

Bramford to Twinstead Tee Connection Project Distribution System Options Report.

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February 2013

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1 INTRODUCTION

Purpose of report

- 1.1 In July 2011, National Grid announced its preferred corridor for developing a scheme for a 400kV connection between Bramford substation in Suffolk (west of Ipswich) and Twinstead Tee in Essex (south of Sudbury). This corridor (Corridor 2) incorporates the route of a 132kV overhead line comprising part of the electricity distribution system owned and operated by the Distribution Network Operator, UK Power Networks (UKPN). This 132kV overhead line runs from Burstall Bridge, 2.5km to the south of Bramford substation, to Twinstead Tee.
- 1.2 The preferred corridor, Corridor 2, would involve removing the existing 132kV overhead line in order to accommodate the 400kV connection. Following the removal of the 132kV overhead line, additional work will be required to maintain the current security of supply to local homes and businesses. When it announced its preferred corridor, National Grid was aware that a new substation could be required to maintain security of supply and had identified some potential sites. However, in accordance with its options appraisal strategy, it was committed to reviewing further the options to replace the lost capacity on the UKPN network.
- 1.3 UKPN has reviewed¹ the options to maintain the security of local electricity supplies. These options included the construction of new 132kV overhead lines or underground cables between different points on its network as well as proposals for new substations.
- 1.4 National Grid has reviewed the options available to UKPN to maintain local electricity supplies and undertaken further evaluation of these options in a manner consistent with National Grid's guidelines on Options Appraisal². The outcome of the review (Strategic Options Appraisal) is set out in the report. The review supports UKPN's assessment that the development of a substation to the west of Twinstead should be the preferred option.
- 1.5 A second report³ considers options for the siting of a substation in more detail and considers specific locations within three identified substation study areas.
- 1.6 In accordance with the Statement of Community Consultation⁴, which refers to issue-specific consultations during Stage Two Consultation, consultation events will be held to obtain representations on the options considered in this report and the Substation Siting

¹ UK Power Networks: 132kV Network Reconfiguration to Accommodate Larger System Works: July 2012.

² National Grid plc. : Our Approach to Options Appraisal : August 2012

³ National Grid plc. : Substation Siting Options Appraisal : February 2013

⁴ National Grid plc. : Bramford to Twinstead Tee 400kV Connection Project – Consultation Strategy : November 2011

Options Appraisal report. Comments received on these reports and representations made during the consultation will help to inform the development of a detailed connection design. Further engagement will take place regarding detailed substation siting, design and preliminary environmental information. Following this, the detailed connection design, including substation, will be further developed and subject to an environmental impact assessment. The consultation strategy will be reviewed before undertaking Stage Three Consultation. This stage will involve National Grid formally publicising, and consulting upon its proposed application for development consent in accordance with the requirements of the Planning Act 2008⁵. Following the Stage Three Consultation, an application for Development Consent for the Bramford to Twinstead Tee Connection Project, incorporating the substation works, will be finalised and submitted to the Planning Inspectorate⁶. At each stage in the development of the connection design, decisions made will be subject to a process of backcheck and review in the light of representations received.

Structure of report

1.7 The report is structured as follows:

- Chapter 2 - sets out an overview of the local electricity network and the need to ensure security of supply, and identifies the options for appraisal;
- Chapter 3 - gives a brief outline of all the options considered as well as assumptions and appraisal methods;
- Chapters 4 to 9 - present the results of the Strategic Options Appraisal;
- Chapter 10 - summarises the findings of the Strategic Options Appraisal and identifies which option should be taken forward for detailed appraisal.

⁵ Planning Act 2008 : 2008 Ch29

⁶ From April 2012 the duties of the Infrastructure Planning Commission, including the processing of applications for Development Consent Orders under the Planning Act 2008, were transferred to the Planning Inspectorate.

2 OVERVIEW OF THE LOCAL ELECTRICITY NETWORK AND STRATEGIC OPTIONS

Operation of the Electricity Transmission and Distribution Networks

- 2.1 The electricity system is made up of networks which operate at different voltage levels. Transmission networks in England and Wales operating at voltages of 400kV and 275kV are used for the bulk transfer of power from generation to distribution networks. This is primarily to facilitate higher power transfers and to reduce the amount of power lost during the transportation process because losses are reduced at higher voltages.
- 2.2 Distribution networks, in contrast, are mainly concerned with the delivery of power to consumers at lower voltages - 132kV, 66kV, 33kV and below. Distribution networks typically provide electricity to users through a network of circuits operating at reducing voltage levels and power carrying capacity.
- 2.3 UK Power Networks Limited includes the three licensed electricity distribution businesses (Eastern Power Networks, London Power Networks and South Eastern Power Networks). Each of these licensed distribution businesses owns assets at 132kV and below and each of them is licensed to distribute power to homes and businesses.
- 2.4 National Grid is an entirely separate business from UKPN and as with electricity distribution, the transmission of electricity in Great Britain requires a licence under Section 6(1)(b) of the Electricity Act 1989⁷ (the "Electricity Act"). National Grid is the operator of the high voltage transmission system for Great Britain and its offshore waters, which is known as the National Electricity Transmission System (the "NETS"), and is the owner of the high voltage transmission system in England and Wales operating at 400kV and 275kV.

The Local Electricity Network

- 2.5 The connection of transmission and distribution networks occurs at Grid Supply Points (GSP). These are typically substations where power is transformed from 400kV or 275kV to 132kV, 66kV or 33kV for onward distribution to consumers.
- 2.6 Bulk Supply Point (BSP) substations operate at 132kV and 66kV and provide a distribution hub where power is transformed to lower voltages for onward distribution to towns, villages, homes, farms and industry from primary substations.
- 2.7 The large towns in the area such as Sudbury (population approx. 12000), Haverhill (population approx. 27000) and Saffron Walden (population approx. 15000) are fed from

⁷ Electricity Act 1989 : Chapter 29

local primary substations which are in turn fed from Bulk Supply Point substations at Braintree, Thaxted and Belchamp. The Bulk Supply Points at Thaxted and Belchamp are supplied from the Grid Supply Point at Pelham to the west.

2.8 Figure 1 below shows the configuration of the existing 132kV double circuit line (the PCB line) which runs between Pelham and Bramford. The circuits are currently broken at Burstall Bridge (indicated by arrows); however, this configuration can be altered when required as part of outage planning (an outage is a temporary interruption to electricity transmission which may be planned (to enable maintenance to take place) or unplanned (as a result of equipment failure)) to provide up to 198MVA (summer) or 246MVA (winter) transfer capacity between Pelham and Bramford, which is sufficient to ensure a secure supply to Thaxted and Belchamp substations.

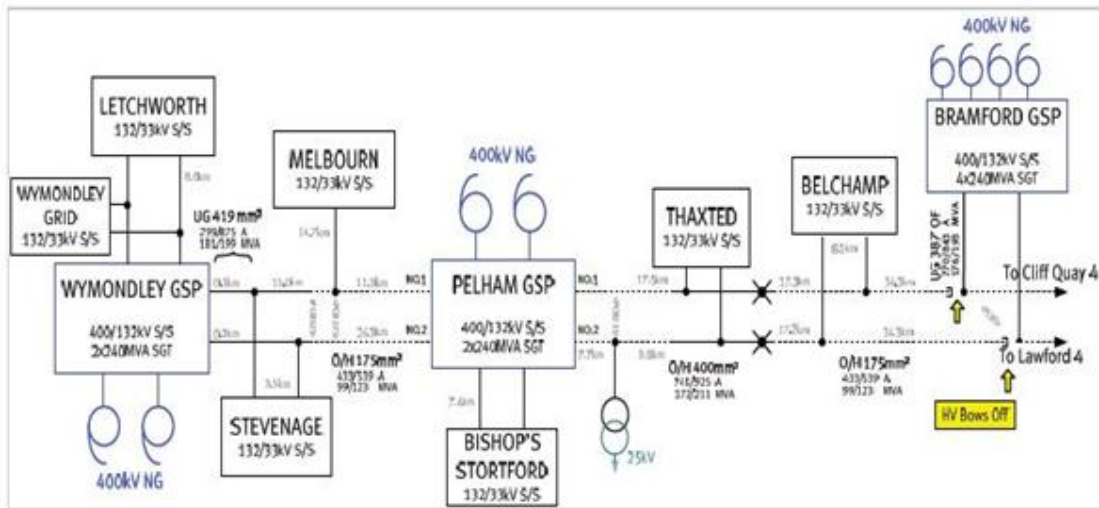


Figure 1. Pelham & Wymondley - Existing network (Conceptual schematic)

2.9 The preferred route corridor for the Bramford to Twinstead Tee connection involves the removal of a section of 132kV overhead line. National Grid has approached UKPN to gain agreement that the 132kV dual circuit overhead line between Twinstead Tee and Burstall Bridge can be removed.

2.10 The removal of the 132kV circuits to Bramford will result in an increased risk to the supply of existing customers and UKPN not complying with the Electricity Networks Association Engineering Recommendation P2/6 (ER P2/6). Each distribution licensee must operate its electricity distribution network to a minimum standard set out in ER P2/6.

2.11 ER P2/6 requires that a minimum level of demand can be supported following faults or planned maintenance of the system. The removal of the existing line would result in

insufficient capacity being available to take system outages, therefore making the system non-compliant within the Thaxted and Belchamp Group. The UKPN report "132kV network reconfiguration to accommodate wider system works" provides a detailed analysis by UKPN of its system P2/6 requirements.

- 2.12 The present report appraises a number of technical options that were considered in the UKPN report. All these options propose connections to replace the 198MVA (summer) or 246MVA (winter) of transfer capacity which would be lost when the existing 132kV overhead line is removed. These options would maintain current levels of distribution network security and reliability to customers served by the Thaxted and Belchamp areas of the UKPN network.
- 2.13 National Grid does not hold any electricity distribution licences in Great Britain and does not own or operate distribution assets. As such, National Grid does not hold independent information or designs for the UKPN system. The management of the UKPN system, and connections to it, are matters for UKPN.
- 2.14 National Grid has reviewed the need case set out in the UKPN report and is satisfied that there is a need for works to the distribution network following the removal of the 132kV line. National Grid has reviewed the analysis undertaken by UKPN with respect to 132kV connection options described within its report and has also carried out further analysis of the 132kV connection options in the UKPN report in accordance with its own options appraisal methods.
- 2.15 The UKPN report has set out a competent technical and capital cost appraisal, which is summarised within this chapter. However, National Grid has provided further information on lifetime cost, environmental and socio-economic issues, in line with its options appraisal process, in later chapters.
- 2.16 The UKPN report presents a detailed analysis of each option in a technical and cost appraisal. UKPN has confirmed its costs are based upon recent experience from tenders for, and construction of similar assets.
- 2.17 The following table summarises the eight options with sub options, as detailed within the UKPN report and their associated capital costs.

Table 1: UKPN's summary of options and associated network/wider costs.

