



Regional Development Plan

Barking, Warley and West Thurrock (EPN)

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

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1 Executive Summary

This Regional Development Plan (RDP) reviews UK Power Networks (UKPN) EPN HV and EHV network supplied from Barking 132kV, Barking West 33kV, Warley 132kV and West Thurrock 33kV Grid Supply Points (GSP).

These GSP supply the London Borough's of Barking & Dagenham, Havering and the Essex boroughs of Thurrock and Brentwood. The combined area has approximately 201,000 customers and is a dense urban part of Outer London and Essex.

Key infrastructure in these areas, all of which are highly populated areas, includes several industrialised areas (eg Fords Dagenham), along with commercial centres such as the Lakeside Shopping Centre. The Cross Thames Rail Link (part of the Euro Rail link) operates through the area crossing the Thames near Lakeside and travelling west via tunnels and viaducts towards London's Victoria station.

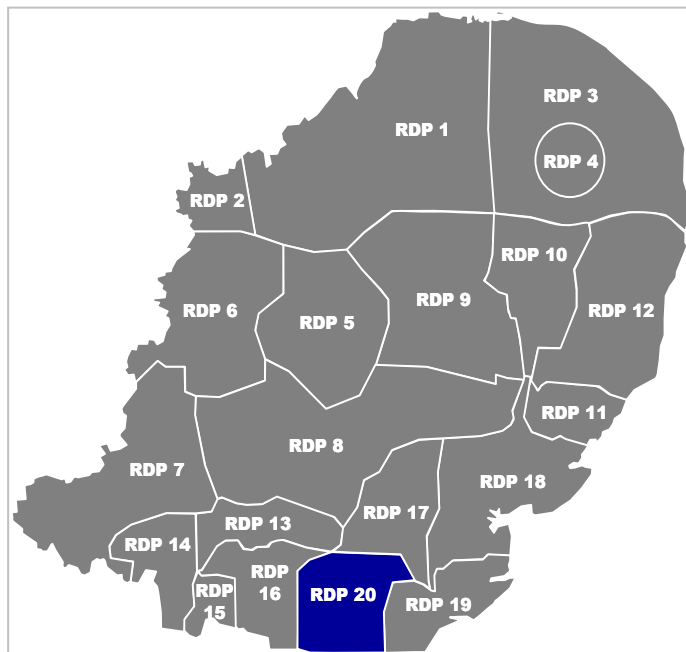


Figure 1 – Area covered by the RDP

Development within the area is mainly limited to the many 'Brownfield sites' spread across this area, a legacy from its industrial heritage. A substantial proportion of the area is covered by the Thames Gateway Regeneration Redevelopment. One of its major sites is known as the Barking Riverside development. Barking Riverside is a 443 acre development on the site of the old Barking Power station along the banks of the River Thames and aims to provide 10,800 homes.

There is generation support from the landfill sites of Rainham 11MW connected to the 33kV circuit between Purfleet Grid and Rainham Primary, Hanson 6MW connected at 11kV to Rainham Primary and other generators below 5MW connected to the 11kV network.

1.1 Summary of issues addressed

The general area is also attracting enquiries from large energy consumers for new Data Centres due to its proximity to the financial centres at Canary Wharf in London. This area has already seen the establishment of two IDNO primary substations (33/11kV), one in Barking and the other in Romford. This combination of new and increased demand creates a difficult environment in which to prepare a long term strategy as any single major enquiry can change the planned development of the network.

Both the Barking GSP sites are shared between the EPN and LPN networks and this review focuses only on the EPN networks at these GSP's. As shared sites the responsibility to maintain adequate supergrid transformer and bus-bar capacity sits with National Grid (NG). NG has reinforcement and asset replacement proposals for both locations and is commented on elsewhere within this document.

The connection of a Data Centre in 2010 to Crowlands Grid at 33kV with an MPR (Maximum Power Requirement) of 28MVA will be one of the main drivers for reinforcement within the area. The Data Centre demand is expected to develop over a period of several years and may potentially not reach the MPR. However should the full capacity be utilised and other generic growth occur on the Crowlands Grid group, reinforcement will be necessary. This reinforcement will require the establishment of a new 132/33kV substation at Gidea Park, an existing 33kV switching station and the transfer of demand off of Crowlands Grid to the new substation.

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This has a knock on effect that will require other reinforcement to maintain network security and flexibility at Hornchurch Grid (Warley supply point).

1.2 Recommended Strategy

The proposals to maintain network and operational security are limited to several key projects. The most important of these are:

- 33kV Trackside Cable replacement. Much of the 33kV interconnecting network through this area is done with cables laid alongside the Network Rail main line into Liverpool Street Station. New routes are planned to remove these cables due to a combination of issues including asset condition, safety and operational constraints. The new routes will be based in the public highway. Works were underway in 2012 with completion expected in early 2015, replacing approximately 72km of 33kV cables between Crowlands, Hornchurch and Shenfield 33kV networks.
- Proposed new Gidea Park Grid substation. As load increases at Crowlands Grid (fed from Barking 132kV) the solution to maintain the firm capacity at Crowlands Grid is to transfer the demand at Romford Primary (approximately 40MVA) to a new 132/33kV substation at Gidea Park substation fed from Hornchurch Grid, part of the Warley Supergrid group.
- Transfer of demand between Grid substations to maintain firm capacity and P2/6 compliance of individual substations and the group loads.
- Romford Reinforcement. Romford is a large conurbation fed by several primaries (Romford, Romford Nth, Straight Rd, Selinas Lane and others). Romford Primary provides nearly 40MVA of the town centre demand. The maximum theoretical capacity is subject to balanced load sharing between the 33kV circuits. With little capacity within the neighbouring primaries there is a foreseeable need to reinforce the network capacity supporting Romford. With several options available the preferred is to establish a Crowlands Grid Local and providing 11kV interconnection. This also has the potential to support Selinas Lane for reinforcement and harmonize the asset replacement of the major plant items.
- 11kV Switchboard Replacement. Within the geographic area served from Barking 132kV and Barking West 33kV GSP's are 6 primary substations equipped with 11kV switchboards without any form of remote control or replacement trucks available. These are typically from the 1950/60's and most have operational restrictions in place and until replaced the 11kV network cannot be fully equipped with automation. Continuing with the switchboard replacement is an important part of improvement to the overall Health Indices the fitting of automation scripts will assist improvement to CI and CML network performance measures
- 132kV ABCB Switchgear Replacement at Barking 'C' GSP. The indoor AIS ABCB switchboard shared with NG and the LPN network is identified by NG for replacement in 2014/17.
- 132kV ABCB Switchgear Replacement at Warley GSP. The outdoor AIS ABCB's are identified for replacement in 2018-22.
- 33kV Switchgear asset replacements are planned at Crowlands Grid, Purfleet Grid and Shenfield Grid substations. Replacement of the AIS 33kV switchgear at these sites will release space for forthcoming asset replacement of 132/33kV transformers and operational requirements, particularly at Purfleet Grid which is also a Local Office for the Thameside area.

Investment Profile

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

RDP	Type	DPCR5 2013-15	2015 /2016	2016 /2017	2017 /2018	2018 /2019	2019 /2020	2020 /2021	2021 /2022	2022 /2023	RIIO-ED1 Total
RDP20	LRE	£0.0m	£0.1m	£0.4m	£7.5m	£3.9m	£1.1m	£0.3m	£0.0m	£0.0m	£13.4m
	NLRE	£11.0m	£4.5m	£3.2m	£4.7m	£5.7m	£3.5m	£7.7m	£5.3m	£0.4m	£34.9m
	TOTAL	£11.0m	£4.5m	£3.6m	£12.1m	£9.6m	£4.7m	£8.1m	£5.3m	£0.4m	£48.3m

Figure 1. LRE and NLRE expenditure profile

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Output Measures

The figure below provides the expected Load Indices (LI) for all substations covered in this RDP at the end of 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 figure 3.

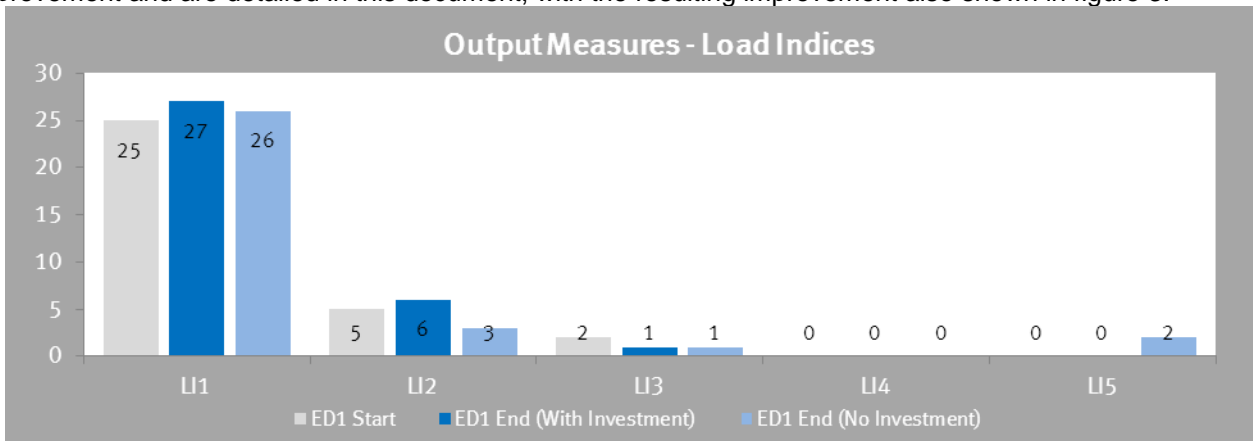
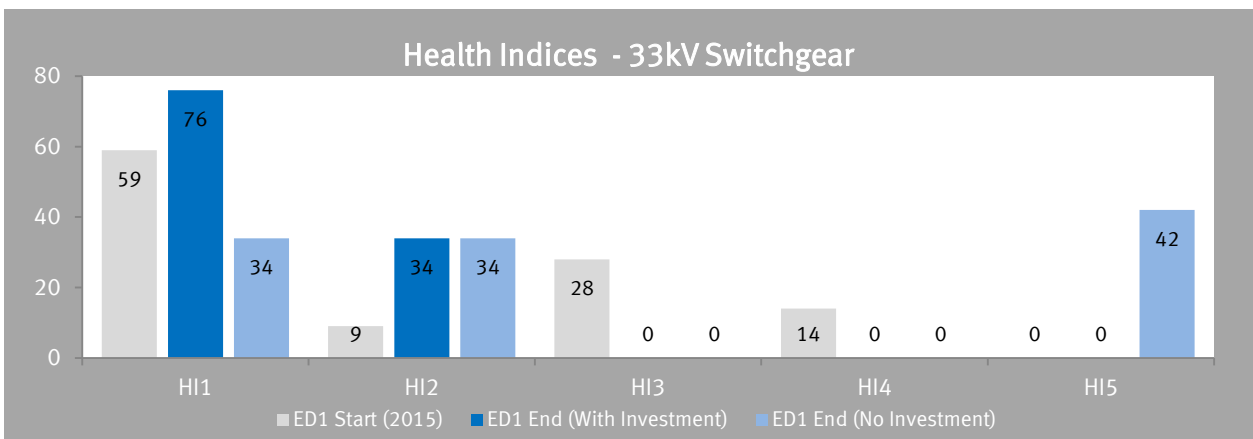
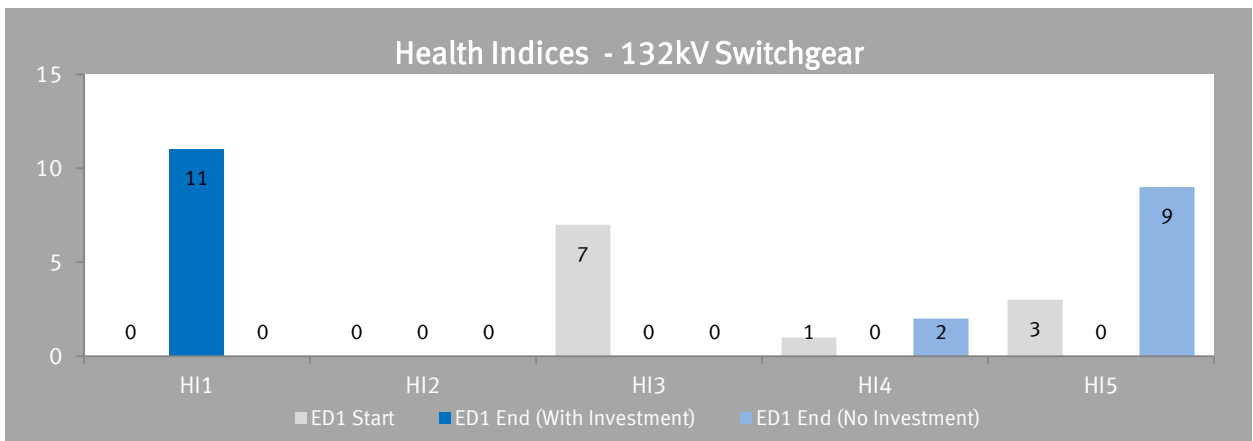


