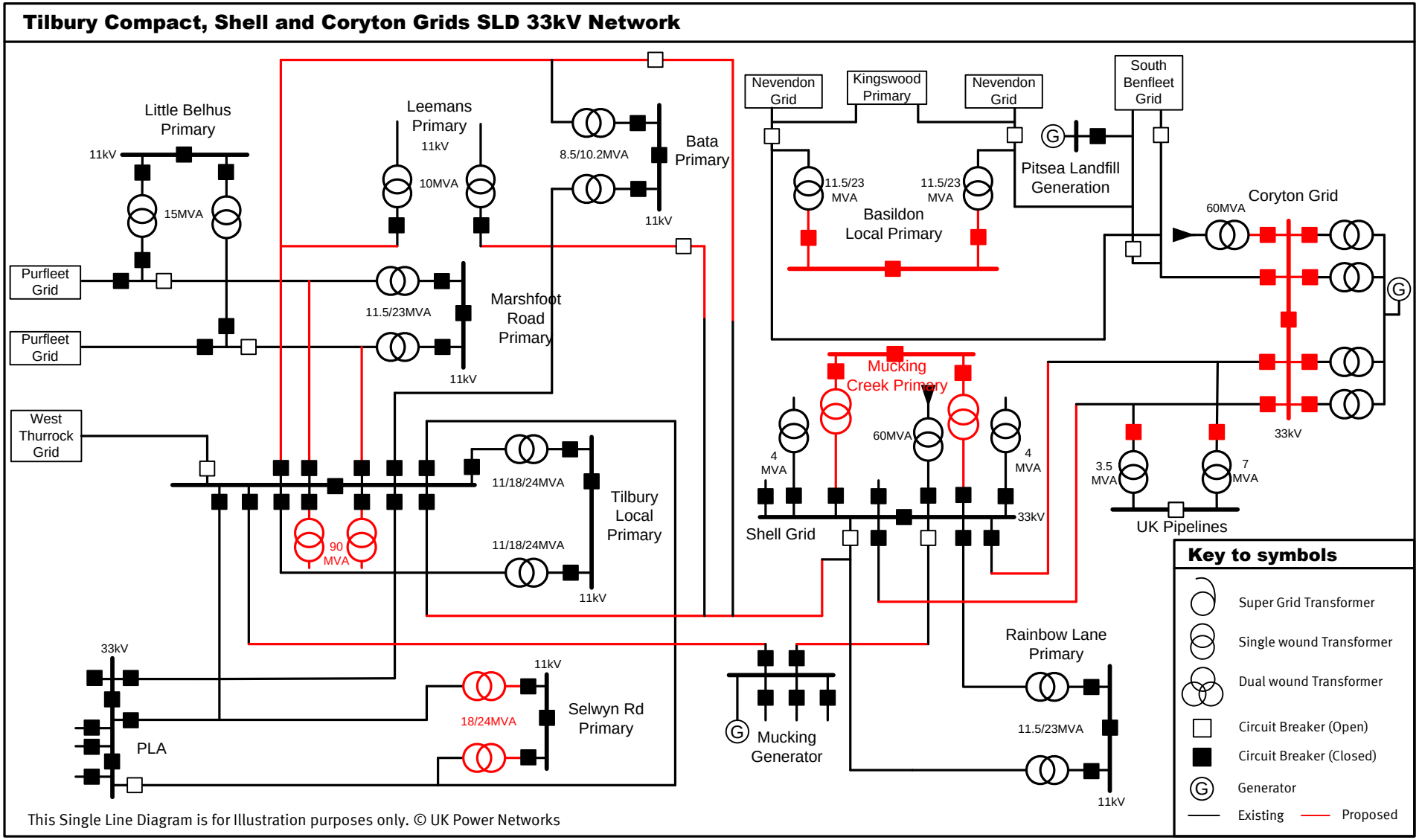
APPENDIX C: SINGLE LINE DIAGRAM - RECOMMENDED STRATEGY