Option Description		P2/6 Compliant Design	UKPN Network Circuit Cost	Overall Cost including wider transmission works
Option 1	Do Nothing	Not compliant	N/A	N/A
Option 2	Replace 132kV circuits between Twinstead and Burstall Bridge (132kV UG cable circuits)	Compliant	£45.30m	£103.00m
Option 3	Extension of the 132kV PCB overhead line from Twinstead			
	3.1.1 Twinstead – Lawford 132kV Substation (New 132kV OHL circuits)	Compliant	£22.60m	£80.50m
	3.1.2 Twinstead – Lawford 132kV Substation (New 132kV UG cable circuits)	Compliant	£40.10m	£98.00m
	3.2.1 Twinstead – Abberton Grid (New 132kV OHL circuits)	Compliant	£21.30m	£75.00m
	3.2.2 Twinstead – Abberton Grid (New 132kV UG cable circuits)	Compliant	£38.50m	£92.50m
Option 4	33kV Reinforcement			
	4.1 Resolve 33kV constraints	Not Compliant	N/A	N/A
	4.2 Increase 33kV interconnection	Not Compliant	N/A	N/A
Option 5	Reinforce Braintree GSP and install new 132kV circuits to Rushley Green			
	5.1.1 132kV Braintree – Rushley Green (New 132kV OHL circuits)	Compliant	£17.00m	£49.00m
	5.1.2 132kV Braintree – Rushley Green (New 132kV UG cable circuits)	Compliant	£30.40m	£62.40m
	5.2.1 132kV Braintree – Abberton teed off to Twinstead (New 132kV OHL circuits)	Compliant-reliant on additional UKPN scheme	£16.50m	£46.50m
	5.2.2 132kV Braintree – Abberton teed off to Twinstead (New 132kV UG cable circuits)	Compliant-reliant on additional UKPN scheme	£31.00m	£63.00m
Option 6	New Grid Supply Point at Twinstead	Compliant	£3.60m	£34.00m
Option 7	New Grid Supply Point at Coggeshall			
	7.1 New Grid Supply Point at Coggeshall (New 132kV OHL circuits)	Compliant	£16.50m	£68.20m
	7.2 New Grid Supply Point at Coggeshall (New 132kV UG cable circuits)	Compliant	£31.00m	£82.70m
Option 8	New Grid Supply Point at Earls Colne			
	8.1 New Grid Supply Point at Earls Colne (New 132kV OHL circuits)	Compliant	£9.80m	£61.50m
	8.2 New Grid Supply Point at Earls Colne (New 132kV UG cable circuits)	Compliant	£22.90m	£74.60m

2.18 The wider transmission works referred to in the table relate to reinforcement works at either Bramford or Braintree substation and modifications to other sections of the 132kV distribution network which would be required for some of the options. A sum of £30.4m has been allowed for the cost of establishing the Grid Supply Point (a National Grid asset) associated with Option 6. This cost was detailed within the National Grid Review of

Strategic Options Report issued in June 2011⁸. This £30.4m cost has been incorporated in the overall costs for Options 7 and 8 which also involve establishing new Grid Supply Points. The inclusion of the cost of wider transmission works allows for fair comparison between all options.

- 2.19 The UKPN report provides a commentary of construction issues including the number of expected crossings for overhead lines and cable circuits. To replace existing capacity, every proposed option utilising new 132kV circuit connections will require a double circuit equivalent to that being removed by National Grid's proposals.
- 2.20 For overhead line options, a double circuit overhead line would be supported on lattice steel pylons of a similar design to those used on the existing 132kV overhead line between Burstall and Pelham with 175mm² conductors. A permanent clear swathe of 30m would be required beneath the overhead line.
- 2.21 For all underground cable options, there would be a requirement to install two 132kV cable circuits consisting of six single core cables with a minimum size of 300mm².
- 2.22 Options 1 and 4 are alternatives which do not satisfy the requirements of ER P2/6 and would not therefore satisfy UKPN Distribution Licence conditions. For this reason, these options are not considered further in this report.
- 2.23 Option 5.2 was proposed by UKPN to implement a connection between Twinstead and a Braintree - Abberton circuit at Coggeshall. This was based upon a planned UKPN project to construct a new connection between Braintree and Abberton. As this option is reliant on a project which is yet to be confirmed and is out of National Grid's control, it cannot be guaranteed to provide the complete connection and carries an unacceptable programme risk. Therefore it is not considered further in this report.
- 2.24 National Grid considers that all compliant options identified in the UKPN report could be constructed safely and therefore represent technically viable alternatives. The following sections of this report provide National Grid's appraisal of the remaining compliant UKPN options.
- 2.25 There is an increased complexity issue associated with Options 7 and 8 as the proposed arrangements connect into a network of existing three ended circuits i.e. Bramford/Pelham – Braintree - Rayleigh. To provide a similar substation solution to that described in Option 6 (a new Grid Supply Point in the vicinity of Twinstead), would create a non-standard solution of a permanent "four-ended" circuit. This would require a permanent derogation from standards from Ofgem. In order to avoid having to seek such a derogation, either a more costly larger substation would need to be built at

⁸ National Grid plc. : Bramford to Twinstead Tee Connection Project – Review of Strategic Options Report : June 2011

Coggeshall/Earls Colne or costly modifications would be required at Braintree. For the purposes of this report these additional costs have not been included.

- 2.26 The UKPN report concluded that developing a substation west of Twinstead Tee at a total capital cost of £34.0m should be its preferred option for replacing the capacity lost following the removal of the existing 132kV overhead line.

3 OPTIONS CONSIDERED AND METHODS FOR APPRAISAL

Options considered

3.1 In its report, UKPN identified eight options, which may be summarised as follows:

- Option 1 - Do Nothing. This option is non-compliant and is not therefore assessed further;
- Option 2 - Replace 132kV circuits between Twinstead and Burstall Bridge. This option would maintain the existing N-1 transfer capacity (planned system maintenance transfers) between Pelham and Bramford by the replacement of an existing 26km of 132kV double circuit overhead line with two 132kV underground circuits to pylon PCB5 near Bramford substation;
- Option 3 - Extension of the 132kV PCB overhead line from Twinstead. This option would maintain the existing N-1 transfer capacity (planned system maintenance transfers) between Pelham and Bramford by the replacement of the existing 26km of 132kV double circuit overhead line with two 132kV circuits to Lawford (24km) or Abberton (22km) Grid. The connection to Lawford would ultimately increase the demand at Bramford. This option would require a fifth Super Grid Transformer (SGT) at Bramford Substation;
- Option 4 - 33kV Network Reinforcement. This option would require either increasing the voltage support (replacing small conductors with larger ones) for the existing 33kV circuits or constructing new 33kV interconnections. However, the option is non-compliant with the standards by which UKPN is required to operate and is therefore not assessed further;
- Option 5 - Reinforce Braintree GSP and install new 132kV circuits to Rushley Green. This option would maintain the existing N-1 transfer capacity (planned system maintenance transfers) between Pelham and Bramford by the replacement of the existing 26km of 132kV double circuit overhead line with two 132kV circuits to Braintree GSP. Alternatively the circuits could connect to a future Braintree-Abberton connection.
- Option 6 - New Grid Supply Point at Twinstead. This option proposes the creation of a new Grid Supply Point to the west of Twinstead Tee;

- Option 7 – New Grid Supply Point at Coggeshall. This option proposes the creation of a new Grid Supply Point near Coggeshall, supplied from the 400kV Bramford-Rayleigh circuits. This option would also require a new 132kV underground cable or overhead line route;
- Option 8 - New Grid Supply Point at Earls Colne. This option proposes the creation of a new Grid Supply Point near Earls Colne, supplied from the 400kV Bramford-Rayleigh circuits. This option would also require a new 132kV underground cable or overhead line route.

3.2 Where the need for a new connection was identified, both overhead and underground solutions were investigated. National Grid is satisfied that the list of options represents a comprehensive statement of those available to address security of supply following removal of a section of the PCB 132kV line. Representations received had identified two further options for 132kV cable routes: between Braintree and Belchamp substations; and between Bramford and Belchamp substations. The former would offer no advantage over an underground cable connection between Braintree and Rushley Green (UKPN Option 5) which would maintain the existing N-1 transfer capacity (planned system maintenance transfers) between Pelham and Bramford. Extending an underground cable connection north from Rushley Green to Belchamp or from Bramford to Belchamp would result in higher costs and environmental effects than those associated with Option 5. This would not meet the requirement to provide an efficient, co-ordinated and economical system of electricity distribution. Neither of these options was therefore subject to further assessment.

Assumptions and methods

3.3 National Grid has reviewed each of the compliant options included in the UKPN report from a technical, environmental, socio-economic and cost perspective.

Method

3.4 The **technical** assessment covers a range of issues mainly relating to the buildability of the option, for example its technical complexity, construction delivery risk, programme implications and outage requirements. Technical matters were addressed by engineers from the Electricity Alliance and their assessment is based on experience with other projects of a similar nature.

3.5 The **environmental** assessment, undertaken by environmental consultants TEP⁹ takes account of publicly available environmental and planning information. The main sources

⁹ TEP : Environmental review of UKPN options : September 2012

of information include environmental designation and information 'shape files' from Natural England and English Heritage through the 'Magic' website; Google Earth and Windows Live web based aerial imagery; Ordnance Survey Explorer 1:25,000 and Landranger 1:50,000 mapping; Local Plans and Local Development Framework (LDF) documents; Environment Agency flood risk data; Essex and Suffolk County Council's Historic Environment and County/Local Wildlife Site Records, published National and County level Landscape Character Assessments, and Digital Terrain Modelling (DTM) data.

3.6 TEP has considered the options in accordance with National Grid guidance documents which include:

- 'Our Approach to the Design and Routeing of New Electricity Transmission Lines'¹⁰;
- The Holford Rules¹¹; and
- The Horlock Rules¹².

TEP also considered the approach to assessment set out in National Policy Statements EN-1 and EN-5¹³ and the context provided by the National Planning Policy Framework¹⁴.

3.7 The UKPN report described options in diagrammatic form and quoted the shortest distance between connection points. TEP has given further consideration to potential route corridors for connections in order to assist its appraisal. The shortest route between connection points was used as a starting point for identifying route corridors, in order to minimise costs and environmental effects in general. However, the route corridors identified have been amended to take account of environmental constraints, as well as the topography and landscape character of the area. These corridors, shown on Figure 9 are generally longer than the distances quoted in the UKPN report which means that the costs of options involving overhead line or underground cable connections are likely to be higher than those identified in that report.

3.8 The **socio-economic** assessment has considered socio-economic constraints within the areas affected by each of the options and whether potential effects can be mitigated. The methodology is consistent with established good practice regarding socio-economic

¹⁰ National Grid: "Our Approach to the Design and Routeing of New Electricity Transmission Lines": August 2012

¹¹ National Grid plc. : The National Grid Company plc. and new high voltage transmission lines - guidelines for line routeing (the Holford Rules) and undergrounding : March 2003

¹² National Grid: The National Grid Company plc. NGC Substations and the environment: Guidelines on setting and design: March 2003

¹³ Department of Energy & Climate Change: National Policy Statements EN-1 (Statement for Energy) and EN-5 (Statement for Electricity Networks Infrastructure): July 2011.

¹⁴ Department for Communities and Local Government: National Planning Policy Framework: March 2012

impact assessment. A range of publications relating to the economic impact of tourism have been considered for this high level assessment. Potential effects on economic activities other than agriculture and tourism are difficult to discern at this level of assessment. All options are located on Best and Most Versatile (BMV) agricultural land.

- 3.9 National Grid considers both capital costs and lifetime costs in its investment decisions.