Figure 2. 2022/23 Load Indices with and without interventions

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



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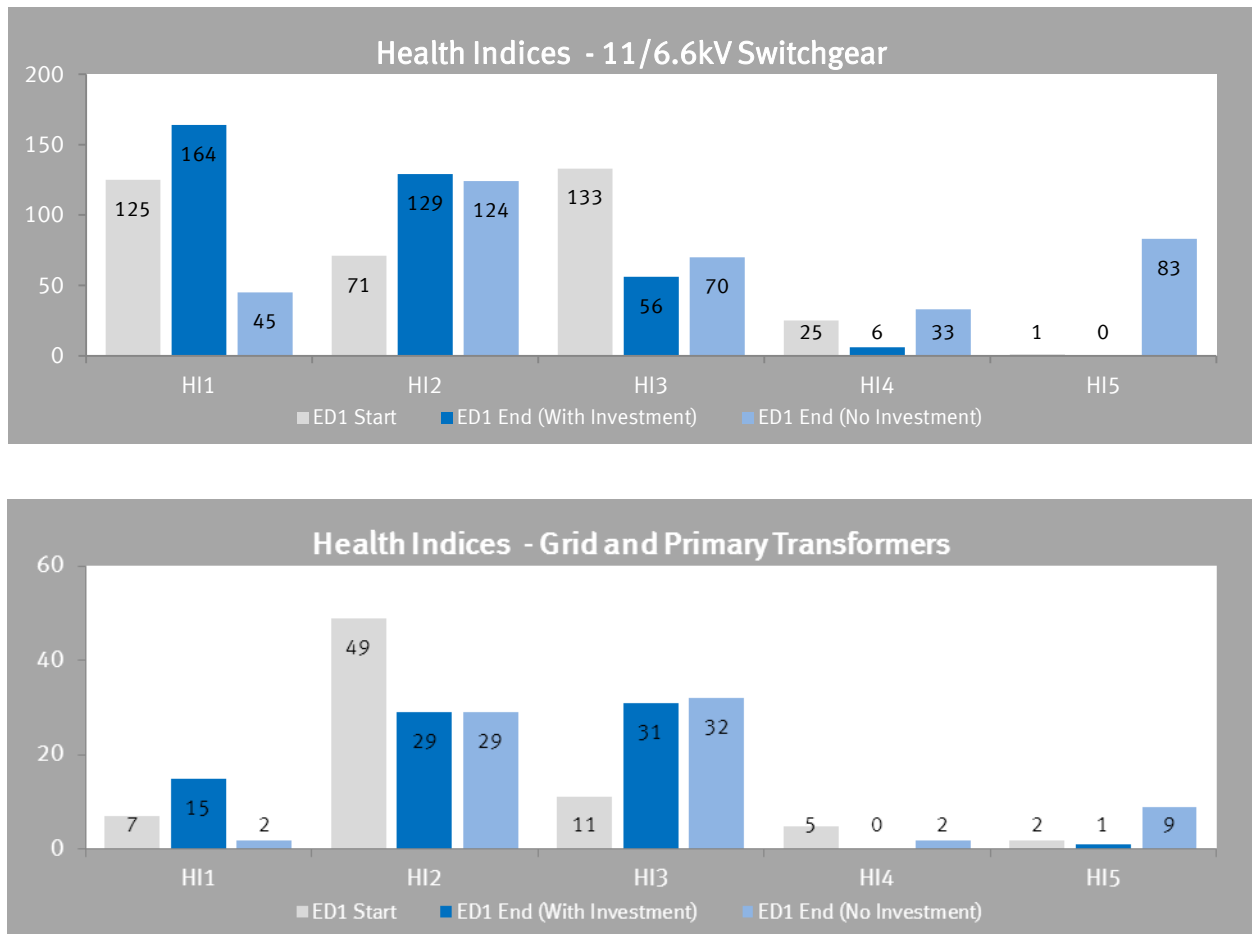


Figure 3. Health Indices by asset category

Scenarios Considered

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

RDP Dependencies and Interactions

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

- Demand increase occurs at predicted rate.
- New Developments within reasonable demand parameters.
- Interaction with RDP 19: Rayleigh – Tilbury Group.

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2 Network configuration

2.1 Existing Network

The 132kV network is typically radial circuits with no 132kV interconnection between the Supply Points. All interconnection is at 33kV flexibility and security is maintained from the robust 33kV interconnecting system. With 28 Primary substations and 6 Grid substations and approximately 201,000 customers with an estimated 450MVA of winter maximum demand, this reflects the density and urban nature of the area supplied by the Barking, West Thurrock and Warley GSP's. Much of the network and substations were built during the 1950's and early 1960's and whilst a substantial amount of work has been done in the last 10 years to address asset health issues there remains a challenge to update and replace the network to deliver a network suitably appropriate for this area. There is a small amount of embedded generation within this group that is mainly focussed at the land fill sites near Rainham.

Within this area there are several major customers connected at 11kV and 33kV, along with two Network Rail Supply Points (Shenfield and Crowlands, a connection to the CTRL (Cross Thames Rail Link – Euro tunnel link), Lakeside shopping Centre, Fords Dagenham and Warley and the Essex side of the River Thames M25 crossings.

2.2 Network changes in progress

The replacement of the 33KV trackside cables between Crowlands Grid to Cherry Tree Primary substation and Crowlands to Romford/Gidea Park/Brentwood and Shenfield has been approved at Gate C with sufficient funds to overcome pinch point issues on the route during 2012. This replaces approximately 72km of cables retained on Network Rail property onto a new highway based route. Completion is expected by 2015. The strategy set out in this plan has been reflected in the proposals for the 33kV cable replacements.

The 33kV networks between Shenfield Grid and Nevendon Grids are to be interconnected as part of a demand transfer scheme to support the new Imperium North/South primary substation for the NYSE Centre in Basildon. The Billericay East Primary will be transferred from Nevendon grid onto Shenfield Grid whilst establishing a permanent interconnection.

3 Summary of Issues

3.1 Development areas

Development in the area is mostly limited to brownfield redevelopment and is largely covered by the Thames Gateway Regeneration and attracts a wide range and number of new connection enquiries ranging from a few MVA to 80MVA. The proximity of this area to the London financial districts in the city and at Canary Wharf makes this an attractive area for new Data Centres. There have been two such centres built within the previous 3 years and enquiries for several sites are currently underway with site demands as high as 80MVA.

The area is also identified for substantial housing development. The figures below are taken from the Local Development Framework documents from each local authority for their required additional housing through to 2031 and apportioned to reflect the number of new homes required by 2023.

- Barking & Dagenham – 10800
- Havering – 12500
- Brentwood – 1700
- Thurrock - 9300

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The documents these figures are taken from are under review to comply with the National Planning Policy Framework. In addition to new housing job creation forms a large part of the local plans and approximately 18,000 new jobs are expected to be created through the same period of time.

The impact of this new housing on the infrastructure is unclear as new technologies for embedded generation and energy conservation become increasingly developed.

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).

Crowlands/Romford/Gidea Park 33kV Circuits - Replace 33kV solid cable circuits

The three Crowlands Grid/Romford/Gidea Park 33kV cables are situated alongside the Great Eastern main line railway out of Liverpool Street Station, and for much of the route are suspended on hangers beside the track. These exposed sections of cable are prone to damage, fires and vandalism as well as accelerated ageing. The condition and fault rate of these cables is monitored for any further deterioration. It is proposed to replace the Crowlands – Romford – Gidea Park circuits in a manner to support future demand transfers from Crowlands to a new grid substation at Gidea Park.

Barking 132kV Grid Supply Point – Replace 132kV Switchgear

Barking C is an NG exit point providing supplies to the EPN, LPN and Network Rail. The site was built in 1951 and has indoor 132kV air blast circuit breakers. Despite being installed indoors the OB14 circuit breakers are still regarded as approaching end of life. Signs of cracking have been discovered on the blast tubes despite the tie bar modification which has been carried out. NG has reported that the building has serious structural defects and is to be replaced. The two EPN circuit breakers will therefore be replaced as part of the NG works. The area is part of the Thames Gateway redevelopment area (Barking Riverside) and the 132kV site may be moved as part of the overall redevelopment.

Warley 132kV Grid Supply Point – Replace 132kV Switchgear

Joint NG/UK Power Networks assessment of the existing concrete structures and CBs suggest that full replacement of the switchboard will be required with design commencing in 2014. It is proposed to replace the existing AIS switchboard with a new AIS switchboard built off line as there is sufficient space at Warley. This AIS solution will help comply with the SF6 requirements of reducing leakage to the atmosphere.

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

The condition assessment of the 1965/67 SCO K30 outdoor oil insulated switchgear installed at Crowlands 132/33kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of this project will see 13 circuit breakers replaced with 13 new circuit breakers.

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

Purfleet Grid has 17 x E01 AIS 33kV CBs that are of a high maintenance type. The highest health index at this site is 7.32 hence the need to replace the switchboard. The site has suffered several flashover incidents in recent years. Several of the feeder circuits are banked as the grid supplies 6 primaries (to be increased to 7 on the transfer of Little Belhus) and interconnects with Tilbury and West Thurrock Grids. The site supplies a predominately commercial area including Lakeside Shopping Centre, CTRL, the Dartford Crossing as well as many other important business users and generator connections. As part of the asset replacement strategy it is proposed to replace these CBs. There have been a number of catastrophic failures nationally of SWS EO1 33kV switchgear.

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

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The condition assessment of the 1960/63 GEC OBA07 outdoor oil insulated switchgear installed at Shenfield 132/33kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of this project will see 12 circuit breakers replaced with 12 new circuit breakers.

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

The condition assessment of the 1959/60/61 SCO FA71 indoor oil insulated switchgear (No R/C) installed at Hutton 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of this project will see 11 circuit breakers replaced with 11 new circuit breakers.

Hornchurch Local 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1961/63 SCO FA71 indoor oil insulated switchgear (No R/C) installed at Hornchurch 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of this project will see 16 circuit breakers replaced with 16 new circuit breakers in a 3 section board.

Selinas Lane 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1966/67 SCO FA4 indoor oil insulated switchgear (No R/C) installed at Selinas Lane 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of this project will see 13 circuit breakers replaced with 13 new circuit breakers.