Tilbury Compact, Shell and Coryton Grids SLD 33kV Network



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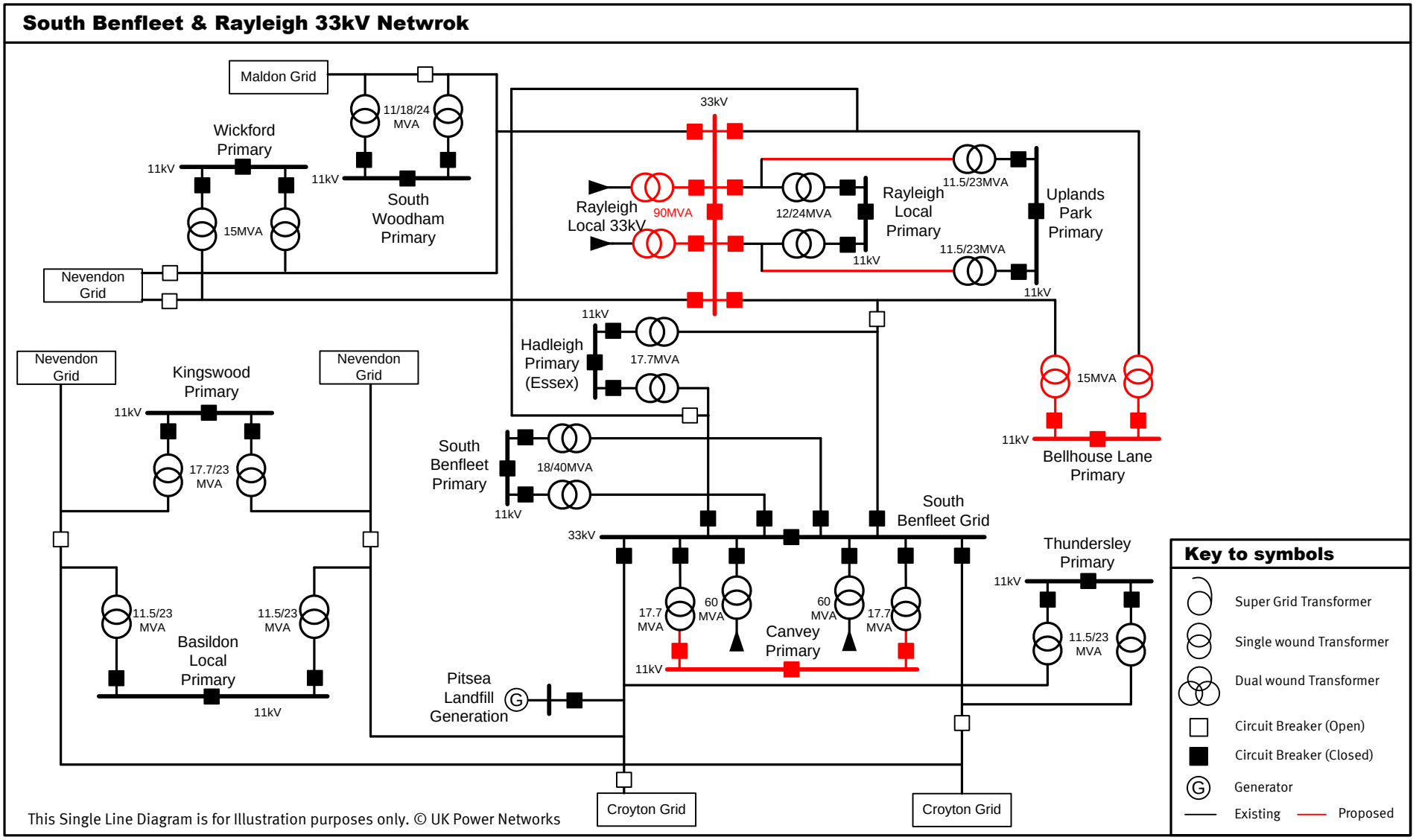
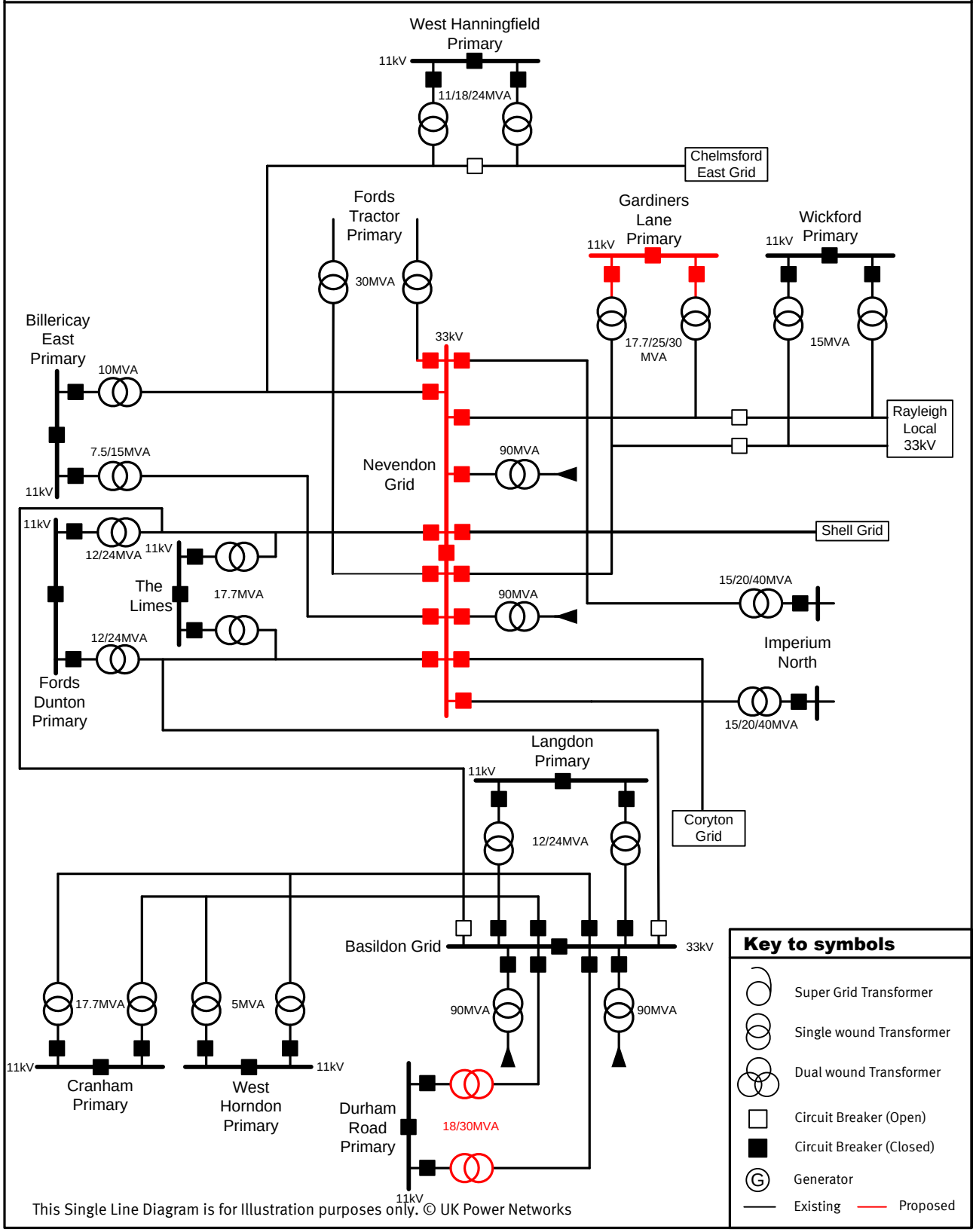
Rayleigh & Tilbury (EPN)