Assumptions

- 3.10 For all options, except Options 5.1 and 6, the point of connection with the remaining UKPN 132kV overhead line network west of Twinstead Tee would be at the first pylon to the west of the existing 'diamond crossing', where the existing 132kV line runs beneath the Twinstead Tee to Braintree 400kV overhead line. This pylon would be modified or replaced to enable a connection between a new overhead line or underground cable. The options using underground cable would require a sealing end platform tower at this location. For the purposes of this report, this point of connection is referred to as 'Twinstead Tee'. For Option 5.1 the connection would be made in the Rushley Green area, north of Castle Hedingham, close to the point where the 132kV overhead line to Belchamp tees off the PCB line. For Option 6 the connection point would be close to the selected substation site.
- 3.11 It is assumed that options requiring 'reinforcement' to existing 132kV overhead lines referred to in the UKPN report would involve reconductoring (replacing the existing conductors or wires on the lines) and there would be no associated long-term environmental effects.
- 3.12 Each 132kV connection option would require a double circuit. For overhead line options a double circuit overhead line would be supported on lattice steel towers of a similar design to the existing 132kV overhead line between Burstall and Pelham. A permanent clear swathe of 30m would have to be kept clear of trees beneath the overhead line. For underground cable options crossing countryside, it has been assumed that a permanent swathe of 10m would have to be kept clear of trees above the double circuit 132kV cables and a working area approximately 30m wide would have to be cleared of all vegetation during construction.
- 3.13 In relation to underground connection options, the UKPN report estimates the percentage of each connection it anticipates could be installed under carriageways. The permanent cable easement and working area would not apply in such cases, but the construction swathe would require a width which could not readily be accommodated on minor roads without affecting hedgerows and verges. In identifying underground

connection corridors in this report it has been assumed that an underground connection could only be accommodated under carriageways on A-roads or B-roads. This means that generally there are few opportunities for underground cable routes to be accommodated under carriageways in the underground route corridors identified in this report.

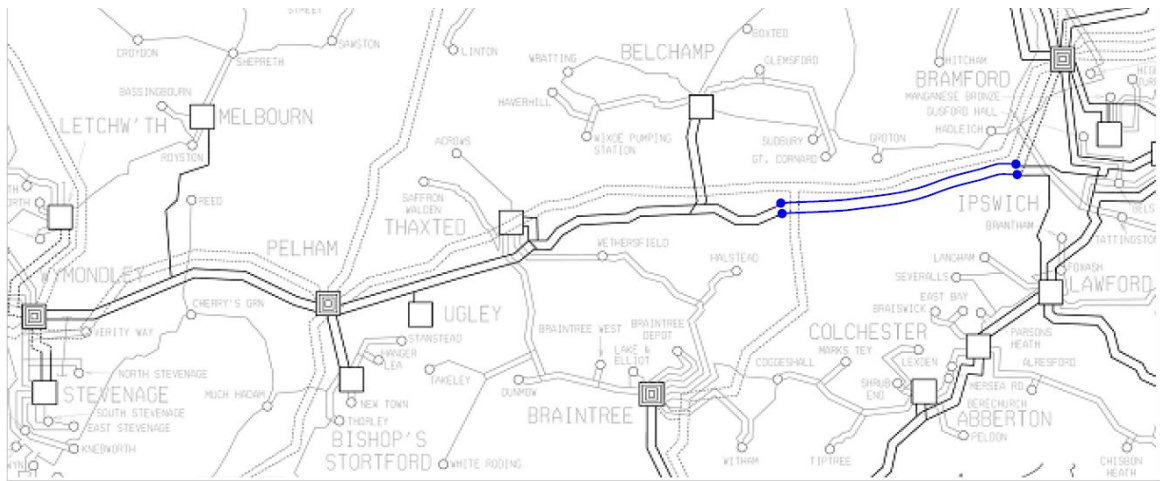
- 3.14 For the purpose of the assessment in this report, National Grid has based the costs on the straight line routes highlighted in the UKPN report. If any of these options were taken forward, a more detailed route (overhead line/underground cable) would need to be developed to take account of environmental and physical constraints. Route lengths therefore would be likely to vary from those shown in this and the UKPN report. As noted in paragraph 3.7, this will also affect the cost estimates quoted in this report.

4 UKPN OPTION 2 - REPLACE 132KV CIRCUITS BETWEEN TWINSTEAD AND BURSTALL BRIDGE

Option Summary

- 4.1 The UKPN report identifies this option as a replacement of the 132kV circuits, being removed as part of National Grid’s proposals, with two underground cable circuits of the same capacity. The UKPN report has identified a number of engineering difficulties associated with a number of crossings and environmental issues including effects on areas of archaeology. However, despite these issues, this would be a technically viable option.

Figure 2: Simplified schematic diagram for Option 2.



- 4.2 UKPN has provided an estimated capital cost for this option of £103.0m including wider transmission works. The approximate route length for this option is 26km.
- 4.3 Option 2 was discounted by UKPN due to the high cost, environmental impact, complex wayleave negotiations and long timescale.

National Grid Further Appraisal

- 4.4 This option requires an underground cable route between Burstall Bridge (pylon PCB5) and Twinstead Tee. A feasible underground cable route has been identified which broadly follows the line of the existing 132kV overhead line with deviations to avoid environmental constraints which include properties, woodland, orchards and a mineral extraction site. This is shown on Figure 9.

Technical Complexities

- 4.5 The installation of cables between Twinstead Tee and Burstall Bridge should not add any additional technical complexities to the UKPN system as this would be a direct replacement for the existing line.
- 4.6 There would be a need for a number of crossings of A roads, rivers, railways and environmentally protected areas which could be achieved by horizontal directional drilling (HDD). These crossings would be feasible. The majority of the underground cable route would be across open fields.
- 4.7 With a cable route of this length there is a risk of the ground conditions varying in different locations. This could lead to the need for extensive shuttering of open excavations (use of timber supports to ensure excavation sides are stable) which would require further resources and increase the programme length.
- 4.8 The cable route installation can be constructed prior to a system outage and would only require system outages on the UKPN system at the later stage of construction for the installation of the two new terminal towers and commissioning. This should fall within routine system outage requirements.

Cost

- 4.9 National Grid, has undertaken a lifetime cost assessment based upon the loss cost of the 132kV circuits proposed, along with the operational and maintenance costs used by National Grid to assess its transmission circuits. The cost estimates, including the UKPN capital costs, are shown in Table 2 below.

Table 2: Costs for Option 2.

Option	Description	Capital cost including wider transmission works	NPV of cost of losses over 40 years	NPV of operation and maintenance cost over 40 years	Lifetime cost
2	Replace 132kV circuits between Twinstead and Burstall Bridge	£103.0m	£4.4m	£1.1m	£108.5m

Environment

Landscape and Visual Amenity

- 4.10 This cable route would cross Dedham Vale Area of Outstanding Natural Beauty (AONB) for more than 3km. It would be possible to avoid the AONB with a longer deviation around its northern boundary. This option would also cross the Stour Valley, Box Valley, Brett Valley and Belstead Brook. There is potential to use HDD techniques to avoid effects on the watercourses and associated vegetation. During construction there would be temporary negative effects on the landscape and on views from properties. There would be no long-term effect on the landscape following reinstatement works after installation of the cables, subject to the avoidance of important landscape features such as woodland through routeing or using HDD techniques.

Ecology

- 4.11 This option would not cross any internationally designated sites for nature conservation. It would run close to two Sites of Special Scientific Interest (SSSIs) (Hintlesham Woods and Arger Fen) although there would be no direct effects on these sites. This option would cross Hadleigh Railway Walk LNR which is a linear site following the former Hadleigh Railway. HDD could be used to avoid effects on this site.
- 4.12 It is assumed that the most sensitive habitats including woodland and waterbodies could be largely avoided in cable routeing or adverse effects can be avoided by using HDD techniques. There would be some habitat loss resulting from cable installation, including hedgerow and hedgerow trees, which may also result in negative effects on protected species. In addition, wildlife friendly working methods can be used to minimise effects during construction with mitigation techniques such as replanting and translocation used to reduce effects in the longer term.

Historic Environment

- 4.13 This option would pass close to one Scheduled Monument (a moated site). However, there would be no direct effects on this heritage asset and no long term effects on setting following reinstatement.
- 4.14 Detailed routeing would avoid direct effects on Listed Buildings and Conservation Areas and there would be no long term effects on setting following reinstatement. There is potential for some negative effects on the historic landscape through the removal of historic hedgerows, although mitigation could be used to reduce these effects.

4.15 There is a high potential for buried archaeology throughout the corridor, especially within the Brett and Stour Valleys. This is evidenced by prehistoric remains recorded within the corridor at these locations. The corridor crosses two areas in the Stour Valley, where a complex of cropmarks indicates the likely presence of prehistoric or Roman settlement activity. These areas are not designated heritage assets, but further investigation could confirm them to be of equivalent significance. There may be scope to avoid each area because they are not recorded as extending across the entire width of the corridor. However, this connection option would require significant assessment and mitigation.

Local Economic Activity

4.16 A cable route between Burstall Bridge and Twinstead would pass through the Stour Valley as well as the Dedham Vale Area of Outstanding Natural Beauty. Both of these areas are attractive areas for tourism given the qualities of the landscape and facilities for walking and cycle routes. Sudbury, to the north, is a market town popular with visitors with a number of businesses supported by tourism, including cafés, pubs, restaurants, bed and breakfast premises, hotels, camping facilities, caravan parks and cycle and boat hire facilities. The cable construction would, in the short term, have negative effects on the landscape experienced by visitors although these effects would be temporary.

4.17 Sudbury also acts as a local employment centre for the surrounding villages. In the short term, this option could bring benefits to the local economy in terms of additional spend by construction teams. All options would benefit the local economy to a degree although the locations benefitting and the extent of such benefits are difficult to quantify when assessing strategic options.

4.18 There would be short term effects on agricultural operations.

Summary

4.19 Option 2 was discounted by UKPN due to the high cost, environmental impact, complex wayleave negotiations and long timescale. National Grid considers that this option would have limited impact on landscape character, views and the local economy. However, there would be particular negative effects in terms of archaeology and biodiversity. This option has the highest capital and lifetime cost of all options.

5 UKPN OPTION 3 - OVERHEAD OR UNDERGROUND CONNECTION BETWEEN LAWFORD/ABBERTON SUBSTATION AND TWINSTEAD TEE

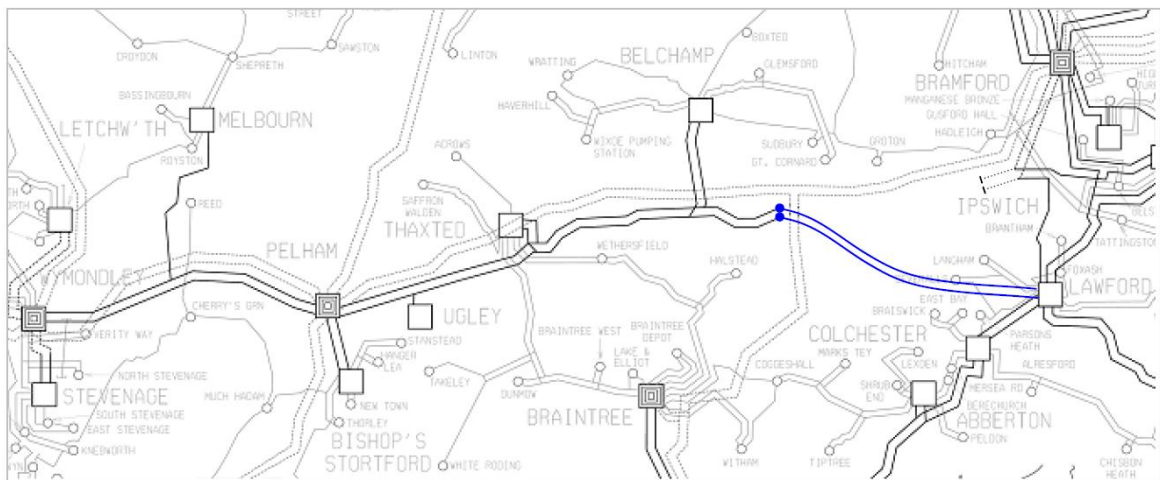
5.1 Option 3 is divided into two sub-options (3.1 and 3.2), each of which allows for connections by overhead line (3.1.1, 3.2.1) and by underground cable (3.1.2, 3.2.2).