Romford North 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1960 SCO FA71 indoor oil insulated switchgear (No R/C) installed at Romford North 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of this project will see 10 circuit breakers replaced with 10 new circuit breakers.

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

The condition assessment of the 1962 SCO FA4 indoor oil insulated switchgear (No R/C) installed at Cherry Tree 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of this project will see 10 circuit breakers replaced with 10 new circuit breakers.

May & Baker 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1958/60 SCO FA71 indoor oil insulated switchgear (No R/C) installed at May & Baker 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.

Noak Hill 33/11kV Primary Substation - Replace 11kV switchgear (2000A)

The condition assessment of the 1960 SCO FA71 indoor oil insulated switchgear (No R/C) installed at Noak Hill 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 12 circuit breakers replaced with 12 new circuit breakers.

High Street 33/11kV Primary Substation - Replace 11kV Switchgear

The condition assessment of the 1977 GEC BVAC indoor VAC switchgear installed at High Street 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 14 circuit breakers replaced with 14 new circuit breakers.

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

The condition assessment of the 1960 SCO FA71 indoor oil insulated switchgear installed at Romford 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 25 circuit breakers replaced with 25 new circuit breakers.

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Elm Park 33/11kV Primary Substation - Retrofit 11kV Switchgear

The condition assessment of the 1966 BRU VSI indoor oil insulated switchgear installed at Elm Park 33/11kV Primary Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 5 circuit breakers retrofitted.

Crowlands 132/25kV Grid Substation - Replace Grid Transformers (GT1B)

The condition assessment of the 1978 HSP Grid Transformer installed at Crowlands 132/25kV Grid Substation has shown that the probability of failure due to degradation will become unacceptable. Completion of the project will see 1 Grid Transformer replaced with 1 new Grid Transformer.

Purfleet 132/33kV Grid Substation - Replace Grid Transformers (GT1, GT2)

The condition assessment of the 1964 PAR Grid Transformer installed at Purfleet 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.

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

The condition assessment of the 1956 PAR Primary Transformer installed at Chequers 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 replaced with 1 new Primary Transformer.

High St 33/11kV Primary Substation - Replace Primary Transformers (T2)

The condition assessment of the 1962 WAT Primary Transformer installed at High St 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 replaced with 1 new Primary Transformer.

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

The condition assessment of the 1961 WAT Primary Transformer installed at Hornchurch Local 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 replaced with 1 new Primary Transformer.

Romford 33/11kV Primary Substation - Replace Primary Transformers (T1, T8, T9)

The condition assessment of the 1963/65 BRU Primary Transformer installed at Romford 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 3 new Primary Transformers.

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

The condition assessment of the 1953 HHE Primary Transformer installed at Selinas Ln 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.

Shenfield 132/33kV Grid Substation - Refurbish Grid Transformer (GT1A)

GT1A suffered a catastrophic failure of the English Electric FBD tapchanger on 22/04/2010. The transformer has been returned to service with the tapchanger shorted out since 2010. GT1A was manufactured in 1964 by English Electric. It is currently assessed as HI 2 (disregarding the tapchanger) and is expected to continue significant continued service following replacement of the failed tapchanger.

3.3 Security of supply analysis

See LI table in Appendix D.

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3.4 Operational and technical constraints

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. These do require operational management during routine and fault switching on the network.

There are no cable bridges or diamond crossings within this network group, however several 132kV dual circuit overhead lines do cross Network Rail lines and major roads such as the M25 and A13.

There are several important customers connected at 33kV and 11kV that provide prominent public services or are major employers, such as the Lakeside Shopping Centre, CTRL auxiliary supplies, Fords at Dagenham. These and others have higher expectations regarding the service and security they receive from the distribution network and often have a reserved capacity greater than their normal usage. The reserve capacity has to be maintained for the customer at all times in accordance with their service contract.

3.5 National Grid

The National Grid Seven Year Statement identifies replacement/upgrading of their 132kV switchgear at both Barking C and Warley. Both sites are equipped with 132kV ABCB's, with those at Barking being situated within a building (that is also in need of significant repairs). Whilst the asset replacement of the Barking C switchgear will allow for different operating arrangements that are currently restricted due to fault level issues. Warley operates with its third SGT on permanent 'Hot Standby' and may require reinforcement in the future. The discussions with NG regarding their plans are ongoing via the Joint Technical Planning Meetings that take place on a quarterly basis. The timing of the asset replacement at these sites is expected to change as NG re-evaluates their own plans.

Barking West 33kV – This supply point is expected to be reinforced with a fifth 275/33kV transformer. National Grid has also stated their intention to replace the 33kV switchgear here as early as 2020. The EPN network currently has 14 33kV CBs feeding major customers and primaries within this area.

3.6 CrossRail

The CrossRail Project across London linking Hampshire and Essex with a tunnel includes alterations to the rail infrastructure as far to the east as Shenfield and passes through this busy area. The cable project to replace the 33kV cables from Crowlands to Shenfield should avoid many of the diversions to accommodate additional tracks and alterations at the stations along the route. Bridge alterations may also be required and require works to cables crossing the Rail Network

4 Recommended strategy

The increase in demand in the area from increased utilisation of reserved capacity from large customers with significant MPR agreements will be the main cause to prompt reinforcement of the 33kV network. The Data Centre connected at King Georges Close and fed from Crowlands Grid substation is the main key to initiating upstream reinforcement affecting Crowlands Grid. Once the demand at Crowlands Grid reaches the firm capacity of the 132/33kV transformers the method of reinforcement will be to provide new additional capacity to enable a transfer of demand between Grid substations and supply points.

The reinforcement proposal for Crowlands Grid is to establish a new 132/33kV substation at Gidea Park substation. The existing 33kV switching station is fed via two 132kV cable presently operating at 33kV fed from Hornchurch Grid. This will require the 33kV network at Hornchurch Grid to be extended to interconnect with Basildon Grid to avoid islanding of the Hornchurch network. The 33kV switchgear at Gidea Park has recently been replaced with this proposal in mind and can be arranged to be incorporated into a 132/33kV substation arrangement. This and the 33kV trackside cable replacement from Crowlands through to Romford and Gidea Park has also been specified to provide for the reinforcement plan and will allow the transfer of Romford Primary

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from Crowlands to the new Gidea Park substation. These proposals previously formed part of the Local Development Plan for Crowlands Grid prepared in 2010.

Recent new Connection enquiries for up to 80MVA if taken further would prevent this solution and other options would need to be considered.

The existing and proposed Network arrangements are shown in appendix B and C.

4.1 Description

See Appendix C for financial and phasing information.

Romford - general primary substation reinforcement

The predicted load at Romford and Romford North Primary Substations will exceed the existing firm capacity during the ED1 period. Due to the nature of the load growth carrying out ITC's at existing Substations is inappropriate. It is therefore proposed to install a new Primary Substation, supplied from Crowlands Grid.

Completion of this project will see 2 new 18/30/40MVA transformers, a new switchboard comprising 11 circuit breakers and up to 1km of new 33kV underground circuits. The 33kV cable element may be avoidable should the 33kV switchgear replacement at Crowlands Grid go ahead, as a Local Primary could be established at Crowlands Grid in the space created.

11kV Demand Transfer Lakeside Primary to Barclay Way

The predicted demand at Lakeside Primary is expected to reach the site firm capacity. It is proposed to provide additional 11kV transfer to Barclay Way Primary substation.

(RDP - Crowlands) Gidea Park Proposed 132/33kV Grid Substation - (2 x 90MVA)

In order to accommodate the predicted growth in demand at Crowlands Grid as the King Georges Close Data Centre takes up their 28MVA MPR and generic load increases, a new 132/33kV substation is planned at the existing Gidea Park 33kV switching substation. Other new loads are being connected to Hornchurch Grid for a second Data Centre that will take the MD at Hornchurch over 100MW. A new Grid substation at Gidea Park will enable the transfer of Romford Primary from the Crowlands Grid 33kV network onto Gidea Park, as well as the primary substations currently supplied from Hornchurch Grid via Gidea Park 33kV switching station (Straight Rd & Noak Hill).

The new Gidea Park substation will be fed by 132kV cables from Hornchurch Grid (currently operating at 33kV) and connected to the twin 175mm 132kV Warley Grid- Hornchurch Grid PB tower line.

The 33kV switchgear at Gidea Park has recently been replaced and the new equipment is set out to accept 2 x 132/33kV transformers. New 132kV disconnectors will be required at Gidea Park and Hornchurch Grid as well as modifications to the protection systems.

Hornchurch 132/33kV Grid Substation - segregate banked 33kV Circuits

The existing 33kV switchboard at Hornchurch 132/33kV Grid substation has banked 33kV circuits that compromise operational and planning requirements. It is therefore proposed to extend the existing switchgear, this type of switchgear is now obsolete and it is proposed to use recovered switchgear from another. This will allow the connection of new feeders to provide connection to Romford Nth Primary as proposed for connection of a new Data Centre, as well interconnection planned via the Cranham 33kV circuits to Basildon Grid.

Crowlands/Romford Nth 33kV FFC Circuits - reinforce cables

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The predicted load on the Crowlands - Romford North/Chase Cross circuit will exceed the existing 33kV cable rating in the ED2 period. It is not possible to lower the load without compromising operational and planning requirements. It is therefore proposed to replace the shared circuit and the second 33kV FFC circuit to Romford North.

Completion of this project will see 2 x 2.5km underground FFC circuits replaced in the ED2 period.

Hornchurch/Cranham proposed 33kV Interconnection (N-2)

The planned 33kV network development involving Crowlands Grid, the proposed Gidea Park Grid and Hornchurch Grid will result in an islanded 33kV network at Hornchurch. Hornchurch Grid is also expected to become a >100MW site with new loads being transferred from Romford North Primary. The proposal is to establish 33kV interconnection to provide approximately 50MVA of n-2 capacity to Hornchurch Grid to meet the requirements of security of supply standards. A new 33kV route of approximately 4km in length is proposed through this dense urban area to Cranham Primary, which is fed at 33kV from Basildon Grid substation. Basildon Grid is fed from the Tilbury 132kV network, whilst Hornchurch is fed from the Warley Group.

4.2 Financial Appraisal and Benefits

- The financial expenditure is shown in Appendix D;
- Appendix E provides the future Health Indices tables changes that would take place from the proposed projects;
- Appendix E provides the Load Indices changes that would take place from the proposed projects.

5 Rejected Strategies

5.1 Third 132/33kV Transformer at Crowlands.

The option to provide reinforcement to Crowlands Grid 33kV bus-bar with a third 132/33kV transformer and 132kV switchgear would resolve the capacity at Crowlands Grid but would not benefit the surrounding 33kV networks at neighbouring Grid substations as much as the proposed option to establish a new Grid substation at Gidea Park which would provide demand transfer to Crowlands, Hornchurch and Shenfield Grid's.

The approximate cost to establish a third 132/33kV transformer with associated switchgear at Crowlands is estimated at £12m.

5.2 New National Grid Supply (BSP) point.

With National Grid supply points already at Barking 132kv and 33kV, Warley and West Thurrock all with capacity available a new BSP is not a logical requirement and has therefore not been fully costed. Though exit charges would be expected to be over £1m per annum in addition to any capital works in the region of £7-£10m.

5.3 New 132/33kV Grid Substation fed from Barking 132kV.

The possibility of a new grid substation fed from Barking 132kV has been considered previously when demand was projected to grow rapidly following discussions with the London Development Agency (as was) regarding the Thames Gateway developments. A new 132/33kV substation was seen as a short term measure to avoid National Grid reinforcement at Barking 33kV. The load centre has not materialised and a new grid substation in the Barking/Dagenham would not benefit the surrounding grid substations. Though the cost appears attractive at approximately £10m it does not provide adequate benefits to existing customers.