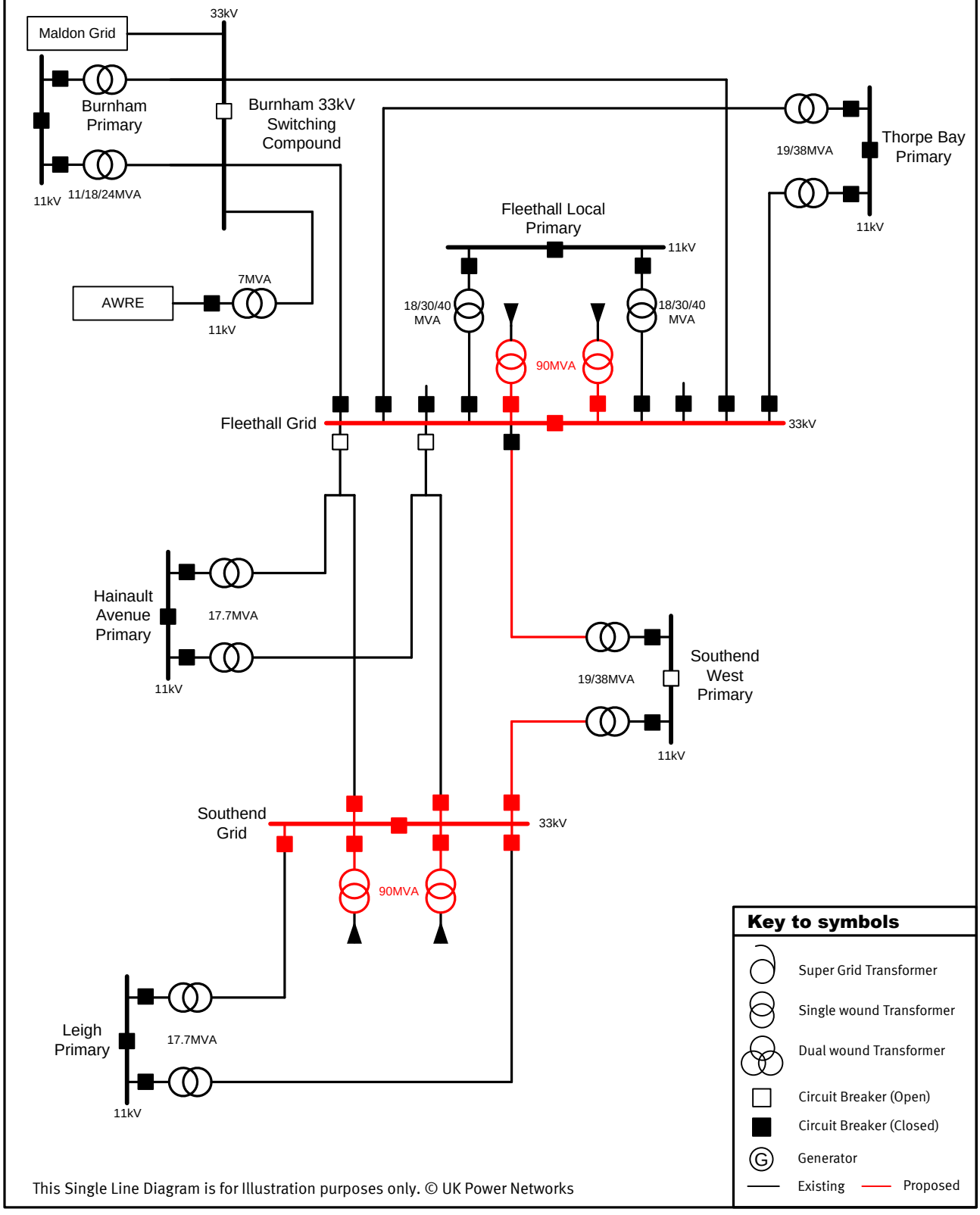
South Benfleet & Rayleigh 33kV Netwrok



Basildon & Nevendon Grid 33kV Network



Fleethall & Southend Grid 33kV Network



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APPENDIX D: DETAILED COSTS FOR RECOMMENDED STRATEGY

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

Cat	Namp Line	Project ID	Description	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
A	1.02.03	2039	PAB - Tilbury - Basildon - Conductor Replacement			489,792	1,117,396						
A	1.02.03	2108	PY - Rayleigh - Fleethall - Conductor Replacement					510,200	1,220,617				
A	1.02.03	5852	PBD - Shell Tee/South Benfleet - Conductor Replacement	128,521	285,392	82,216							
A	1.02.03	7551	PP - Tilbury 132kV - Tilbury Local 132kV - Conductor Replacement						30,907	92,722			
A	1.09.01	2037	Tilbury/Shell/Coryton 33kV OHL Circuit - 33kV Wood Pole OHL Replacement				249,999	605,280					
A	1.09.01	5890	Rebuild Fleethall - Burnham 33kV OHL P1 - P49	429,166									
A	1.09.01	7577	3H28D - Tilbury Compact Grid/Mucking Generator/Shell Grid 33kV OHL Circuit - 33kV Wood Pole OHL Replacement					126,960	231,017				
A	1.09.01	7590	3H28K - Bata / Leemans - 33kV Wood Pole OHL Replacement				143,861	266,278					
A	1.48.01	2094	Rayleigh GSP 132kV Exit Point - Install 132kV Switchgear (2000A)	1,179,757	589,879								
A	1.48.02	7614	UK Pipelines 132/33kV Grid Substation - Replace 33kV Switchgear							210,034			
A	1.48.11	7608	Southend 132/33kV Grid Substation - Replace 33kV Switchgear							316,322	736,498	222,379	
A	1.48.11	7622	Coryton 132/33kV Grid Substation - Replace 33kV Switchgear								337,798	812,591	245,028
A	1.50.01	2040	Basildon Local 33/11kV Primary Substation - Replace Switchboard (2000A)	118,489									
A	1.50.01	2091	Gardiners Lane 33/11kV Primary Substation - Replace Switchgear (2000A)								251,179	637,429	
A	1.50.01	2105	Wickford 33/11kV Primary Substation - Replace 11kV Switchboard (2000A)	723,422									
A	1.50.01	7636	Canvey 33/11kV Primary Substation - Replace 11kV Switchgear							252,267	653,264		
A	1.51.01	5526	Rayleigh Local 132/33kV Grid Substation - Replace 132/33kV (2 x 90MVA)	1,081,948									
A	1.51.01	7718	Southend 132/33kV Grid Substation - Replace Grid Transformers (GT1B, GT2B)									774,385	2,185,675
A	1.51.01	7721	Tilbury Local 132/33kV Grid Substation - Replace Grid Transformers (GT5, GT7)						774,382	2,185,538			