Option 3.1 – Twinstead – Lawford 132kV substation

Option Summary

5.2 The UKPN report identifies this option as an overhead line or underground cable from Twinstead Tee to Lawford substation requiring the installation of two 132kV circuits along a 24km route. The report identifies engineering difficulties such as river, rail and road crossings. The report also identifies environmental issues, including impact on the Dedham Vale AONB and areas of archaeological interest, as well as the requirement for wayleave consents. Despite these issues, this would be a technically viable option.

Figure 3: Simplified schematic diagram for Options 3.1.1 and 3.1.2.



5.3 UKPN has provided an estimated capital cost for Option 3.1.1 (overhead) of £80.5m and for Option 3.1.2 (underground cable) of £98m. The approximate route length for this option is 24km.

National Grid Further Appraisal

5.4 Potential route corridors are shown on Figure 9. An overhead line corridor (Option 3.1.1) has been identified which minimises landscape and visual effects on the Stour Valley and the Dedham Vale AONB. It runs south from Twinstead Tee along the existing 400kV

overhead line for approximately 8km before taking a route east to Lawford Substation whilst trying to avoid the highest ground. It is envisaged that a new 132kV overhead line could parallel the existing 400kV overhead line for 8km, although it would have to go underground for two short sections to avoid oversailing properties. The corridor splits (north and south) at the eastern end as this area is particularly constrained with a Scheduled Monument (which comprises a series of crop marks), Ardleigh Reservoir and Ardleigh village, which is partly in a Conservation Area.

- 5.5 A northern variant would run to the north of the reservoir, Scheduled Monument and Ardleigh village Conservation Area. A southern variant would run north or south of Horkesley Heath, and then follow the A120 to the south of the Scheduled Monument and reservoir. It may be difficult to route close to the A120 and avoid oversailing property. This may mean that a section of underground cables would be needed. These options would be 28km and 29.5km respectively.
- 5.6 The underground cable route (Option 3.1.2) could take a more direct route (23km) through the Dedham Vale AONB as the long-term effects of an underground cable on the AONB would be broadly neutral following reinstatement.
- 5.7 The UKPN report suggests that 30% of this route could be in carriageway. The roads in the area are mainly minor roads that do not run in a south-east / north-west direction and it is difficult to see how this could be achieved. It is possible that the B1508 south-east of Bures could be used in part, although this would result in a longer underground cable route.

Technical Complexities

- 5.8 The installation of a connection between Twinstead Tee and Lawford is not expected to add any additional technical complexities to the UKPN system. However, there would be an additional requirement to reinforce the 132kV circuit from Lawford to Bramford and to provide 132kV switchgear replacement.
- 5.9 Option 3.1.1 would involve the 132kV circuits crossing the 400kV Bramford-Braintree overhead line either by means of a diamond crossing or short section of underground cable. Other cable sections may be required on this route to avoid oversailing properties.
- 5.10 Option 3.1.2 would necessitate a number of crossings of A roads, rivers, railways and environmentally protected areas which could be achieved by horizontal directional drilling (HDD). These crossings would not present significant issues in terms of buildability. The majority of the underground cable route would be across open fields.

- 5.11 With a cable route of this length there is a risk of the ground conditions varying in different locations. This could lead to the need for extensive shuttering of open excavations which would require further resources and increase the programme length.
- 5.12 The connection would only require system outages on the UKPN system at the later stage of construction for the installation of the two new terminal towers and commissioning. This should fall within routine system outage requirements.

Cost

- 5.13 National Grid, has undertaken a lifetime cost assessment based upon the loss cost of the 132kV circuits proposed, along with the operational and maintenance costs used by National Grid to assess its transmission circuits. The cost estimates including the UKPN capital costs are shown in Table 3 below.

Table 3: Costs for Options 3.1.1 and 3.1.2.

Option	Description	Capital cost including wider transmission works	NPV of cost of losses over 40 years	NPV of operation and maintenance cost over 40 years	Lifetime cost
3.1.1	Extension of 132kV PCB line Twinstead – Lawford 132kV Substation (new 132kV OHL circuits)	£80.5m	£8.3m	£1.1m	£89.9m
3.1.2	Extension of 132kV PCB line Twinstead – Lawford 132kV Substation (new 132kV UG circuits)	£98.0m	£4.0m	£2.1m	£104.1m

Environment

Landscape and Visual Amenity

- 5.14 Option 3.1.1 north is the closest overhead line option to the Dedham Vale AONB. Option 3.1.1 north runs within 2km of the AONB for 15km of its length and there is the potential for effects on views from and to the AONB. Option 3.1.1 south would be slightly more distant from the AONB.

- 5.15 Option 3.1.1 was identified to provide an overhead line option between Twinstead Tee and Lawford, whilst minimising effects on the Stour and Colne river valleys. It runs along the existing 400kV overhead line to a point to the north of Earls Colne before running in an easterly direction along an area of higher ground between the Stour and Colne valleys. This area comprises Essex County Council's Stour Valley (C8) Blackwater/Stour Farmland (B3) and North Colchester Farmlands (E4) Landscape Character Areas and consists of gently undulating farmland with medium to large scale field patterns. The identified corridor is close to and includes areas of woodland which would provide opportunities for screening. This option does not avoid woodland altogether as the route is partly defined by the existing overhead line, although short sections of underground would allow a new overhead line to 'switch sides' avoiding some losses. Elsewhere, detailed routeing would allow woodland losses to be minimised.
- 5.16 A new 132kV overhead line would give rise to negative effects on landscape character and views. It would also give rise to localised effects on landscape features where vegetation clearance may be required to achieve safety clearances. This option also has the potential to have effects on views to and from the nationally designated Dedham Vale AONB.
- 5.17 As with all of the cable routes under consideration, there would be no long-term effect on the landscape associated with Option 3.1.2 following reinstatement, subject to the avoidance of important landscape features such as woodland through routeing or using HDD techniques. This cable route crosses through 5.5km of the Dedham Vale AONB. As with the undesignated landscape, the effects would be temporary. However, there is an option to avoid the AONB altogether if this option were to be taken forward, although this would require a longer deviation to the west and south of the AONB.
- 5.18 Option 3.1.2 crosses the Stour Valley twice. There is potential to use HDD techniques to avoid effects on the watercourse and associated vegetation. During construction there would be temporary negative effects on views from properties, although with reinstatement there would be no long term effects.

Ecology

- 5.19 Options 3.1.1 and 3.1.2 would avoid direct effects on internationally and nationally designated wildlife sites. The construction and operation of an overhead line (Option 3.1.1) has the potential to give rise to negative effects on habitats resulting from the construction of access tracks, at pylon positions and where conductors oversail trees, where clearance may be required for safety clearances. In general, County Wildlife Sites and/or woodland could be avoided through detailed routeing. However, at one location

on 3.1.1 north and three locations on 3.1.1 south, these extend across the full width of the corridor. In these locations habitat loss is likely.

- 5.20 It is assumed with Option 3.1.2 that the most sensitive habitats including woodland and waterbodies can be largely avoided in cable routeing. There would be some habitat loss resulting from cable installation, including hedgerow and hedgerow trees, which may also result in negative effects on protected species. There is potential to use HDD techniques to avoid effects on the most sensitive habitats. In addition, wildlife friendly working methods can be used to minimise effects during construction with mitigation techniques such as replanting and translocation used to reduce effects in the longer term.

Historic Environment

- 5.21 Option 3.1.1 passes within 1km of three Scheduled Monuments and close to numerous Listed Buildings which are scattered through the area. Direct effects on above ground heritage assets would be avoided in detailed routeing. However, overhead lines have the potential to have negative effects on the setting of heritage assets, which would need to be taken into consideration in detailed routeing. In particular, the northern variant of Option 3.1.1 passes close to Ardleigh Conservation Area and could affect its setting.
- 5.22 Negative effects on historic hedges would largely be avoided with an overhead line option.
- 5.23 There is potential for effects on buried archaeology in the construction of access tracks and in the construction of pylon foundations. Detailed routeing would seek to avoid areas where there are known or likely buried remains so that they can remain in situ but effects can be resolved through localised mitigation measures where avoidance is not possible. A northern variant of Option 3.1.1 would cross the former Bosted Airfield, a World War II airfield. An overhead connection on this corridor would have direct and indirect negative effects on this non-designated heritage asset, but these effects may be lessened through localised mitigation measures.
- 5.24 Option 3.1.2 passes close to two Scheduled Monuments; however, there would be no direct effects on these heritage assets and there would be no long term effects on setting following reinstatement. Detailed routeing would avoid direct effects on Listed Buildings and Conservation Areas and there would be no long term effects on setting following reinstatement.
- 5.25 With Option 3.1.2 there is potential for some negative effects on the historic landscape through the removal of historic hedgerows, although mitigation could be used to reduce these effects.

5.26 There is a high potential for buried archaeology throughout the corridor. The corridor crosses two areas: adjacent to the River Stour, where a complex of crop marks indicates the likely presence of prehistoric or Roman settlement activity and; a cluster of ring ditches (also evidenced from crop marks). Ring ditches are associated with prehistoric burial practice. These areas are not designated heritage assets but further investigation could confirm them to be of equivalent significance. There are further clusters of ring ditches and other crop mark remains including evidence of enclosures (indicative of settlement activity) within the corridor, some of which are similar in character to the nearby Wissington ring ditch cluster and the crop mark site at Ardleigh, which are scheduled monuments. Option 3.1.2 would require particular assessment and mitigation.

Local Economic Activity

5.27 There are potential socio-economic impacts for both overhead and underground options. Option 3.1.1 north (overhead line) runs close to the southern boundary of the Dedham Vale AONB and Option 3.1.2 (underground cable) runs through the south-western corner of the AONB. Dedham Vale AONB is a destination for tourists drawn by its attractive landscape and views. An overhead line option close to the AONB may have a negative effect on these factors and on the tourism experience. There would be potential for some mitigation although the overhead line options following mitigation would still have harmful impacts on views from various vantage points.

5.28 There is potential for localised temporary impacts on some agricultural operations during construction but neither the underground cable nor the location of permanent structures to accommodate an overhead line would compromise the operation of individual farming units.

5.29 An overhead line along this route would appear in views from a number of small towns and villages within 1 km of Option 3.1.1 and could affect their attraction to visitors. Option 3.1.1 south runs close to the northern edge of Colchester and has the potential to constrain future land uses. In terms of the impacts on local tourism and economy, there would be some long term impact. All options would benefit the local economy to a degree but the locations benefitting and the extent of such benefits are difficult to quantify when assessing strategic options.

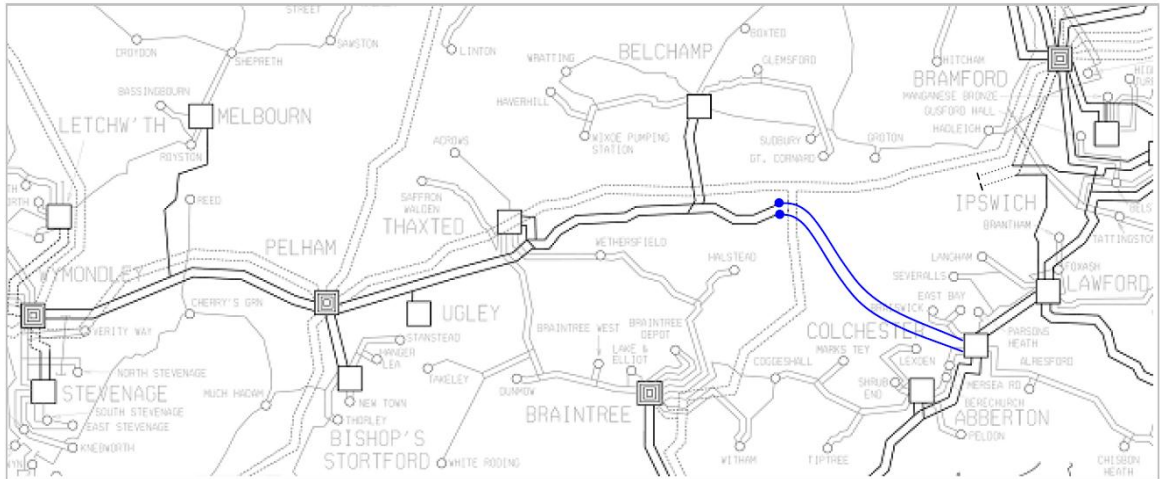
Option 3.2 - Twinstead - Abberton 132kV Substation.