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

5.4 New 33/11kV Substation fed from Barking West 33kV.

There is no requirement for a new primary substation fed from Barking West at present as existing substations have adequate capacity to meet the foreseeable growth in demand. If required for new demand the cost could be in the region of £7-£9m. (Though there may be opportunities from 33kV circuits being surrendered from 33kV customers to avoid some new cable laying costs.)

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, Havering, Barking & Dagenham, Thurrock and The Thames gateway.

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
1.0	1/2/2013	Howard Green	Draft for review
1.1	5/2/2013	Howard Green	Mods from review
1.2	17/5/2013	Howard Green	Revised LI Tables etc.
1.3	24/6/2013	Howard Green	Revised text
1.4	20/3/2014	Howard Green	Aligned to ED1
2.0	27/03/2014	Minor	Regulation

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

7 Document sign off

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

Recommended by:

Name	Role	Signature	Date
Howard Green	Infrastructure Planner		20/03/14
Nuno Da Fonseca	Infrastructure Planning Manager (EPN)		

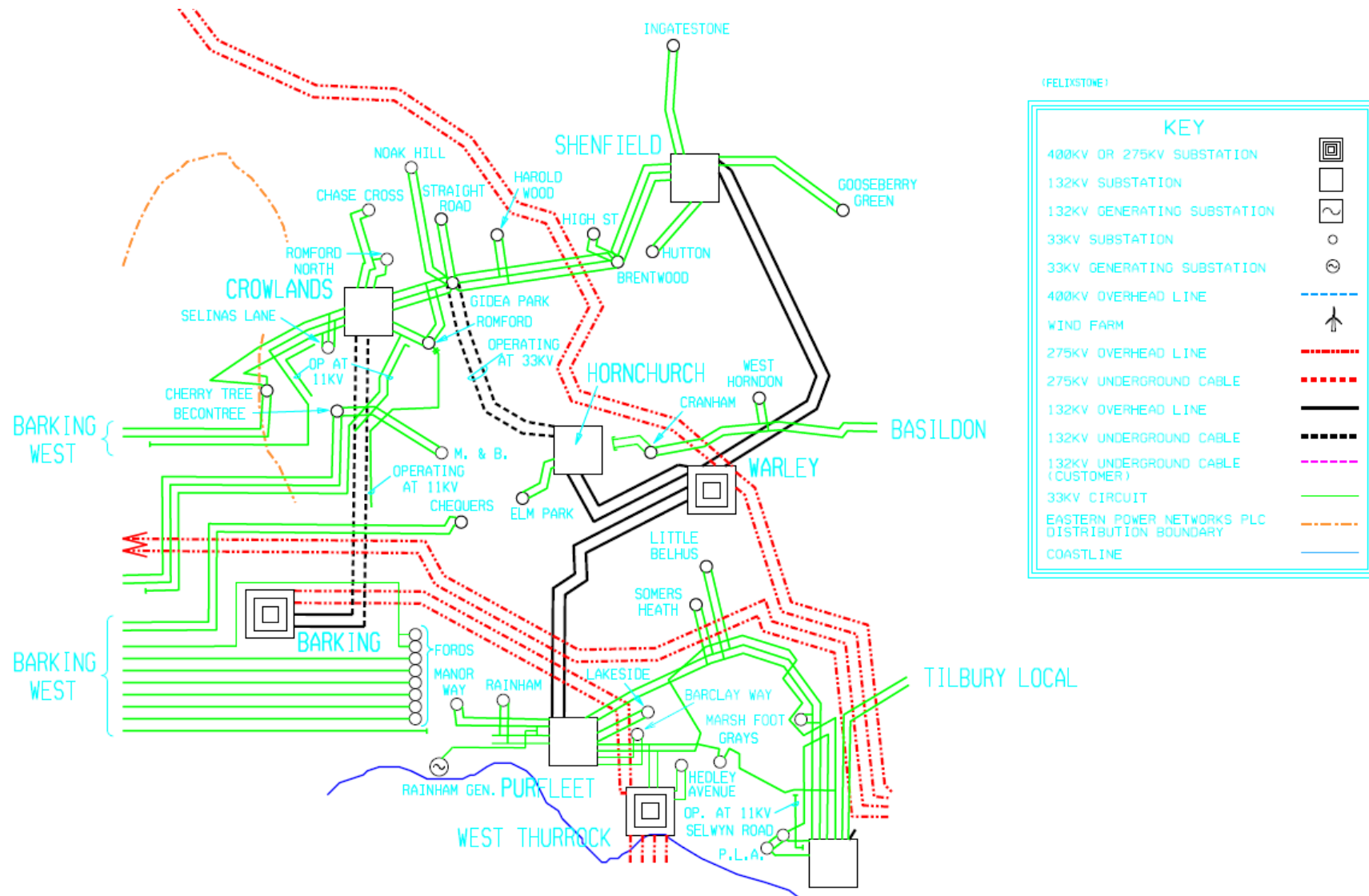
Approval by:

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

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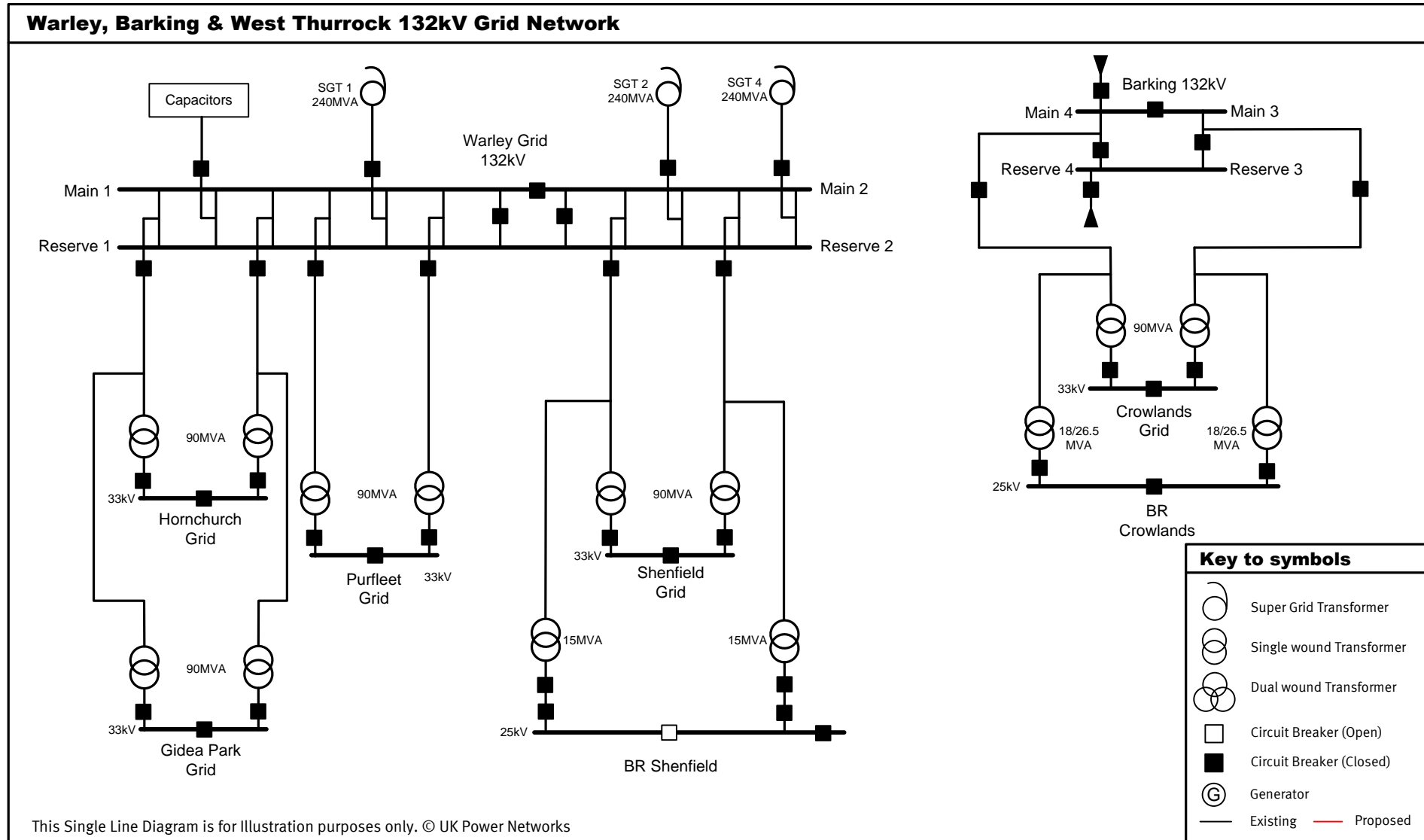
Barking, Warley and West Thurrock