A	1.51.03	3810	Selwyn Rd 33/11kV Primary Substation - Replace Primary Transformers (T1, T2)										394,039

Rayleigh & Tilbury (EPN)

DETAILED COSTS FOR RECOMMENDED STRATEGY

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

Cat	Namp Line	Project ID	Description	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023
A	1.51.03	7752	Durham Rd 33/11kV Primary Substation - Replace Primary Transformers (T1, T2)								394,039	748,365	
A	1.51.03	7772	Thundersley 33/11kV Primary Substation - Replace Primary Transformers (T1, T2)						394,040	748,364			
A	1.51.11	7711	Coryton 132/33kV Grid Substation - Refurbish Grid Transformers (GT2)							34,013	116,904		
A	1.51.11	7732	Marshfoot Road 33/11kV Primary Substation - Refurbish Primary Transformers (T2)		25,510	125,407							
A	1.51.11	7736	Southend West 33/11kV Primary Substation - Refurbish Primary Transformers (T1, T2)									51,020	250,814
H	1.29.01	7595	Southend Grid / Fleethall Primary 33kV Fluid Filled Cables - 33kV FFC Replacement							302,085	626,706		
H	1.29.01	7597	Tilbury Grid / Marshfoot Rd Primary 33kV Fluid Filled Cables - 33kV FFC Replacement				402,780	990,407					
R	1.33.01	2030	Thundersley 33/11kV Primary Substation - ITC (2 x 18/30MVA)										
R	1.33.03	5602	Bellhouse Lane 33/11kV Primary Substation - ITC (2 x 12/18/24MVA) and 11kV Switchboard				239,153	956,614	1,165,362				
R	1.33.07	3850	Mucking Creek Proposed 33/11kV Primary Substation - (2 x 18/30/40MVA)			40,658	1,130,286	893,164					
R	1.34.02	6345	Leigh 33/11kV Primary Substation - 11kV Transfer Scheme to Hadleigh Road and Bellhouse Ln									16,703	319,834
R	1.34.02	6346	11kV Transfer from Hainault Ave Prim to Fleethall Local								16,703	319,834	
R	1.34.02	6347	11kV Demand Transfer from Basildon Local to Langdon Primary			16,703	319,834						
R	1.34.02	6348	11kV Demand Transfer from Canvey to South Benfleet Local Primary				16,703	319,834					
R	1.34.02	8429	Tilbury local 33/11kV Primary substation - Progress 11kV Interconnection	33,622									
R	1.35.01	3798	(RDP - Fleethall/Southend) Fleethall 132/33kV Grid Substation - ITC (2 x 90MVA)						65,170	1,466,332	1,986,049	0	
R	1.36.03	2060	Rayleigh Local 132/33kV Grid Substation - Replace 33kV Switchgear (2000A)	462,082									
R	1.36.03	2671	Nevendon 132/33kV Grid Substation - Replace 33kV Switchgear (Fault Level)	43,502	978,792	697,983							
R	1.37.07	3800	Rayleigh Local/Uplands Park 33kV FFC Circuits - Reinforce Circuits (600A)		65,213	1,119,609							