Option Summary

5.30 The UKPN report identifies this option as an overhead line (Option 3.2.1) or underground cable (Option 3.2.2) from Twinstead Tee to Lawford substation requiring the installation

of two 132kV circuits along a 24km route. The report identifies engineering difficulties such as river, rail and road crossings. The report also identifies environmental issues as well as the requirement for wayleave consents. Despite these issues, this would be a technically viable option.

Figure 4: Simplified schematic diagram for Option 3.2.1 and 3.2.2



5.31 UKPN has provided an estimated capital cost for Option 3.2.1 (overhead) of £75m and for Option 3.2.2 (underground) of £92.5m. The approximate route length for this option is 22km.

National Grid Further Appraisal

5.32 An overhead line corridor has been identified which minimises landscape and visual effects on the Stour Valley and the Dedham Vale AONB. It runs south from Twinstead Tee along the existing 400kV overhead line for approximately 10km to Chalkney Wood before taking a route south-east to Abberton Substation. It is envisaged that the new 132kV overhead line could parallel the existing 400kV overhead line for 10km, although it would have to go underground for a couple of short sections to avoid oversailing properties. As the corridor approaches Abberton Substation there are other existing overhead lines approaching the substation from the west which form a constraint. The alignment of the existing 66kV overhead line could be used for the new 132kV overhead line connection and the existing 66kV connection could be put underground within the underground connection corridor identified as part of Option 3.2.2. The overhead line corridor for Option 3.2.1 is approximately 26.5km in length.

5.33 The underground cable corridor takes the most direct route, whilst avoiding areas of environmental constraint. The corridor narrows at Marks Tey to pass through built

development where it also crosses the A12 and the railway line. The underground cable route approaches Abberton Substation close to other overhead lines which would need to be taken into account in cable routeing. This underground cable corridor is approximately 24.5km in length.

Technical Complexities

- 5.34 The installation of a connection between Twinstead Tee and Abberton is not expected to add any additional technical complexities to the UKPN system. However, there would be an additional requirement to reinforce the 132kV circuit from Lawford to Bramford and to provide 132kV switchgear replacement. Reinforcement of the 132kV circuits to Rayleigh would also be required.
- 5.35 Option 3.2.1 would involve the 132kV circuits crossing the 400kV Bramford-Braintree overhead line either by means of a diamond crossing or short section of underground cable. Other cable sections may be required on this route to avoid oversailing properties.
- 5.36 Option 3.2.2 would necessitate a number of crossings of A roads, rivers, railways and environmentally protected areas which could be achieved by horizontal directional drilling (HDD). These crossings would not present significant issues in terms of buildability. The majority of the underground cable route would be across open fields.
- 5.37 With a cable route of this length there is a risk of the ground conditions varying in different locations. This could lead to the need for extensive shuttering of open excavations which would require further resources and increase the programme length.
- 5.38 The connection would only require system outages on the UKPN system at the later stage of construction for the installation of the two new terminal towers and commissioning. This should fall within routine system outage requirements.

Cost

- 5.39 National Grid, has undertaken a lifetime cost assessment based upon the loss cost of the 132kV circuits proposed, along with the operational and maintenance costs used by National Grid to assess its transmission circuits. The cost estimates, including the UKPN capital costs, are shown in Table 4 below.

Table 4: Costs for Options 3.2.1 and 3.2.2.

Option	Description	Capital cost including wider transmission works	NPV of cost of losses over 40 years	NPV of operation and maintenance cost over 40 years	Lifetime cost
3.2.1	Extension of 132kV PCB line Twinstead – Abberton Grid (new 132kV OHL circuits)	£75.0m	£7.6m	£1.0m	£83.6m
3.2.2	Extension of 132kV PCB line Twinstead – Abberton Grid (new 132kV UG circuits)	£92.5m	£3.7m	£1.9m	£98.1m

Environment

Landscape and Visual Amenity

- 5.40 Option 3.2.1 would be over 5km from the Dedham Vale AONB at its closest point where it parallels the existing 400kV overhead line. This option would not give rise to effects on views to or from the AONB.
- 5.41 Option 3.2.1 runs along the existing 400kV overhead line to the south of Earls Colne through Essex County Council’s Stour Valley (C8), Blackwater/Stour Farmland (B3) and Colne Valley (C7) Landscape Character Areas before running in a south-easterly direction through Gosfield Wooded Farmland (B4) and South Colchester Farmlands (E2) Landscape Character Areas to Lawford Substation. The identified corridor is close to and includes areas of woodland which would provide opportunities for screening. This option does not avoid woodland altogether as the route is partly defined by the existing overhead line, although short sections of the undergrounding would allow a new overhead line to ‘switch sides’ avoiding some losses. Elsewhere detailed routeing would allow woodland losses to be avoided. Where it deviates from the route of the existing 400kV overhead line, the corridor avoids the areas of highest ground to minimise visibility.

- 5.42 A new 132kV overhead line would give rise to negative effects on landscape character and views. It would also give rise to localised effects on landscape features where vegetation clearance may be required to achieve safety clearances.
- 5.43 As with all of the underground cable routes under consideration, there would be no long-term effect on the landscape associated with Option 3.2.2 following reinstatement subject to the avoidance of important landscape features such as woodland through routeing or using HDD techniques. This cable route does not cross through any designated landscapes.
- 5.44 Option 3.2.2 crosses the River Colne. There is potential to use HDD techniques to avoid effects on the water course and associated vegetation. During construction there would be temporary negative effects on views from properties, although with reinstatement these would not be long term effects.

Ecology

- 5.45 For the majority of its length, Option 3.2.1 does not cross any internationally or nationally designated sites for nature conservation. On the approach to Abberton Substation, however, the corridor crosses the northernmost part of the area at Abberton Reservoir which is internationally designated as a Special Protection Area (SPA) and Ramsar Site and nationally designated Site of Special Scientific Interest (SSSI). It is also an RSPB Important Bird Area. There are already two existing overhead lines crossing this area on their approach to Abberton Substation. The cumulative effects of existing and proposed overhead lines on the internationally designated site would require detailed consideration and assessment of the potential for bird collisions and any necessary mitigation should this option be taken forward.
- 5.46 The construction and operation of an overhead line has the potential to give rise to negative effects on habitats resulting from the construction of access tracks at pylon positions, and where conductors oversail trees, vegetation clearance may be required to achieve safety clearances. In general, County Wildlife Sites and/or woodland could be avoided through detailed routeing. However, at one point just south of the Twinstead Tee, County Wildlife Sites and woodland extend across the full width of the corridor. In this location habitat loss is likely.
- 5.47 Option 3.2.2 would also cross the northernmost part of the designated area at Abberton Reservoir. This water body would be avoided in routeing and installation of underground cable and if undertaken at a seasonally appropriate time, it is unlikely to affect the integrity of this designated site.

5.48 It is assumed that the most sensitive habitats including woodland and waterbodies can be largely avoided in cable routeing. There would be some habitat loss resulting from cable installation, including hedgerow and hedgerow trees, which may also result in negative effects on protected species. There is potential to use HDD techniques to avoid effects on the most sensitive habitats. In addition, wildlife friendly working methods can be used to minimise effects during construction with mitigation techniques such as replanting and translocation used to reduce effects in the longer term.

Historic Environment

5.49 Option 3.2.1 passes within 1km of a Scheduled Monument at Alphamstone and within 2km of an extensive Scheduled Monument at Colchester (although there are large areas of woodland between the Scheduled Monument and the overhead line corridor). Option 3.2.1 passes between Conservation Areas at Earls Colne and Wakes Colne and there are numerous Listed Buildings within and close to the corridor. Direct effects on above ground heritage assets would be avoided in detailed routeing. However, an overhead line has the potential to have negative effects on the setting of heritage assets, which would need to be taken into consideration in detailed routeing if this option were to be taken forward.

5.50 Negative effects on historic hedges would largely be avoided with an overhead line option.

5.51 There is potential for effects on buried archaeology in the construction of access tracks and in the construction of pylon foundations. Detailed routeing would seek to avoid areas where there are known or likely buried remains so that they can remain in situ but effects can be resolved through localised mitigation measures where avoidance is not possible.

5.52 Option 3.2.2 passes within 1km of a Scheduled Monument at Alphamstone, although there would be no direct effect on this heritage asset and there would be no long term effects on setting following reinstatement. Detailed cable routeing would avoid direct effects on Listed Buildings and Conservation Areas and there would be no long term effects on setting following reinstatement.

5.53 There is potential for some negative effects on the historic landscape through the removal of historic hedgerows, although mitigation could be used to reduce these effects.

5.54 There is a high potential for buried archaeology throughout the corridor, evidenced by prehistoric remains recorded throughout the corridor. At Fordstreet, the corridor is constrained by a crop mark complex that occupies the corridor between the eastern edge

of the conservation area and the edge of the corridor. To the south of Copford Green, a group of cropmarks extend across the full width of the corridor at three separate locations. These are not designated heritage assets but further investigation could confirm them to be of equivalent significance. Option 3.2.2 would require particular assessment and mitigation.

Local Economic Activity

- 5.55 There are potential socio-economic impacts for both overhead and underground options. The overhead line Option 3.2.1 runs south of Twinstead along the route of the existing 400kV overhead line. There appear to be few tourism receptors along this route until the proposed overhead line joins the existing 132kV line close to Abberton where the setting of Abberton Reservoir Visitors' Centre could be affected. However, given the existing overhead lines in this area, the impact on tourism as a result of a further overhead line would be minor.
- 5.56 There is potential for localised temporary impacts on some agricultural operations during construction as both Options 3.2.1 and 3.2.2 cross large areas of agricultural land, but neither the underground cable nor the siting of pylons would compromise the operation of individual farming units.
- 5.57 The underground cable option is unlikely to have long term impacts on the local economy although some short terms effects on traffic and transport would occur where the underground cable crosses a number of major roads and a railway. The use of HDD would minimise impacts. All options would benefit the local economy to a degree but the locations benefitting and the extent of such benefits are difficult to quantify when assessing strategic options.

Summary

- 5.58 Option 3 was neither discounted nor recommended as the preferred connection by UKPN. The length of new overhead line sub-options (3.1.1 and 3.2.1) would be significant and National Grid considers that these options would have a negative effect on the landscape character, views and local economy. The underground sub-options (3.1.2 and 3.2.2) would potentially have particularly harmful impacts in terms of archaeology and biodiversity. Additional reinforcement works would be associated with Option 3 and there are technical and environmental constraints on the approaches to both Lawford and Abberton substations.