APPENDIX A: GEOGRAPHICAL DIAGRAM

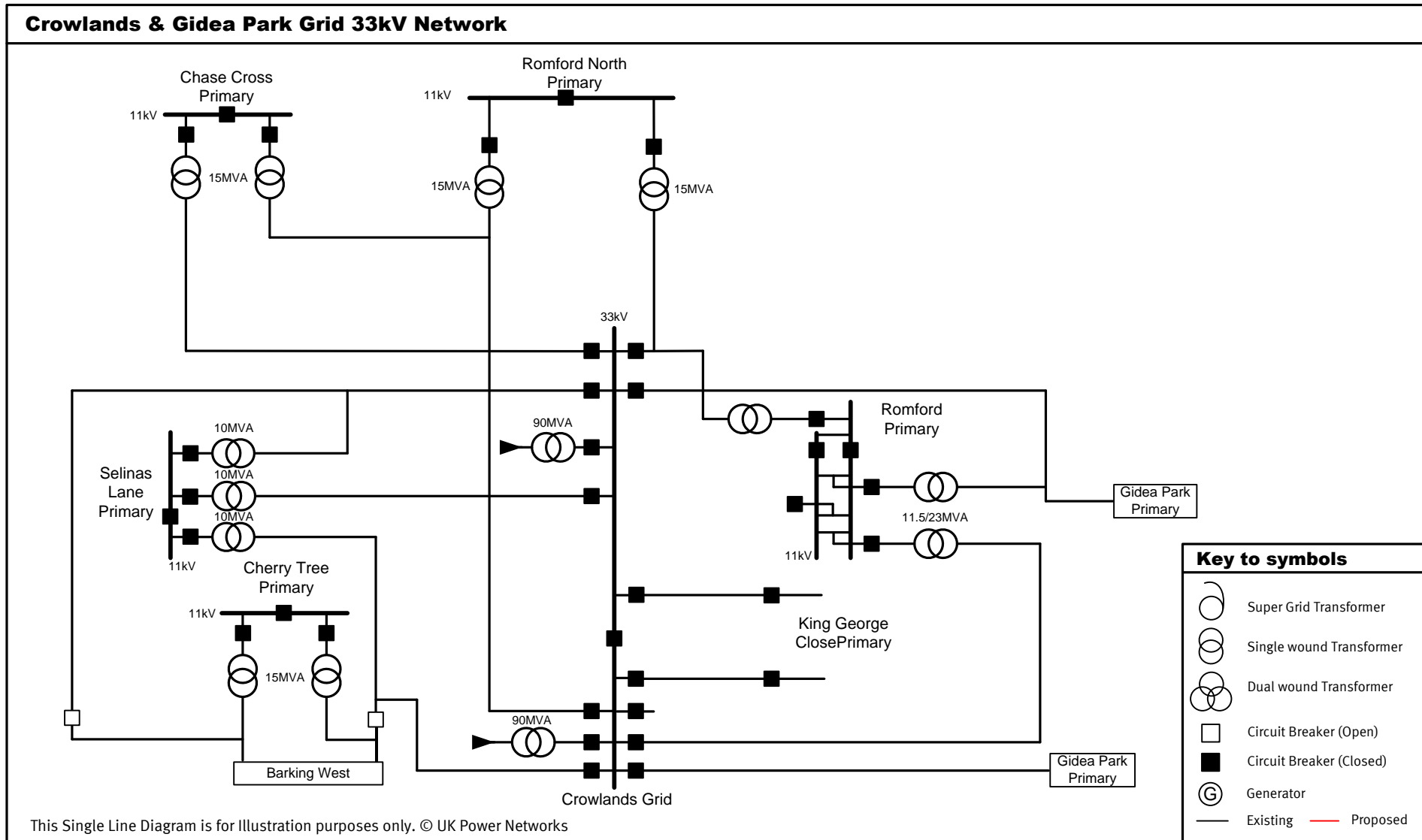


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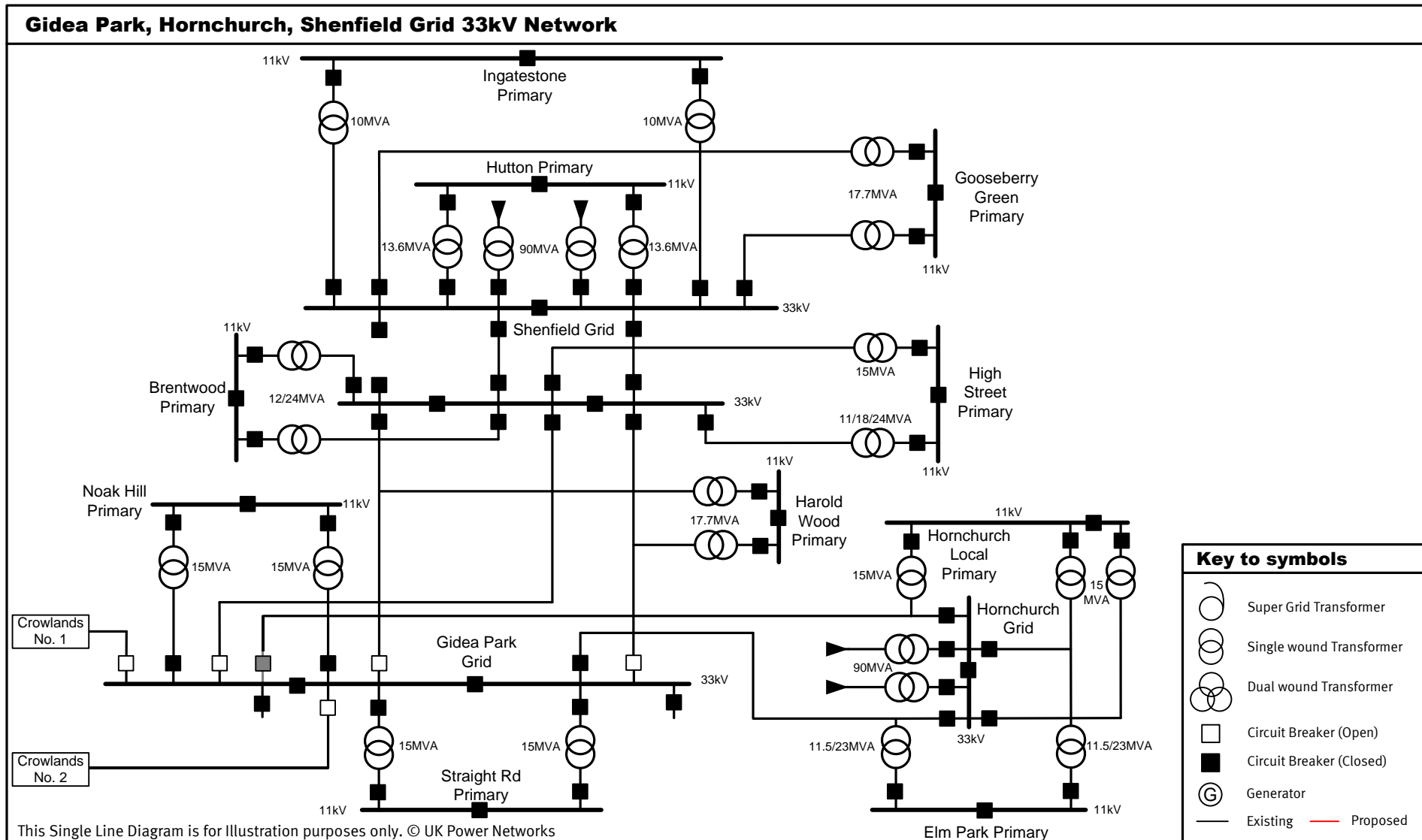
APPENDIX B: SINGLE LINE DIAGRAM – EXISTING NETWORK