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
Basildon Grid 33	W	Switchgear	114.3		114.3	59.1	61.2	LI1	LI1		114.3	LI1	D	Yes
Basildon Local Total	W	Circuit Rating	21.7	1875	21.7	15.9	17.1	LI1	LI1	6347	21.7	LI1	C	Yes
Bata	W	Transformer	10.2		10.2	2.7	3.0	LI1	LI1		10.2	LI1	B	Yes
Bellhouse Ln	W	Switchgear	15.2		15.2	14.3	17.1	LI2	LI5	5602	21.7	LI1	C	Yes
Burnham	W	Circuit Rating	21.8		21.8	12.4	13.5	LI1	LI1		21.8	LI1	C	Yes
Canvey	W	Switchgear	22.8		22.8	21.2	22.4	LI2	LI3	6348	23.0	LI3	C	Yes
Chalvedon	W	Transformer	24.0		24.0	16.2	17.1	LI1	LI1		24.0	LI1	C	Yes
Cranham	W	Switchgear	22.8		22.8	14.9	16.0	LI1	LI1		22.8	LI1	C	Yes
Durham Road	W	Switchgear	22.8		23.0	18.4	19.4	LI1	LI2		23.0	LI2	C	Yes
Fleethall Grid 33	W	Switchgear	71.4		71.4	66.3	79.6	LI3	LI5	3798	114.0	LI1	D	Yes
Fords Dunton	S	Transformer	20.0		20.0	14.7	14.7	LI1	LI1		20.0	LI1	C	Yes
Gardiners Ln	W	Switchgear	22.8	8125	22.8	13.4	14.0	LI1	LI1	2091	28.0	LI1	C	Yes
Hadleigh Essex	W	Transformer	21.2		21.2	14.7	15.8	LI1	LI1	6345	21.2	LI1	C	Yes
Hainault Ave	W	Transformer	21.3		21.3	17.4	18.8	LI2	LI2	6346	21.3	LI2	C	Yes
Kingswood	S	Transformer	17.7		17.7	13.6	14.2	LI1	LI2		17.7	LI2	C	Yes
Leigh	W	Transformer	23.0		23.0	21.8	21.4	LI2	LI2	6345	23.0	LI2	C	Yes
Marshfoot Road	W	Transformer	23.0		23.0	13.9	14.8	LI1	LI1		23.0	LI1	C	Yes
Nevendon Grid 33	S	Transformer	90.0		90.0	65.0	68.0	LI1	LI1		90.0	LI1	D	Yes
Rainbow Lane total	W	Switchgear	22.8		22.8	22.0	24.4	LI3	LI5	3850	22.8	LI1	C	Yes
Rayleigh Local	W	Circuit Rating	18.5		18.5	13.0	13.9	LI1	LI1		18.5	LI1	C	Yes
Rayleigh Local 33	W	Switchgear	71.4	0955	114.3	85.6	92.2	LI1	LI2		114.3	LI2	D	Yes
Selwyn Road	S	Transformer	10.0		10.0	7.1	7.8	LI1	LI1		10.0	LI1	B	Yes
South Benfleet Grid 33	W	Switchgear	68.6		82.1	56.0	59.7	LI1	LI1		82.1	LI1	C	Yes
South Benfleet Primary	W	Circuit Rating	36.0		36.0	14.3	15.3	LI1	LI1	6348	36.0	LI1	C	Yes
Southend Grid 11	W	Transformer	72.0		72.0	46.4	49.9	LI1	LI1		72.0	LI1	C	Yes
Southend Grid 33	W	Transformer	72.0		72.0	45.1	49.0	LI1	LI1		72.0	LI1	C	Yes
Southend West total	W	Transformer	38.0		38.0	17.4	18.6	LI1	LI1		38.0	LI1	C	Yes
The Limes	S	Transformer	17.7		17.7	12.4	13.0	LI1	LI1		17.7	LI1	C	Yes
Thorpe Bay	W	Circuit Rating	35.4		35.4	28.7	31.3	LI2	LI2		35.4	LI2	C	Yes
Thundersley	W	Switchgear	22.8		22.8	14.6	15.5	LI1	LI1		22.8	LI1	C	Yes
Tilbury Compact Grid 33	W	Transformer	72.0		85.1	73.5	76.2	LI2	LI2		85.1	LI2	D	Yes
Uplands Park	W	Circuit Rating	18.5		18.5	19.6	20.8	LI4	LI5	3800	23.0	LI2	C	Yes
West Horndon	W	Transformer	5.0		5.0	4.3	4.7	LI2	LI2		5.0	LI2	B	Yes
Wickford	W	Transformer	19.5		19.5	17.2	18.7	LI2	LI3		19.5	LI3	C	Yes
Langdon	W	Transformer	24.0		24.0	15.6	15.6	LI1	LI1		24.0	LI1	C	Yes
Mucking Creek (New)	W	Transformer			0.0	0.0	0.0			3850	40.0	LI1	B	Yes
Tilbury Local	W	Transformer	24.0	24	24.0	5.5	5.5	LI1	LI1	8429	18.0	LI1	B	Yes