6 UKPN OPTION 5 – REINFORCE BRAINTREE GSP.

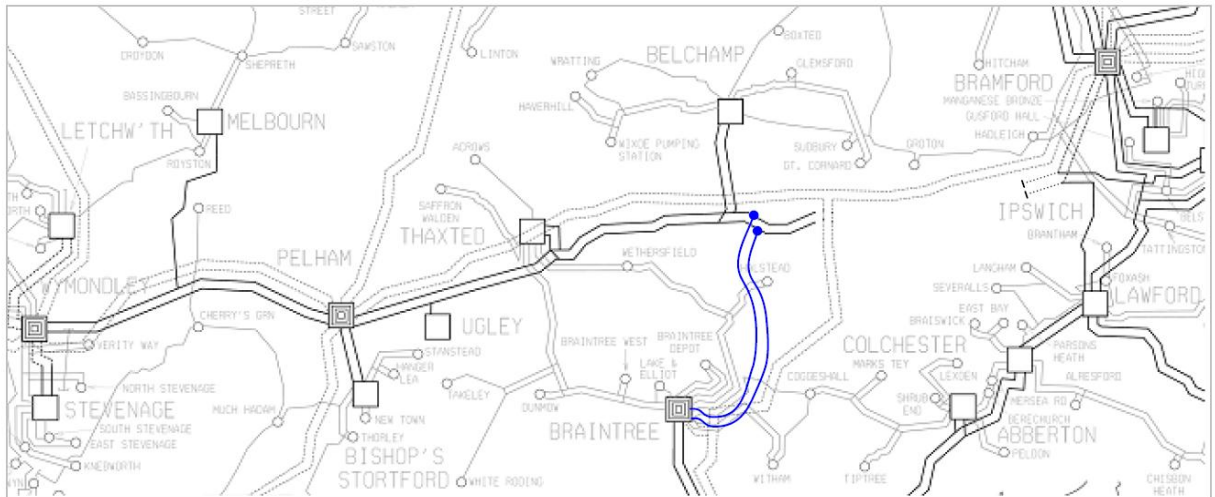
6.1 In the UKPN report, Option 5 was divided into two sub-options which involve reinforcing Braintree Substation and providing 132kV connections to either Twinstead Tee (Option 5.1) or Abberton (Option 5.2). The latter was excluded from further assessment for the reasons set out in paragraph 2.23.

Option 5.1 New 132kV dual circuits between Braintree Substation and the 132kV PCB overhead line near Rushley Green.

Option Summary

6.2 The UKPN report identifies this option as new dual 132kV circuits between Braintree and the 132kV PCB overhead line near Rushley Green. This option would require modifications to be made to existing 132kV pylons on the PCB overhead line near Belchamp Tee (Rushley Green) and the existing overhead line near Bramford. The UKPN report identifies environmental and engineering difficulties associated with crossings. However, regardless of these issues, the option would be technically viable.

Figure 5: Simplified schematic diagram for Option 5.1



6.3 UKPN has provided an estimated capital cost for Option 5.1.1 (overhead) of £49m and for Option 5.1.2 (underground) of £62.4m. The approximate route length for this option is 17km.

- 6.4 Option 5.1 was discounted by UKPN due to high cost, high risk factor in terms of environmental and archaeological issues, complex wayleave negotiations and long timescale.

National Grid Further Appraisal

- 6.5 Two overhead line corridors have been identified to achieve this connection option. Both options initially utilise the same route corridor from Braintree substation, following the settlement edge of Braintree and running north for approximately 6km. The route corridor then divides into two options. The eastern variant of 5.1.1 is an option which connects to the existing overhead line east of the 'diamond crossing' at Rushley Green. The route corridor is approximately 16km long and runs past the western edge of Halstead and passes to the east of Castle Hedingham and Sible Hedingham.
- 6.6 The western variant of Option 5.1.1 connects to the existing overhead line west of the 'diamond crossing' at Rushley Green. The route corridor is approximately 18km long and runs to the west of the villages of Gosfield, Castle Hedingham and Sible Hedingham. Both variants partly follow the route of existing double circuit 33kV overhead lines running from points close to the A1017 and south Gosfield in a north-easterly direction to Halstead (eastern variant) and in a north-westerly direction toward Wetherfield (western variant).
- 6.7 Two underground cable corridors have been identified to achieve this connection option. The western variant is the most direct (approximately 17km) running in a northerly direction from Braintree substation whilst avoiding environmental constraints. It is assumed that the majority of this route could be accommodated in carriageway along the A131 and A1017, depending on the existence of underground services in these roads. At the northern end of the corridor this option connects to the existing 132kV overhead line to the west of the A1017 in order to avoid crossing the River Colne and Colne Valley Railway.
- 6.8 The eastern variant is slightly longer (approximately 17.5km) running in a north to north-easterly direction, passing over farmland to the west of Halstead.

Technical Complexities

- 6.9 The installation of a connection between Braintree and Rushley Green is not expected to add any additional technical complexities to the UKPN system. Substation reinforcement works would be required.
- 6.10 The eastern variant of Option 5.1.2 would necessitate a number of crossings of A roads and Bourne Brook, the Blackwater river and the River Colne, which could be achieved by horizontal directional drilling (HDD). These crossings would not present significant issues in terms of buildability. The majority of the underground cable route would be across open fields.
- 6.11 With a cable route of this length there is a significant risk of the ground conditions varying in different locations. This could lead to the need for extensive shuttering of open excavations which would require further resources and increase the programme length.
- 6.12 The western variant of Option 5.1.2 would necessitate a number of crossings of A roads and Bourne Brook and the Blackwater river, which could be achieved by horizontal directional drilling (HDD). These crossings would not present significant issues in terms of buildability. This study assumes that the majority of the cables route would be installed in carriageway along A roads.
- 6.13 The connection would only require system outages on the UKPN system at the later stage of construction for the installation of the new terminal towers and commissioning. This should fall within routine system outage requirements. A sequence of outages would also be required on the National Grid system to accommodate the connection of the substation.

Cost

- 6.14 National Grid has undertaken a lifetime cost assessment based upon the loss cost of the 132kV circuits proposed, along with the operational and maintenance costs used by National Grid to assess its transmission circuits. The cost estimates, including the UKPN capital costs, are shown in Table 5 below.

Table 5: Costs for Options 5.1.1 and 5.1.2.

Option	Description	Capital cost including wider transmission works	NPV of cost of losses over 40 years	NPV of operation and maintenance cost over 40 years	Lifetime cost
5.1.1	Reinforce Braintree GSP and install new 132kV circuits to Rushley Green. 132kV Braintree – Rushley Green (new 132kV OHL circuits)	£49.0m	£8.9m	£0.9m	£58.8m
5.1.2	Reinforce Braintree GSP and install new 132kV circuits to Rushley Green. 132kV Braintree – Rushley Green (new 132kV UG circuits)	£62.4m	£5.7m	£1.7m	£69.8m

Environment

Landscape and Visual Amenity

- 6.15 The eastern and western variants of Option 5.1.1 are approximately 15km from the Dedham Vale AONB at their closest point. These options would not give rise to effects on the views to or from the AONB.
- 6.16 The eastern variant runs through Essex County Council’s Blackwater/Stour Farmland (B3); the Colne Valley (C7); Gosfield Wooded Farmland (B4); Blackwater and Brain Valley (C6) and the Central Essex Farmland (B1) Landscape Character Areas between Rushley Green and Braintree Substation. The identified corridor crosses the Colne River Valley, Blackwater River Valley, Bourne Brook and the intervening higher ground. The slopes of the River Colne valley may provide opportunities to ‘background’ a new overhead line in places. An overhead line on the higher ground above the valley is likely

to add to its prominence in landscape and views. In addition, this corridor option passes to the immediate west of Halstead.

- 6.17 The western variant passes through areas of similar landscape character to the eastern variant but runs over higher ground which is likely to add to its prominence in landscape and views.
- 6.18 Both variants of Option 5.1.1 include and are close to woodland, which may provide opportunities for screening. On both corridor options detailed routeing would generally allow woodland losses to be avoided.
- 6.19 Both corridor options run close to historic parkland at Stisted Hall (which although not a registered park and garden does form part of a Conservation Area). Effects on this historic landscape could be minimised through detailed routeing.
- 6.20 Both corridor options run less than 1km from Gosfield Hall Registered Park and Garden. In particular, the western variant runs approximately 0.5km from the registered landscape with little intervening vegetation or built form. A new overhead line has the potential to have adverse effects on the character of the park.
- 6.21 Generally a new 132kV overhead line would give rise to negative effects on landscape character and views in areas where there are presently no high voltage overhead lines. It would also give rise to localised effects on landscape features where vegetation removal may be required to achieve safety clearances.
- 6.22 As with all of the cable routes under consideration, there would be no long-term effect on the landscape following reinstatement subject to the avoidance of important landscape features, such as woodland, through routeing or using HDD techniques. These cable routes do not cross through any designated landscapes.
- 6.23 Both variants of Option 5.1.2 cross the Bourne Brook and the Blackwater River. The eastern variant also crosses the River Colne at a point northwest of Halstead. There is potential to use HDD techniques to avoid effects on these watercourses and associated vegetation.
- 6.24 For the western variant, where it is assumed that the majority of the route could be accommodated in carriageway, the temporary negative effects on landscape character during construction and reestablishment periods could be minimised. This route corridor is particularly constrained by existing woodland and settlement to the north of Gosfield, which could result in some tree losses if the cable route cannot be accommodated in the carriageway of the A1017, as has been assumed.

- 6.25 During construction there would be a temporary negative effect on views from properties although with reinstatement in general there would not be long term effects.

Ecology

- 6.26 Neither variant of Option 5.1.1 would cross any internationally or nationally designated sites for nature conservation. The western variant of Option 5.1.1 runs close to Bovingdon Hall Woods SSSI, southwest of Gosfield. Both corridor options run close to or include County Wildlife Sites and ancient or existing mature woodland, notably within the Colne Valley and to the south of Gosfield. On both corridor options it would be possible to avoid any direct effects on designated sites and avoid loss of woodland through detailed routeing.
- 6.27 Option 5.1.2 would not cross any internationally or nationally designated sites for nature conservation. It is assumed that the most sensitive habitats including woodland and waterbodies can be largely avoided in cable routeing. There would be some habitat loss resulting from cable installation, including hedgerow and hedgerow trees, which may also result in negative effects on protected species. There is potential to use HDD techniques to avoid effects on the most sensitive habitats. In addition, wildlife friendly working methods can be used to minimise effects during construction with mitigation techniques such as replanting and translocation used to reduce effects in the longer term.
- 6.28 For a western variant of Option 5.1.2, where it is assumed that the majority of the route could be accommodated in carriageway, the negative effects on habitats and protected species would be minimised. The avoidance of tree losses is reliant on the cables being accommodated in carriageway.

Historic Environment

- 6.29 Both variants of Option 5.1.1 pass approximately 1km west of a conservation area at Stisted. Both options run less than 1km from Gosfield Hall Registered Park and Garden, and notably the western variant of Option 5.1.1 runs approximately 0.5km from the registered landscape. There are numerous Listed Buildings within and in close proximity to both sub-options. Direct effects on above ground heritage assets would be avoided in detailed routeing. However, overhead lines have the potential to have negative effects on the setting of heritage assets, which would need to be taken into consideration in detailed routeing.
- 6.30 Negative effects on historic hedges would largely be avoided with an overhead line option.