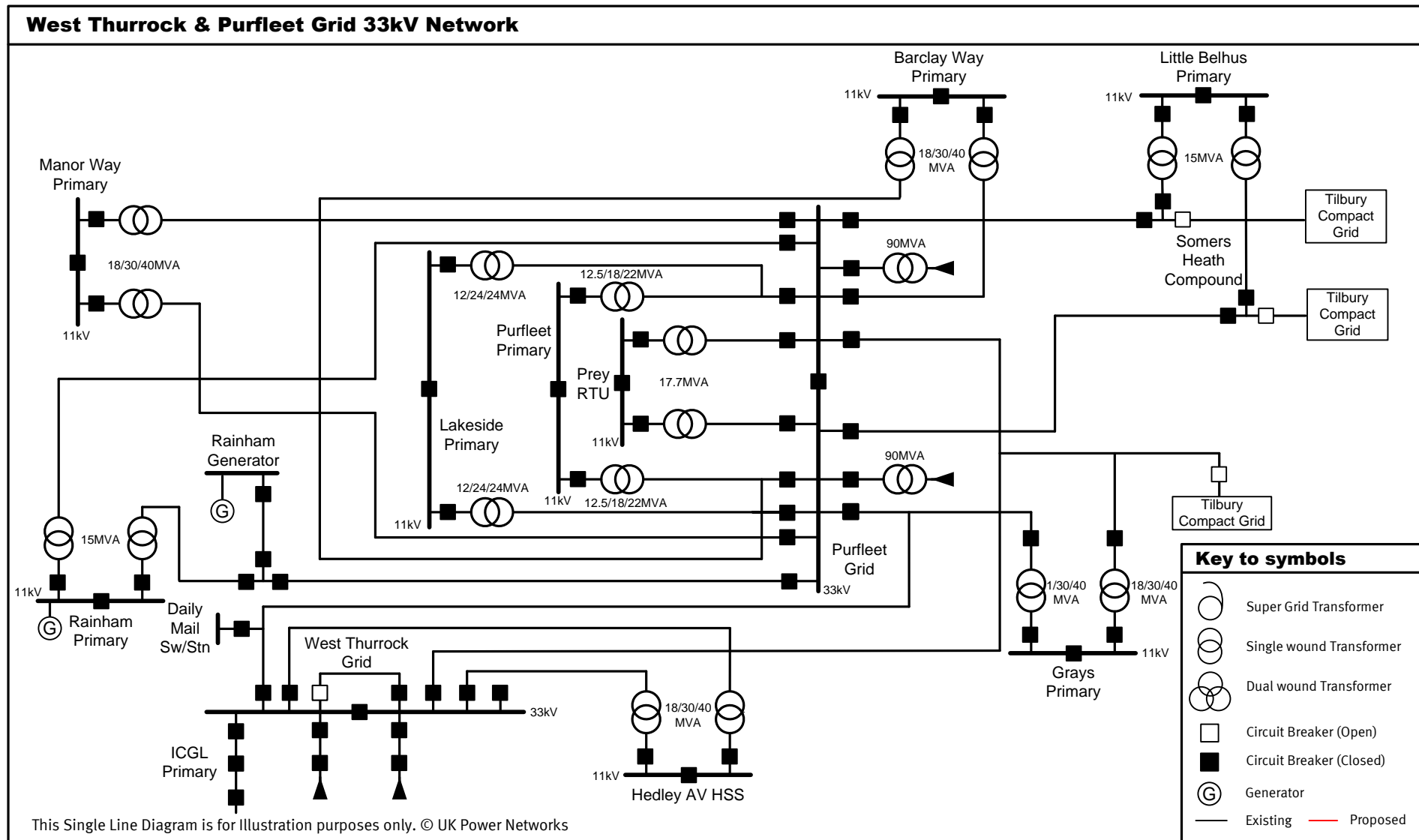
Barking, Warley and West Thurrock

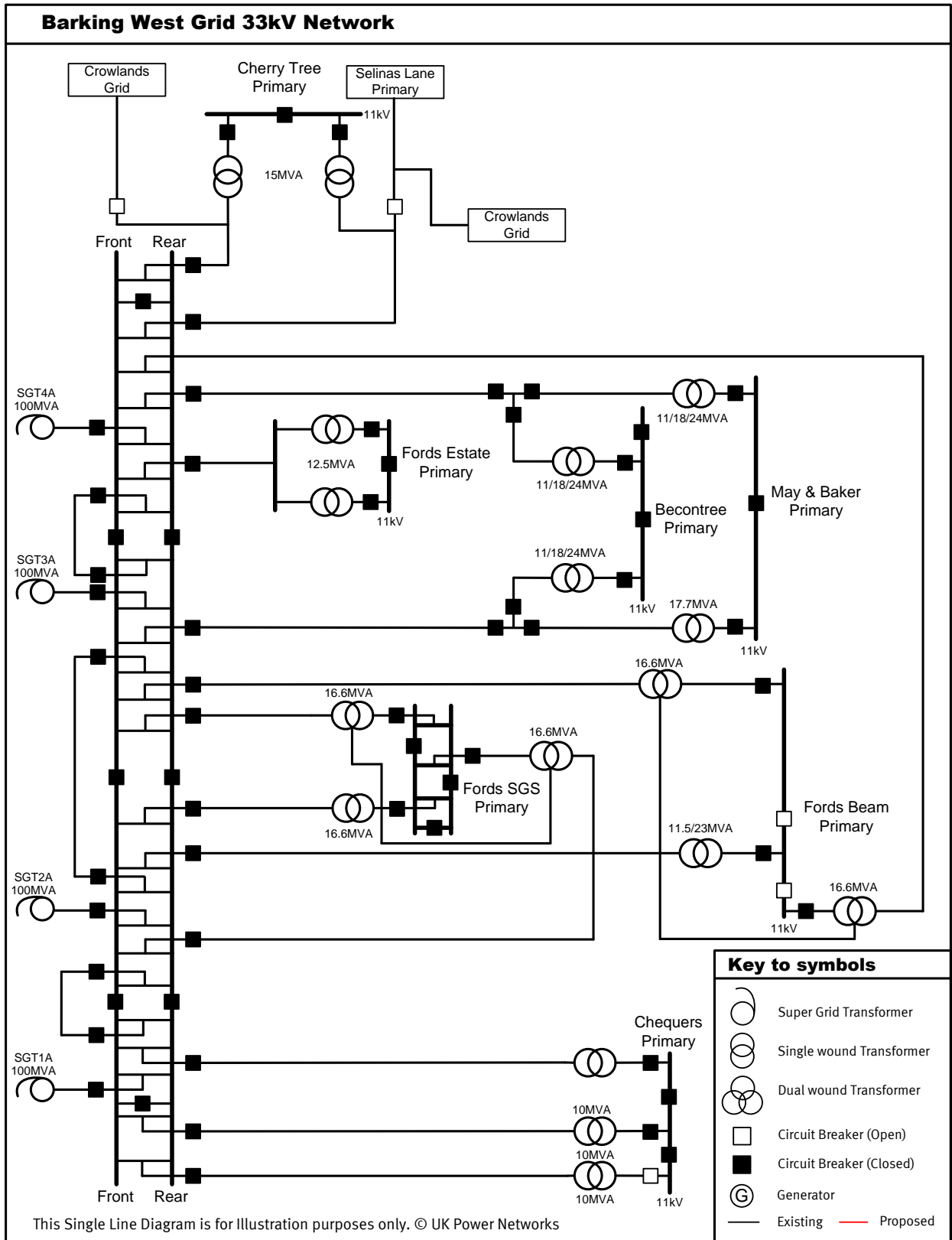


Barking, Warley and West Thurrock



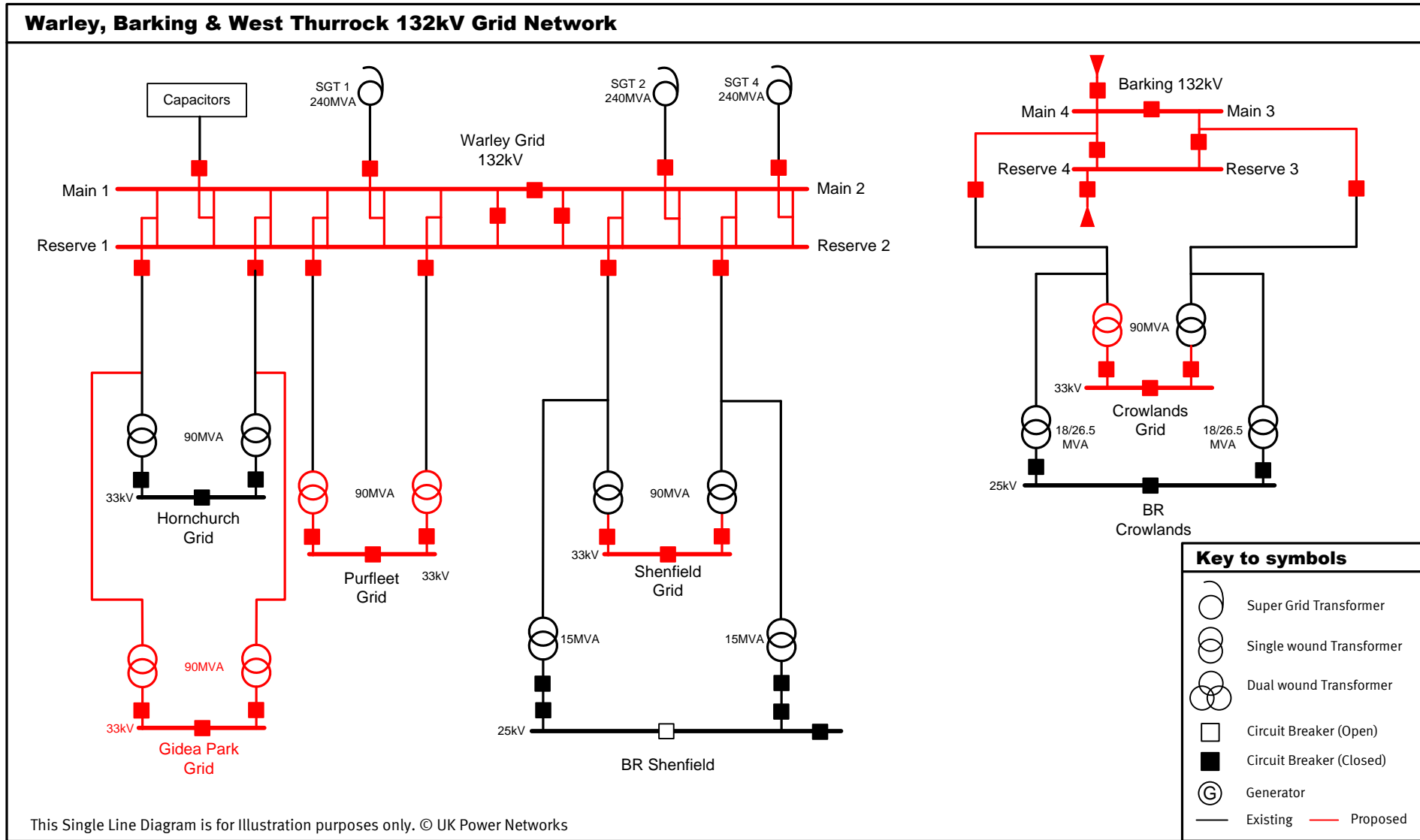
Barking, Warley and West Thurrock



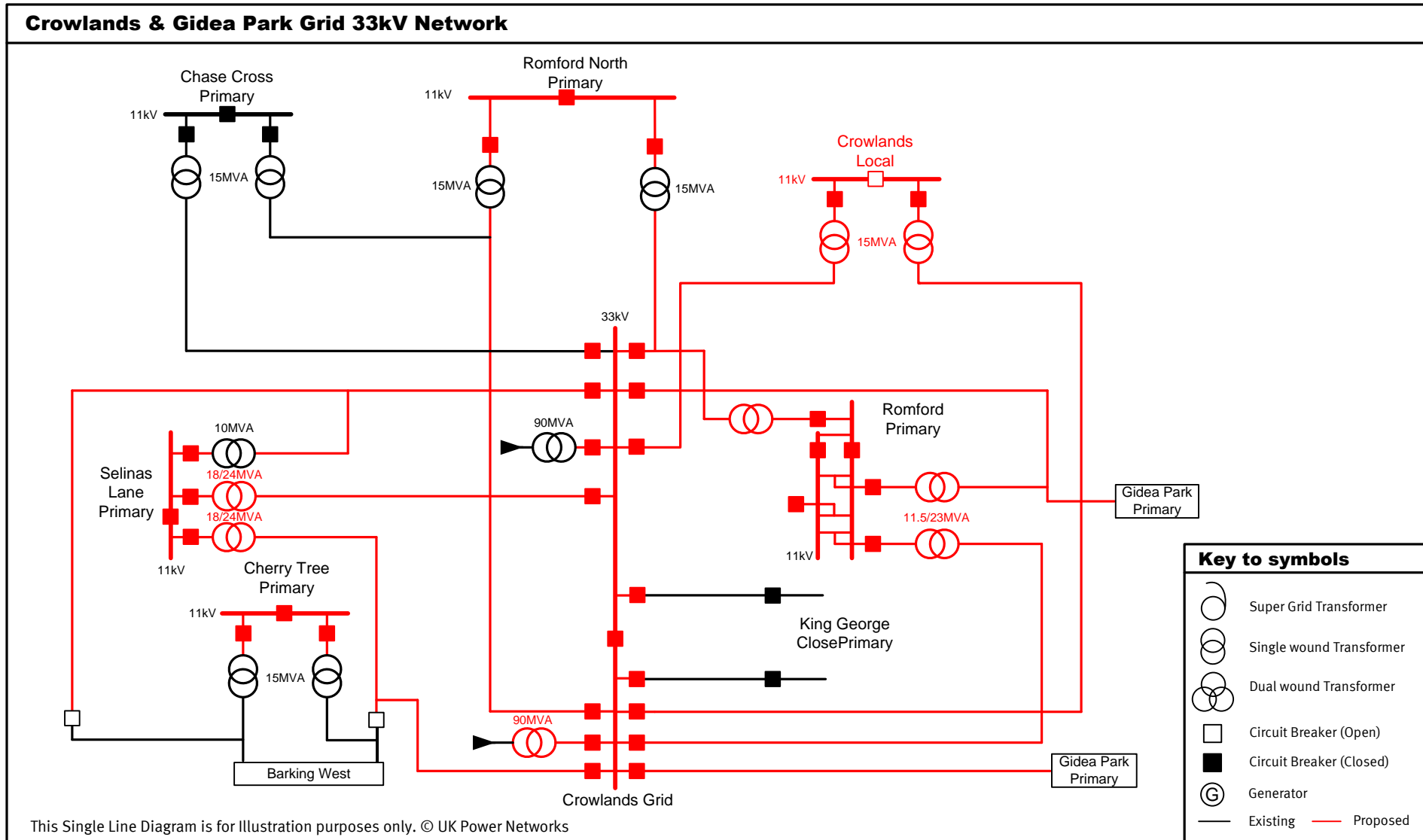


Barking, Warley and West Thurrock

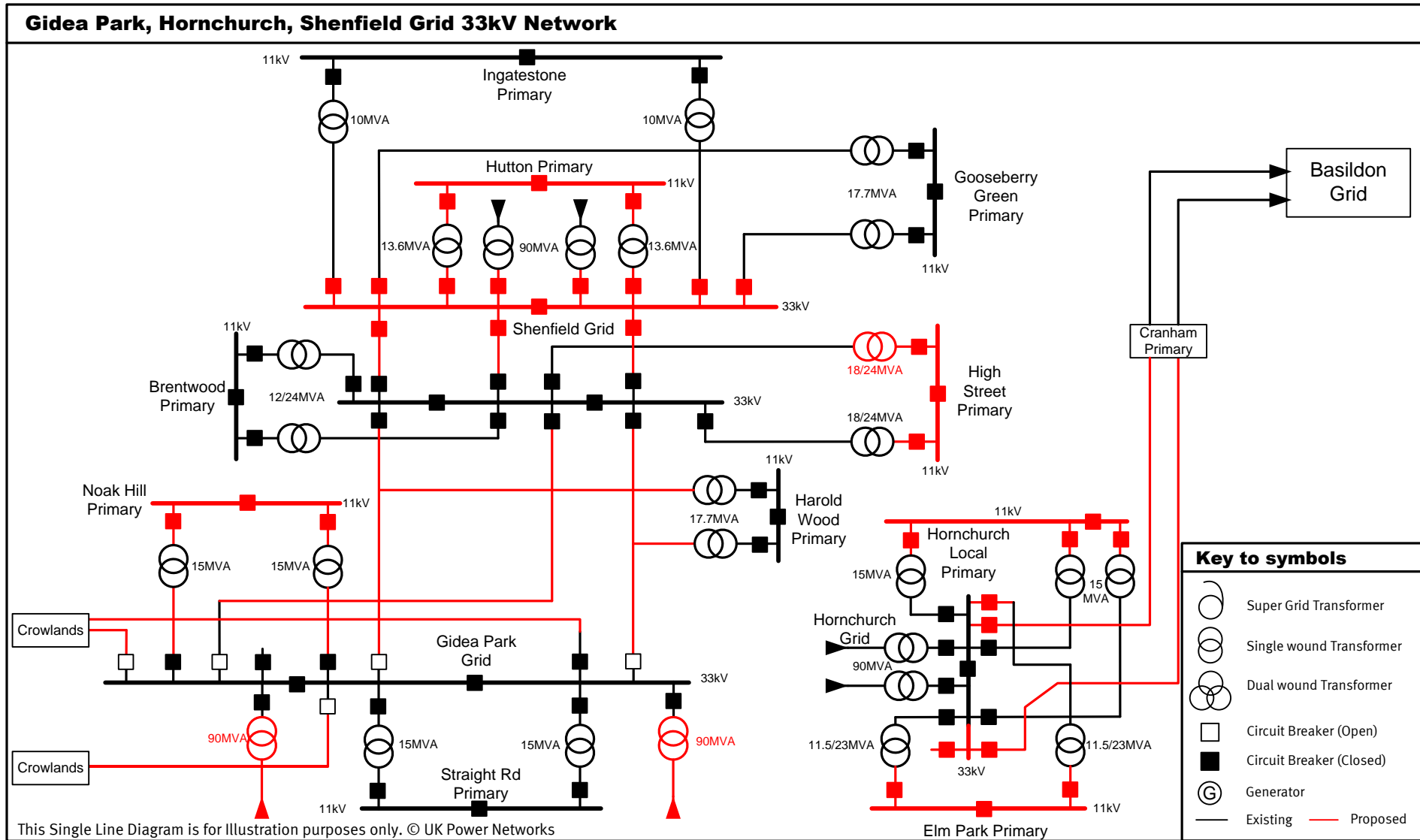
APPENDIX C: SINGLE LINE DIAGRAM – RECOMMENDED STRATEGY



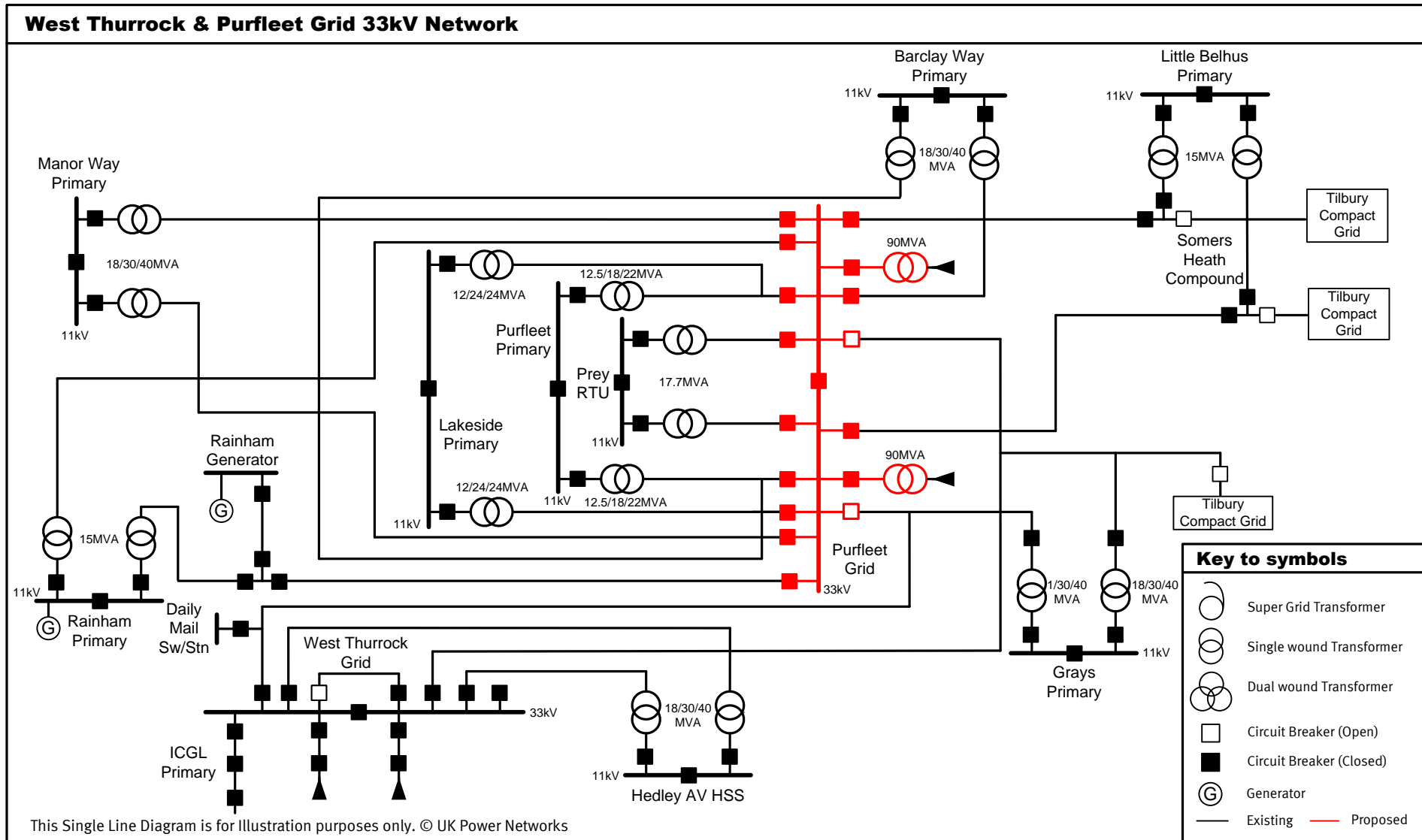
Barking, Warley and West Thurrock



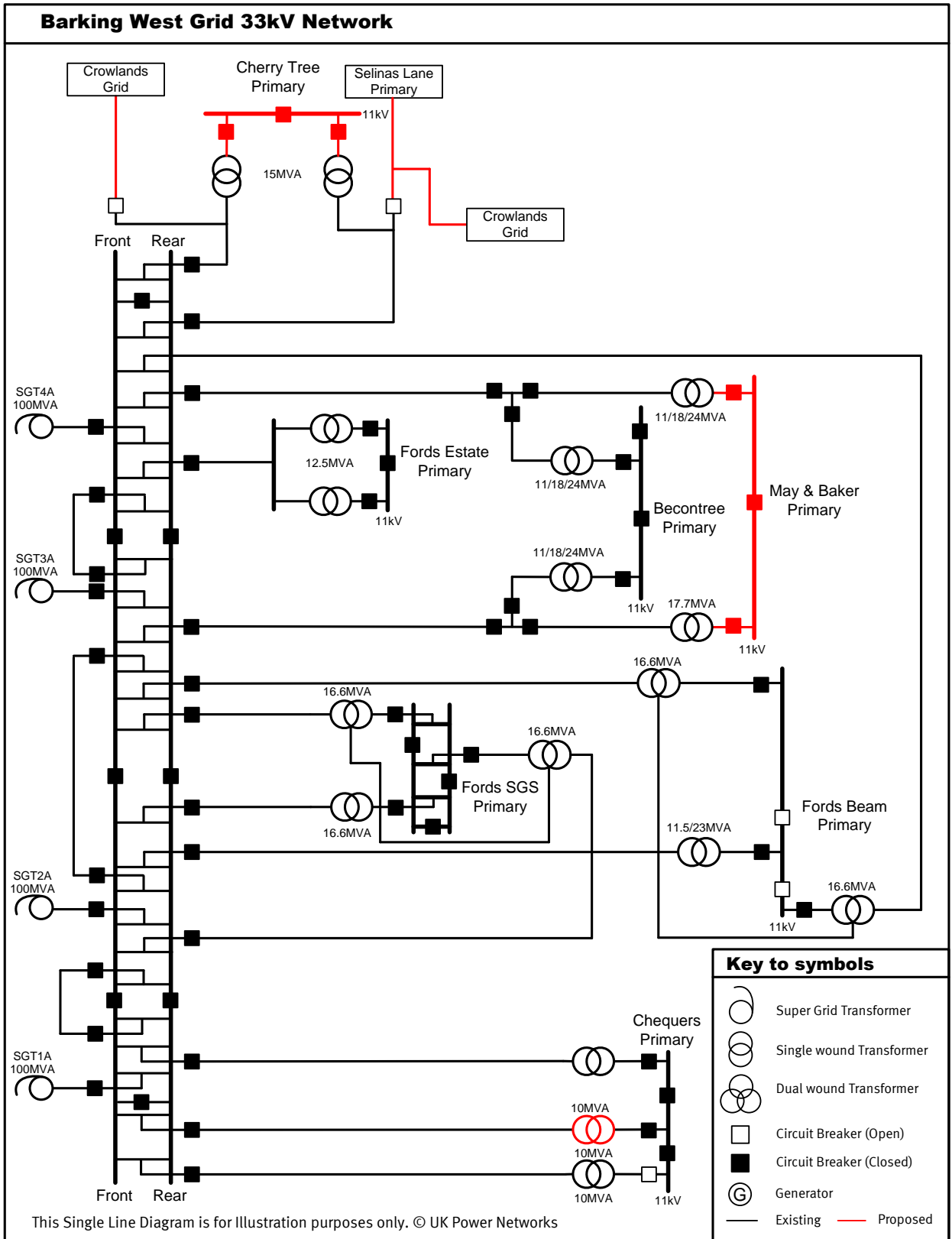
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Barking, Warley and West Thurrock



Barking, Warley and West Thurrock



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Barking, Warley and West Thurrock

APPENDIX D: DETAILED COSTS FOR RECOMMENDED OPTION

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	1.07.01	2056	Crowlands/Romford/Gidea Park 33kV Circuits - Replace 33kV Solid Cable Circuits	4,301,078	1,598,098								
A	1.48.06	2061	Barking 132kV Grid Supply Point - Replace 132kV Switchgear EPN (NG*)		249,835	1,665,565	798,440						
A	1.48.06	3940	Warley 132kV Grid Supply Point - Replace 132kV Switchgear						1,475,857	932,401	3,345,277	2,535,138	
A	1.48.11	2059	Crowlands 132/33kV Grid Substation - Replace 33kV Switchgear								369,541	964,019	273,718