APPENDIX F: OUTPUT MEASURES – HEALTH INDICES (LI)

132KV SWITCHGEAR (2013 INFORMATION)

	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
NEVENDON GRID		2					2					2			
RAYLEIGH LOCAL GRID				1	10					11					
RAYLEIGH MAIN 132KV	18					18					18				
TILBURY 132KV TEE POINT		2					1	1				1	1		
TOTAL	**18**	**4**		**1**	**10**	**18**	**3**	**1**		**11**	**18**	**3**	**1**		

33KV SWITCHGEAR (2013 INFORMATION)

	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
BASILDON GRID	5		6	1	1	3	2		3	5	3	2		3	5
CORYTON GRID			3	6						9	9				
FLEETHALL GRID		14							14		3			11	
NEVENDON GRID	3		1	11		2	1			12	15				
RAYLEIGH LOCAL 33KV	1	9				1	9				10				
SOUTH BENFLEET GRID			11						11		11				
SOUTHEND GRID 33KV				8						8	8				
TILBURY COMPACT GRID	14	1					15					15			
UK PIPELINES				2						2	2				
TOTAL	**23**	**24**	**21**	**28**	**1**	**6**	**27**		**28**	**36**	**61**	**17**		**14**	**5**

11/6.6KV SWITCHGEAR (2013 INFORMATION)