- 6.31 With both variants of Option 5.1.1, there is potential for effects on buried archaeology in the construction of access tracks and in the construction of pylon foundations. Detailed routeing would seek to avoid areas where there are known or likely buried remains so that they can remain in situ but effects can be resolved through localised mitigation measures where avoidance is not possible.
- 6.32 The western variant of Option 5.1.2 passes within 0.5km of Gosfield Hall Registered Park and Garden. Both the eastern and western variants are within 1km of Hedingham Castle Scheduled Monument. The cable installation may give rise to short term negative effects on these heritage assets during construction. However, there would be no long term effects following reinstatement.
- 6.33 Detailed cable routeing would avoid direct effects on Listed Buildings and Conservation Areas and there would be no long term effects on setting following reinstatement.
- 6.34 With both variants of Option 5.1.2, there is potential for some negative effects on the historic landscape through the removal of historic hedgerows, although mitigation could be used to reduce these effects.
- 6.35 There is a high potential for buried archaeology throughout the eastern corridor of Option 5.1.2. There are crop marks within the corridor that could, on further investigation prove to be of equivalent significance to a designated asset.
- 6.36 There is also a high potential for buried archaeology throughout the corridor of the western variant of Option 5.1.2. The corridor passes through the remains of Langthorne Brick Works, a non-designated asset. The asset covers the full width of the corridor where it narrows at Sible Hedingham.
- 6.37 Both variants of Option 5.1.2 cross an area of cropmark evidence for prehistoric activity at High Garret. To the north of Braintree is Lyons Hall, the site of a medieval building and further crop mark complexes. The site of a Roman building to the east of Braintree is another crop mark site that could on further investigation prove to be of equivalent significance to a designated asset.
- 6.38 Both variants could require significant assessment and mitigation. However, given the assumption that the majority of the route on the western variant would be accommodated in carriageway, effects could be avoided in most areas and the need for mitigation minimised.

Local Economic Activity

- 6.39 The western variant of Option 5.1.1 runs through large areas of farmland and close to or through a number of areas of woodland. An allocated employment/development site is located to the east of the eastern variant of Option 5.1.1, although this is unlikely to be affected by the overhead line.
- 6.40 There are a number of historic buildings, parks and gardens within close proximity of the overhead line routes. This area also accommodates many walks including the Colne Valley Path and passes close to settlements used as bases for tourist visits. Given the length of the route and the number of pylons that would be required, there is potential for impact on these tourism receptors, although mitigation would reduce this impact.
- 6.41 All options skirt the east/south-east of Braintree where there are shops, restaurants, cafés and pubs as well as Braintree Museum. There is potential for some impact on tourism in and around Braintree, although following mitigation, the impact would be minor.
- 6.42 There is potential for localised temporary impacts on some agricultural operations during construction as both Options 5.1.1 and 5.1.2 cross large areas of agricultural land, but neither the underground cable nor the location of permanent structures to accommodate an overhead line would compromise the operation of individual farming units. Option 5.1.2 would have no long term effects on socio-economic issues following reinstatement of the construction works. All options would benefit the local economy to a degree but the locations benefitting and the extent of such benefits are difficult to quantify when assessing strategic options.

Summary

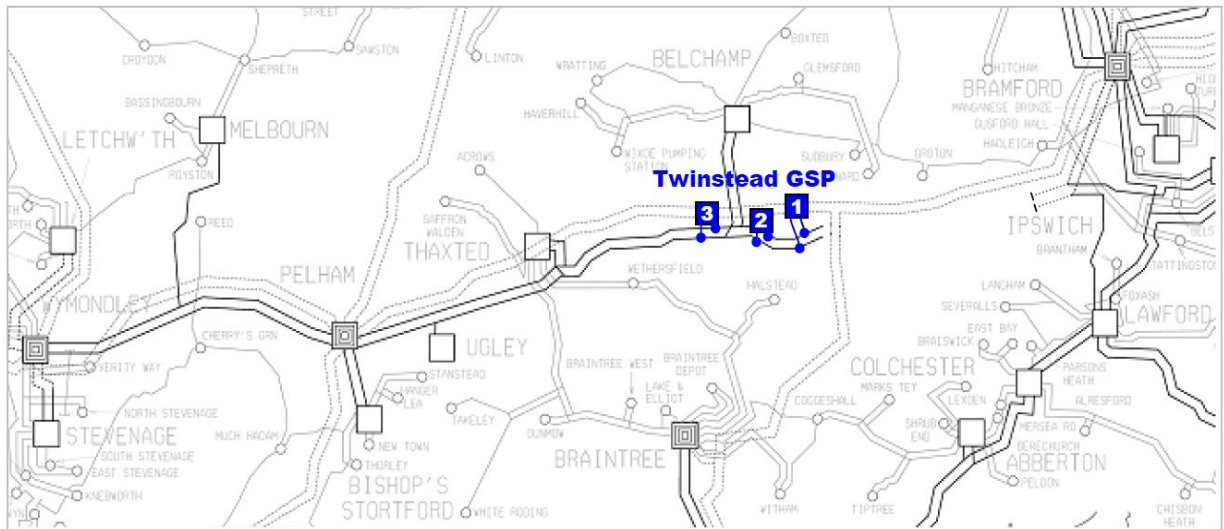
- 6.43 Option 5.1 was discounted by UKPN due to the high cost, high risk factor (archaeological and environmental), complex wayleave negotiations and long timescale. Whilst this option has lower costs than other overhead line/underground cable options, National Grid considers that the overhead Option 5.1.1 would result in long term negative effects on landscape, views and the setting of historic assets. The underground options are likely to have a harmful impact on archaeology and biodiversity in the area, in particular, although there is potential for accommodating some cable sections under carriageways which could reduce these effects.

7 UKPN OPTION 6 - SUBSTATION WEST OF TWINSTEAD TEE

Option Summary

7.1 Following discussions between the then Distribution Network Operator EDF and National Grid, a Substation Siting Study¹⁵ had been carried out in 2009 by environmental consultants TEP which examined options for locating a new substation in the area west of Twinstead as a means of providing a connection to the local electricity distribution network in the event that Corridor 2 were selected for the Bramford to Twinstead Tee Connection. Corridor 2 was selected as the preferred corridor in 2011 and the UKPN report included the three sites identified in the 2009 study in its Option 6. No major engineering difficulties have been identified and this option would be a technically viable option.

Figure 6: Simplified schematic diagram for Option 6 showing 3 identified sites.



7.2 Option 6 has previously been the subject of discussions between UKPN, EDF (precursor to UKPN) and National Grid. This is UKPN's recommended option to be taken forward.

7.3 UKPN has provided an estimated capital cost for Option 6 of £3.6m. The total cost including wider transmission works is estimated as £34m.

¹⁵ TEP: "Bramford to Twinstead Connection, Grid Supply Point Siting Study": October 2009.

National Grid Further Appraisal

- 7.4 The potential requirement for a substation to the west of Twinstead Tee was identified in the Route Corridor Study¹⁶ for the Bramford to Twinstead Tee connection. It noted that this would be required if Corridor 2 were taken forward, which proposed the acquisition and removal of the existing UKPN 132kV overhead line between Burstall Bridge and Twinstead Tee. The Grid Supply Point Siting Study considered the potential to site a substation between Twinstead Tee and Thaxted and identified three feasible substation study areas for further investigation, which are named in the UKPN report as Options 6.1 Butlers Wood, 6.2 Delvyn's Lane and 6.3 Colne Valley.
- 7.5 These substation study areas are all close to the existing Twinstead Tee to Pelham 400kV overhead line, requiring short sections of overhead line or underground cable connection to connect with the existing 400kV and 132kV overhead lines. For the purposes of this study it is assumed that the connection to the existing overhead lines will not provide any differentiation between options.

Technical Complexities

- 7.6 No significant technical complexities have been identified. Connecting the substation to the southern circuits on the 400kV overhead line would require a more technically complex solution although this is achievable and would only be necessary in some locations.
- 7.7 The construction of the associated overhead line works on both the 132kV and 400kV systems would require some temporary works managed using routine outage arrangements.

Cost

- 7.8 National Grid, has undertaken a lifetime cost assessment based upon the loss cost of the 132kV circuits proposed, along with the operational and maintenance costs used by National Grid to assess its transmission circuits. The cost estimates including the UKPN capital costs are shown in Table 6 below.

¹⁶ TEP : Bramford to Twinstead 400kV overhead line project : Route Corridor Study for Public Consultation : October 2009

Table 6: Costs for Option 6.

Option	Description	Capital cost including wider transmission works	NPV of cost of losses over 40 years	NPV of operation and maintenance cost over 40 years	Lifetime cost
6	New Grid Supply Point at Twinstead	£34.0m	£2.7m	£0.1m	£36.8m

Option 6.1 Substation study area at Butlers Wood and Waldegrave Wood

7.9 There is an opportunity to locate a substation close to the existing 400kV overhead line and near the A131 where Butlers Wood and Waldegrave Wood offer opportunity to screen views.

Environment

Landscape and Visual Amenity

7.10 The substation site area is within Essex County Council’s Blackwater/Stour Farmland (B3) Landscape Character Area. The area is close to the existing 400kV Twinstead Tee to Braintree overhead line and the A131 which reduces the sensitivity of the landscape. This landscape is described as having an undulating to flat landform with large scale field patterns and is of moderate sensitivity. The effects of a substation on the wider landscape would be reduced as large blocks of mature woodland would provide screening.

7.11 The area is close to the existing Twinstead Tee to Braintree overhead line and the A131 which reduces the sensitivity of the landscape.

7.12 There are relatively few properties in the area and woodland would assist in filtering and screening views. In addition, effects on landscape and visual amenity could be lessened by additional woodland planting within the substation site.

Ecology

7.13 Butler’s and Waldegrave Woods are Ancient Woodlands and a Local Wildlife Site. The woodlands would be retained and there would be limited effects on biodiversity as the adjacent arable land is of low ecological value. There may be some hedgerow and hedgerow tree loss; however, wildlife friendly working methods can be used to minimise

effects during construction with mitigation techniques such as replanting and translocation used to reduce effects in the longer term.

Historic Environment

- 7.14 There are 4 Grade II Listed Buildings and 1 Grade II* Listed Buildings just outside the study area and a number of other Listed Buildings within 1km of the study area. Effects on the setting of these buildings would need to be given detailed consideration in siting a substation in this area. However, given the size of the study area, it is anticipated that a substation could be located to reduce the effects on the setting of designated heritage assets to an acceptable level and additional woodland planting within the substation site could assist in lessening effects further.
- 7.15 There is potential for effects on buried archaeology. Detailed siting would seek to avoid areas where there are likely buried remains so that they can remain in situ. However, mitigation would be an option if avoidance is not possible.

Local Economic Activity

- 7.16 There are no specific business or tourism assets in the vicinity and the option would result in limited loss of Grade 2 agricultural land. All options would benefit the local economy to a degree but the locations benefitting and the extent of such benefits are difficult to quantify when assessing strategic options.

Option 6.2 Substation Option at Delvyn's Lane

- 7.17 There is an opportunity to build a substation close to the existing 400kV overhead line where Ramacre Wood would screen some views.

Environment

Landscape and Visual Amenity

- 7.18 The substation study area is within Essex County Council's Blackwater/Stour Farmland (B3) Landscape Character Area. This landscape is described as having an undulating to flat landform with large scale field patterns and is of moderate sensitivity. This site would benefit from the screening provided by Ramacre Wood.
- 7.19 There are relatively few properties in the area and Ramacre Wood would assist in filtering and screening some views. In addition, effects on landscape and visual amenity could be lessened by additional woodland planting within the substation site.

Ecology

- 7.20 The verges on Delvyn's Lane are designated County Wildlife Sites, although direct effects could be avoided through siting and detailed design. Ramacre Wood would be retained and there would be limited effects on biodiversity as the area around Ramacre wood is largely arable with little ecological value. There may be some hedgerow and hedgerow tree loss; however, wildlife friendly working methods can be used to minimise effects during construction with mitigation techniques, such as replanting and translocation used to reduce effects in the longer term.

Historic Environment

- 7.21 There are 3 Grade II listed buildings within the study area, a further 4 Grade II listed buildings just outside the study area and a number of other Grade II listed buildings within 1km of the study area. Effects on the setting of these buildings would need to be given detailed consideration in siting a substation in this area. However, given the size of the study area, it is anticipated that a substation could be located to reduce the effects on the setting of designated heritage assets to an acceptable level and additional woodland planting within the substation site could assist in lessening effects further.
- 7.22 There is potential for effects on buried archaeology. Detailed siting would seek to avoid areas where there are likely buried remains so that they can remain in situ. However, mitigation would be an option if avoidance is not possible.