A	1.48.11	2431	Purfleet 132/33kV Grid Substation - Replace 33kV Switchgear		95,475	1,613,527	374,403						
A	1.48.11	3388	Shenfield 132/33kV Grid Substation - Replace 33kV Switchgear			331,992	845,789	263,472					
A	1.50.01	2016	Hutton 33/11kV Primary Substation - Replace 11kV Switchgear				251,179	637,429					
A	1.50.01	2017	Hornchurch Local 33/11kV Primary Substation - Replace 11kV Switchgear						38,048	1,084,097			
A	1.50.01	2052	Selinas Lane 33/11kV Primary Substation - Replace 11kV Switchgear				255,788	708,075					
A	1.50.01	2057	Romford North 33/11kV Primary Substation - Replace 11kV Switchgear					244,832	617,425				
A	1.50.01	2087	Cherry Tree 33/11kV Primary Substation - Replace 11kV Switchgear					244,832	617,425				
A	1.50.01	2088	May & Baker 33/11kV Primary Substation - Replace 11kV Switchgear					234,119	539,771				
A	1.50.01	2512	Noak Hill 33/11kV Primary Substation - Replace 11kV Switchgear (2000A)							252,267	653,264		
A	1.50.01	7646	High Street 33/11kV Primary Substation - Replace 11kV Switchgear				279,043	673,398					
A	1.50.01	7660	Romford 33/11kV Primary Substation - Replace 11kV Switchgear					466,813	1,364,277				
A	1.50.01	7684	Elm Park 33/11kV Primary Substation - Retrofit 11kV Switchgear										81,632