	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
BASILDON LOCAL PRIMARY	15					15					15				
BATA PRIMARY		9					2	7				2	7		
BURNHAM PRIMARY	9					3	6				3	6			
CANVEY PRIMARY		1	11					1	9	2	12				
CHALVEDON PRIMARY		9					7	2				7	2		
CRANHAM PRIMARY		3	6					9					9		
FLEETHALL GRID/LOCAL	13					13					13				
FORDS DUNTON PRIMARY		12					12					12			
GARDINERS LN PRIMARY		4	7				1	4	6		11				
HADLEIGH PRIMARY ESSEX	11						11					11			
HAINAULT AV PRIMARY	12					12					12				
KINGSWOOD PRIMARY	3	6	3			2	2	8			2	2	8		
LEIGH PRIMARY	15					15					15				
MARSHFOOT ROAD PRIMARY		7						7					7		
RAINBOW LN PRIMARY		3	9					12					12		
RAYLEIGH LOCAL PRIMARY	9						9					9			
SELWYN RD PRIMARY	12						12					12			
SOUTH BENFLEET PRIMARY	13					13					13				
SOUTHEND GRID 11KV		6	22					27	1				27	1	
SOUTHEND WEST PRIMARY		7	3				4	6				4	6		
THE LIMES		8	1				5	3	1			5	3	1	
THUNDERSLEY PRIMARY		3	5					8					8		
THORPE BAY		13					10	3				10	3		
TILBURY LOCAL PRIMARY	9					9					9				
UPLANDS PK PRIMARY	0	9	2	0	0	0	8	2	1	0	0	8	2	1	0
WEST HORNDON PRIMARY	0	7	0	0	0	0	2	5	0	0	0	2	5	0	0
WICKFORD PRIMARY	10	0			0	10	0	0	0		10	0	0	0	
BELLHOUSE LN PRIMARY	0	0	6	2	1	0		6	0	3	0	0	6	0	3
BILLERICAY EAST PRIMARY	0	2	4	0	0	0	0	6	0	0	0	0	6	0	0
DURHAM RD PRIMARY	12					12					12				
BELLHOUSE LN PRIMARY			6	2	1			6		3	9				
MUCKINGCREEK											10				
TOTAL	**143**	**109**	**85**	**4**	**2**	**104**	**91**	**122**	**18**	**8**	**157**	**90**	**111**	**3**	**3**

GRID AND PRIMARY TRANSFORMERS (2013 INFORMATION)

	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
BASILDON GRID	2	2					2	2				2	2		
BASILDON LOCAL PRIMARY			2					2					2		
BATA PRIMARY		2						2					2		
BURNHAM PRIMARY	2						2					2			
CANVEY PRIMARY		2						2					2		
CHALVEDON PRIMARY		2					1	1				1	1		
CRANHAM PRIMARY		2					2					2			
CORYTON GRID			1						1				1		
FLEETHALL GRID/LOCAL		1	1					2			2				
FORDS DUNTON PRIMARY		2					1	1				1	1		
GARDINERS LN PRIMARY			2					2					2		
HADLEIGH PRIMARY ESSEX		2						2					2		
HAINAULT AV PRIMARY		2						2					2		
KINGSWOOD PRIMARY		2						2					2		
LEIGH PRIMARY		2						2					2		
MARSHFOOT ROAD PRIMARY		1			1			1		1			1	1	
NEVENDON GRID		2						2					2		
RAINBOW LN PRIMARY		2						2					2		
RAYLEIGH LOCAL 33KV		2		2				2		2	2		2		
RAYLEIGH LOCAL PRIMARY	1	1					1	1				1	1		
SELWYN RD PRIMARY			1	1					1	1	2				
SOUTH BENFLEET GRID		2						2					2		
SOUTH BENFLEET PRIMARY	1	1					2					2			
SOUTHEND GRID 11KV		2						2					2		
SOUTHEND GRID 33KV		4		1	1		2	2		2	2	2	2		
SOUTHEND WEST PRIMARY			2						2				2		
THE LIMES		2						2					2		
THUNDERSLEY PRIMARY				1	1					2	2				
THORPE BAY		2						3					3		
TILBURY COMPACT GRID					2					2	2				
TILBURY LOCAL PRIMARY	2						2					2			
UPLANDS PK PRIMARY			2					2					2		
WEST HORNDON PRIMARY			2					2					2		
WICKFORD PRIMARY		2					2					2			
BELLHOUSE LN PRIMARY		2						2					2		
TILBURY LOCAL GRID					2					2					2
BILLERICAY EAST PRIMARY	1		1				1	1			1	1			
DURHAM RD PRIMARY		1	1				1			1	2				
BELLHOUSE LN PRIMARY		2						2			2				
NEVENDON GRID LOCAL											2				
MUCKINGCREEK											2				
TOTAL	9	49	15	5	7		19	50	4	13	21	18	48	1	2

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.