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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	1.51.01	7714	Crowlands 132/25kV Grid Substation - Replace Grid Transformers (GT1B)								404,961	1,074,999	
A	1.51.01	7716	Purfleet 132/33kV Grid Substation - Replace Grid Transformers (GT1, GT2)							774,385	2,185,675		
A	1.51.03	7748	Chequers 33/11kV Primary Substation - Replace Primary Transformers (T2)							174,618	396,583		
A	1.51.03	7759	High St 33/11kV Primary Substation - Replace Primary Transformers (T2)				174,618	396,583					
A	1.51.03	7761	Hornchurch Local 33/11kV Primary Substation - Replace Primary Transformers (T1)				174,618	396,583					
A	1.51.03	7768	Romford 33/11kV Primary Substation - Replace Primary Transformers (T1, T8, T9)					389,148	1,020,267	304,167			
A	1.51.03	7770	Selinas Ln 33/11kV Primary Substation - Replace Primary Transformers (T1, T2)								394,039	748,364	
A	1.51.11	8402	Shenfield 132/33kV Grid Substation - Refurbish Grid Transformer (GT1A)	145,000									
A	1.55.02	5756	Crowlands Grid 132kV FMVG CT/VT Replacement	63,894									
A	1.55.02	8425	Barking 132kV GSP - BTH VT Replacement	104,591									
H	1.29.01	2976	Gidea Pk/Noak Hill 33kV FFC Circuit - Replace Cables		204,080	847,952							
H	1.29.01	4300	Shenfield/Brentwood 33kV Circuits - Replace 33kV Fluid Filled Cable Circuits (FFC)	2,076,870	2,145,865								
R	1.33.07	2053	Romford - General Primary Substation Reinforcement.				16,146	226,045	904,179	1,129,451			
R	1.34.02	6350	11kV Demand Transfer Lakeside Primary to Barclay Way							16,703	319,834		
R	1.35.01	3788	(RDP - Crowlands) Gidea Park Proposed 132/33kV Grid Substation - (2 x 90MVA)				140,112	5,604,469	3,017,621				
R	1.36.03	3477	Hornchurch 132/33kV Grid Substation - Segregate Banked 33kV Circuits			52,460	209,840	157,380					
R	1.37.07	2978	Crowlands/Romford Nth 33kV FFC Circuits - Reinforce Cables										49,807
R	1.37.07	3570	Hornchurch/Cranham Proposed 33kV Interconnection (N-2)				63,151	1,488,406					

Barking, Warley and West Thurrock

APPENDIX E: OUTPUT MEASURES – LOAD INDICES

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

Substation	Season	First Limitation	FC NOW (MVA)	DPCR5 Intervention		RIIO-ED1 without intervention				RIIO-ED1 with Intervention			P2/6 at End of ED1	
				NAMP	FC ED1 Start (MVA)	2014 (S) 14/15 (w)	2022 (S) 22/23 (W)	2014 (S) 14/15 (w)	2022 (S) 22/23 (W)	NAMP	FC ED1 end (MVA)	2022 (S) 22/23 (W)	P2/6 Class	Comply
Bardlay Way	S	Transformer	30.0		30.0	11.9	12.0	LI1	LI1	6350	30.0	LI1	C	Yes
Becontree	S	Transformer	18.0		18.0	8.5	9.2	LI1	LI1		18.0	LI1	B	Yes
Billericay East	W	Transformer	13.0		13.0	11.1	12.0	LI2	LI2	4070	15.0	LI2	C	Yes
Brentwood	W	Switchgear	23.8		23.8	16.3	17.8	LI1	LI1		23.8	LI1	C	Yes
Chase Cross	W	Circuit Rating	19.3		19.3	11.2	12.1	LI1	LI1		19.3	LI1	C	Yes
Chequers	S	Transformer	20.0		20.0	8.8	9.3	LI1	LI1		20.0	LI1	B	Yes
Cherry Tree	W	Transformer	19.5		19.5	12.8	14.0	LI1	LI1		19.5	LI1	C	Yes
Crowlands Grid 33	W	Switchgear	114.3		114.3	102.2	124.0	LI3	LI5	3788	114.3	LI2	D	Yes
Elm Park	W	Transformer	23.0		23.0	15.0	16.2	LI1	LI1		23.0	LI1	C	Yes
Gooseberry Green	W	Transformer	21.3		21.3	14.0	15.3	LI1	LI1		21.3	LI1	C	Yes
Grays	W	Circuit Rating	22.3		22.3	15.9	17.2	LI1	LI1		22.3	LI1	C	Yes
Harold Wood	W	Transformer	21.2		21.2	10.9	11.7	LI1	LI1		21.2	LI1	B	Yes
Hedley Avenue	S	Transformer	30.0		30.0	19.7	20.1	LI1	LI1		30.0	LI1	C	Yes
High Street	W	Transformer	19.5		19.5	14.4	15.4	LI1	LI1	7759	24.0	LI1	C	Yes
Hornchurch Grid 33	W	Transformer	108.0		108.0	87.4	113.0	LI2	LI1	3788	108.0	LI1	D	Yes
Hornchurch Local	W	Circuit Rating	37.0		37.0	26.3	28.3	LI1	LI1		37.0	LI1	C	Yes
Hutton	W	Transformer	16.3		16.3	14.2	15.3	LI2	LI2		16.3	LI2	C	Yes
Ingatestone	W	Transformer	12.0		12.0	7.7	8.6	LI1	LI1		12.0	LI1	B	Yes
Lakeside	S	Switchgear	22.9		22.9	19.3	19.5	LI2	LI2	2512	22.9	LI2	C	Yes
Little Belhus	W	Transformer	18.0		18.0	7.9	8.8	LI1	LI1		18.0	LI1	B	Yes
Manor Way	W	Circuit Rating	25.1		25.1	14.4	15.0	LI1	LI1		25.1	LI1	C	Yes
May & Baker	W	Transformer	21.2		21.2	12.1	12.7	LI1	LI1		21.2	LI1	C	Yes
Noak Hill	S	Transformer	15.0		15.0	9.0	9.8	LI1	LI1		19.5	LI1	B	Yes
Purfleet Grid 33	W	Circuit Rating	100.0		111.7	86.5	89.5	LI1	LI1	2053	125.9	LI1	D	Yes
Purfleet T1 & T2	S	Transformer	17.7		17.7	9.4	9.6	LI1	LI1	2053	17.7	LI1	B	Yes
Purfleet T3 & T4	S	Transformer	18.0		18.0	13.2	13.3	LI1	LI1		18.0	LI1	C	Yes
Rainham (EPN)	W	Transformer	19.5		19.5	11.5	12.4	LI1	LI1		19.5	LI1	C	Yes
Romford	W	Transformer	44.0		44.0	42.9	45.8	LI3	LI5		44.0	LI2	C	Yes
Romford North	W	Transformer	19.5		19.5	10.6	11.5	LI1	LI1	3788	19.5	LI1	B	Yes
Selinas Lane	S	Transformer	20.0		20.0	13.9	14.9	LI1	LI1	2053	20.0	LI1	C	Yes
Shenfield Grid 33	W	Switchgear	114.3		114.3	77.8	85.5	LI1	LI1		114.3	LI1	D	Yes
Straight Road	W	Transformer	19.5		19.5	17.7	19.1	LI2	LI3		19.5	LI3	C	Yes
Gidea Park Grid 33 (New)			0.0		0.0	0.0	0.0			0	117.0	LI2	D	Yes
Crowlands local (New)			0.0		0.0	0.0	0.0			0	40.0	LI1	C	Yes

Barking, Warley and West Thurrock

APPENDIX F: OUTPUT MEASURES - HEALTH INDICES (HI)

Substation	132kV Switchgear														
	ED1 Start (2015)					ED1 End (2023) No Investment					End of ED1 (2023) With Investment				
	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
BARKING 132			2						2		2				
WARLEY GRID 132KV			5	1	3					9	9				
TOTAL			7	1	3				2	9	11				

Substation	33kV Switchgear														
	ED1 Start (2015)					ED1 End (2023) No Investment					End of ED1 (2023) With Investment				
	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
BARKING WEST	14						14					14			
BECONTREE PRIMARY	2					2					2				
BRENTWOOD PRIMARY	12					12					12				
CROWLANDS GRID	2			13		2				13	15				
GIDEA PK PRIMARY	14					14					14				
GRAYS PRIMARY	2					2					2				
HEDLEY AV HSS		2					2					2			
HORNCHURCH GRID		7					7					7			
PURFLEET GRID			17							17	17				
SHENFIELD GRID	2		11	1		2				12	14				
WEST THURROCK GRID	11						11					11			
TOTAL	59	9	28	14		34	34			42	76	34			

Barking, Warley and West Thurrock

OUTPUT MEASURES - HEALTH INDICES (HI)

Substation	11/6.6kV Switchgear														
	ED1 Start (2015)					ED1 End (2023) No Investment					End of ED1 (2023) With Investment				
	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5	HI1	HI2	HI3	HI4	HI5
BARCLAY WAY PRIMARY	11						11					11			
BECONTREE PRIMARY		11					11					11			
BILLERICAY EAST PRIMARY		2	4					6					6		
BRENTWOOD PRIMARY	13						13					13			
CHASE CROSS PRIMARY			13					13					13		
CHEQUERS PRIMARY	15					1	14				1	14			
CHERRY TREE PRIMARY			6	4						10	10				
ELM PARK PRIMARY		7	5				7	3	2			12			
GARDINERS LN PRIMARY		4	7				1	4	6			1	4	6	
GOOSEBERRY GRN PRIMARY	9					9					9				
GRAYS PRIMARY	17					17					17				
HAROLD WOOD PRIMARY			10					10					10		
HEDLEY AV HSS	11						11					11			
HIGH ST PRIMARY			14						4	10	14				
HORNCHURCH LOCAL PRIMARY			11	4	1				1	15	16				
HUTTON PRIMARY			8	3						11	11				
INGATESTONE PRIMARY	8						8					8			
LAKESIDE PRIMARY		11					11					11			
LITTLE BELHUS PRIMARY	13					3	10				3	10			
MANOR WAY PRIMARY	15					15					15				
MAY & BAKER PRIMARY			5	3					2	6	8				
NOAK HILL PRIMARY			9	3						12	12				
PURFLEET PRIMARY		23	1				14	10				14	10		
RAINHAM PRIMARY		4	9					13					13		
ROMFORD NORTH PRIMARY			3	7						10	10				
ROMFORD PRIMARY		9	16					9	13	3	25				
SELINAS LN PRIMARY			12	1				2	5	6	13				
STRAIGHT RD PRIMARY	13						13					13			
TOTAL	125	71	133	25	1	45	124	70	33	83	164	129	56	6	

OUTPUT MEASURES - HEALTH INDICES (HI)

	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
BARCLAY WAY PRIMARY		2					2					2			
BARKING 132															
BARKING WEST															
BECONTREE PRIMARY		2						2					2		
BILLERICAY EAST PRIMARY	1		1				1	1				1	1		
BRENTWOOD PRIMARY		2					1	1				1	1		
CHASE CROSS PRIMARY		2					2					2			
CHEQUERS PRIMARY		2		1				2		1	1		2		
CHERRY TREE PRIMARY		2					1	1				1	1		
CROWLANDS GRID		3	1				3		1		1	3			
ELM PARK PRIMARY		2						2					2		
GARDINERS LN PRIMARY			2					2					2		
GIDEA PK PRIMARY											2				
GOOSEBERRY GRN PRIMARY		2					1	1				1	1		
GRAYS PRIMARY	2						2					2			
HAROLD WOOD PRIMARY		2					2					2			
HEDLEY AV HSS	1	1					1	1				1	1		
HIGH ST PRIMARY	1				1	1				1	2				
HORNCHURCH GRID		2					2					2			
HORNCHURCH LOCAL PRIMARY		2		1			1	1		1	1	1	1		
HUTTON PRIMARY		2						2					2		
INGATESTONE PRIMARY		2					1	1				1	1		
LAKESIDE PRIMARY		2						2					2		
LITTLE BELHUS PRIMARY		2					2					2			
MANOR WAY PRIMARY	1	1				1		1			1		1		
MAY & BAKER PRIMARY	1	1					2					2			
NOAK HILL PRIMARY		2						2					2		
PURFLEET GRID			1	1						2	2				
PURFLEET PRIMARY		4						4					4		
RAINHAM PRIMARY		1		1			1			1		1			1
ROMFORD NORTH PRIMARY		2					2					2			
ROMFORD PRIMARY			2		1			1		2	3				
SELINAS LN PRIMARY			2	1				1	1	1	2		1		
SHENFIELD GRID		4					2	2				2	2		
STRAIGHT RD PRIMARY			2					2					2		
WARLEY GRID 132KV															
WEST THURROCK GRID															
TOTAL	7	49	11	5	2	2	29	32	2	9	15	29	31		1