Local Economic Activity

- 7.23 This option would result in limited loss of Grade 2 agricultural land. The setting of a self catering tourist facility at Pannells Ash could be affected. Overall, effects on local economic activity would be minor. All options would benefit the local economy to a degree but the locations benefitting and the extent of such benefits are difficult to quantify when assessing strategic options.

Option 6.3 Substation Option at Colne Valley Farm Park

- 7.24 There is an opportunity to build a substation in the Colne Valley close to the existing 400kV overhead line and near the A1017, where the valley sides would limit wider views.

Environment

Landscape and Visual Amenity

- 7.25 The substation study area is within Essex County Council's Colne Valley (C7) Landscape Character Area, which is a shallow valley landscape along the meandering River Colne. This site is between the settlements of Caste Hedingham and Great Yeldham and there is other existing built development at this point in the valley.
- 7.26 There are several properties in close proximity to the site on the southern edge of Great Yeldham and the northern edge of Castle Hedingham which could have views of a substation at this location. Other potential visual receptors include visitors to the Colne Valley Railway Visitor Attraction to the immediate south. Effects on landscape and visual amenity could be lessened by additional woodland planting within the substation site.

Ecology

- 7.27 There are no wildlife designations in the area and the study area is predominantly in agricultural use and uses associated with the Colne Valley Railway. It is of limited ecological value.

Historic Environment

- 7.28 There is a Grade II Listed Buildings within the study area and a further Grade II Listed Building just outside the study area, as well as a number of other Grade II Listed Buildings within 1km of the study area. Effects on the setting of these buildings would need to be given detailed consideration in siting a substation in this area although it is anticipated that effects could be reduced to an acceptable level. Castle Hedingham Scheduled Monument is 2km to the south west of the site. This Scheduled Monument is set within woodland on higher ground and effects on setting would need to be taken into consideration if this option is taken forward. Additional woodland planting within the substation site could assist in lessening effects on setting.
- 7.29 Buried archaeology recorded within this substation study area includes the non-designated site of a Roman cremation burial found in 1953 at Dickett's Hill. This is a good indicator that additional buried archaeology of the same date can be expected in this area. The A1017 is also the putative line of a Roman road and this is also an indicator that there could be associated buried archaeology. There is a high potential for buried archaeology at this substation location. Detailed siting would seek to avoid areas

where there are known or likely buried remains so that they can remain in situ. However, mitigation may be an option if avoidance is not possible.

Other

- 7.30 The River Colne flows through this study area and it is partly within Flood Zone 2 (risk of flooding 1 in 100 years) and 3 (risk of extreme flooding 1 in 1000 years). This would need to be addressed in the detailed siting and design if this option is taken forward.

Local Economic Activity

- 7.31 The Colne Valley Railway and Visitor Attraction is adjacent to Option 6.3. Hedingham Castle is also close by and is a tourism attraction. There is potential for disturbance associated with the construction phase to affect the business operations of the former and the location of a substation close to the entrance to the attraction may have a negative effect on visitors. The effects on visitors to Hedingham Castle are likely to be limited. All options would benefit the local economy to a degree but the locations benefitting and the extent of such benefits are difficult to quantify when assessing strategic options.

Summary

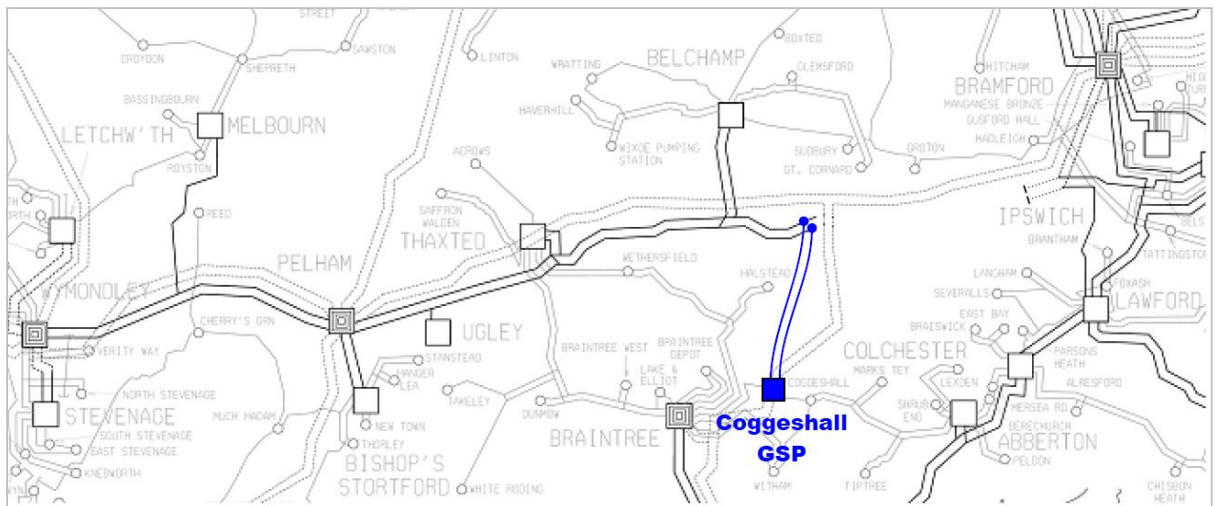
- 7.32 UKPN recommends this option for further consideration. These sites had been identified in an earlier Substation Siting Study undertaken by TEP for National Grid which considered the development of a substation west of Twinstead Tee to be a practical option. Environmental and socio-economic effects are more localised in this location compared with other options. From a technical point of view, this is the least complex option as well as the option with the lowest cost.

8 UKPN OPTION 7 - NEW SUBSTATION AT COGGESHALL

Option Summary

- 8.1 The UKPN report identifies this option as the creation of a new Grid Supply Point near Coggeshall, supplied from the 400kV Bramford – Rayleigh overhead line. This option requires new 132kV circuits between Coggeshall GSP and the PCB overhead line. The UKPN report identifies environmental and engineering difficulties associated with crossings. However, despite these issues, this would be a technically viable option.

Figure 7: Simplified schematic diagram for Options 7.1 and 7.2.



- 8.2 UKPN provided an estimated capital cost for Option 7.1 (overhead) of £37.8m and for Option 7.2 (underground) of £52.3m, to which must be added the £30.4m cost of National Grid’s Grid Supply Point. The approximate route length for this option is 17.5km.
- 8.3 These options were discounted by UKPN due to cost, high risk factor (archaeological and environmental), complex wayleave negotiations, long timescale and public awareness of new 132kV overhead lines.

National Grid Further Appraisal

- 8.4 This option requires a new substation in the vicinity of Coggeshall and a new 132kV connection between the substation and Twinstead Tee. These options are described below and are shown on Figure 9.

- 8.5 There are two options for an overhead line between Coggeshall and Twinstead Tee. One option would run closely parallel with the existing 400kV overhead line; however, this would require a number of short sections of undergrounding to avoid oversailing property. An alternative overhead line option would run to the west of the existing 400kV overhead line in a direct line to Twinstead Tee whilst avoiding environmental constraints. Both options are just over 16km long.
- 8.6 An underground cable corridor (Option 7.2) has been identified to achieve this connection option taking a relatively direct route whilst avoiding environmental constraints (16.5km). The UKPN report estimated 40% in carriageway, although this does not appear to be achievable with this route as there are only relatively minor roads largely running east/west through the area.

Technical Complexities

- 8.7 The installation of a connection between Twinstead Tee and Coggeshall is not expected to add any additional technical complexities to the UKPN system. Substation reinforcement works would be required.
- 8.8 Short cable sections may be required on Option 7.1 parallel to avoid oversailing properties where the route would run parallel to the existing 400kV overhead line.
- 8.9 Option 7.2 would necessitate a number of crossings of A roads and environmentally protected areas which could be achieved by horizontal directional drilling (HDD). These crossings would not present significant issues in terms of buildability. The majority of the underground cable route would be across open fields.
- 8.10 With a cable route of this length there is a significant risk of the ground conditions varying in different locations. This could lead to the need for extensive shuttering of open excavations which would require further resources and increase the programme length.
- 8.11 The connection would only require system outages on the UKPN system at the later stage of construction for the installation of the two new terminal towers and commissioning. This should fall within routine system outage requirements. A sequence of outages would also be required on the National Grid system to accommodate the connection of the substation.

Cost

- 8.12 National Grid, has undertaken a lifetime cost assessment based upon the loss cost of the 132kV circuits proposed, along with the operational and maintenance costs used by

National Grid to assess its transmission circuits. The cost estimates including the UKPN capital costs are shown in Table 7 below.

Table 7: Costs for Options 7.1 and 7.2.

Option	Description	Capital cost including wider transmission works	NPV of cost of losses over 40 years	NPV of operation and maintenance cost over 40 years	Lifetime cost
7.1	New Grid Supply Point at Coggeshall (New 132kV OHL circuit)	£68.20m	£8.9m	£0.9m	£78.0m
7.2	New Grid Supply Point at Coggeshall (New 132kV UG circuit)	£82.70m	£5.7 m	£1.7m	£90.1m

Environment

Substation Site

Landscape and Visual Amenity

- 8.13 The substation study area is to the east of Braintree between Braintree and Coggeshall. It is within Essex County Council’s Blackwater and Brain Valley (C6) Landscape Character Area and effects on the wider landscape would be reduced as topography and blocks of woodland offer opportunity to provide screening. The area is on relatively low ground and is close to the existing Twinstead Tee to Braintree 400kV overhead line and the A120 which further reduces effects on the landscape.
- 8.14 There are relatively few properties in the area and the woodland blocks would assist in screening views from these receptors. Effects on landscape and visual amenity could be lessened by additional woodland planting within the substation site.

Ecology

- 8.15 There are no designated sites within the identified study area. It is assumed that the woodlands in the area would be retained for their ability to reduce views to the proposed substation so there would be limited effects on biodiversity. There may be some hedgerow and hedgerow tree loss; however, wildlife friendly working methods can be used to minimise effects during construction with mitigation techniques, such as replanting and translocation used to reduce effects in the longer term.

Historic Environment

- 8.16 There are 3 Grade II listed buildings within the substation study area and there are other Grade II Listed Buildings within 1km of the site and 1 Grade I Listed Building approximately 500m to the south of the study area. Effects on the setting of these buildings would need to be given detailed consideration in siting a substation in this area, although existing woodland would help to limit effects and it is anticipated that effects on settings could be reduced to an acceptable level.
- 8.17 There are no known archaeological remains within the study area, although there is potential for the survival of previously unknown remains. The study area does not appear to lie within the setting of any local designated heritage assets. Detailed substation siting would seek to avoid areas where there are likely buried remains so that they can remain in situ. However, mitigation may be an option if avoidance is not possible.

Local Economic Activity

- 8.18 The substation site would result in the loss of a small area of agricultural land, but this should not compromise the operation of individual farming units. Whilst there would be impacts on views, this is unlikely to affect socio-economic receptors in this area. All options would benefit the local economy to a degree but the locations benefitting and the extent of such benefits are difficult to quantify when assessing strategic options.

Overhead Line Option 7.1

Landscape and Views

- 8.19 The eastern variant of Option 7.1 is over 5km from the Dedham Vale AONB at its closest point where it parallels the existing 400kV overhead line. The western variant is a further 3km from the AONB boundary. These options would not give rise to effects on views to or from the AONB.

- 8.20 The eastern variant of Option 7.1 runs along the route of the existing 400kV overhead line through Essex County Council's Stour Valley (C8); Blackwater/Stour Farmland (B3); the Colne Valley (C7); Gosfield Wooded Farmland (B4) and Blackwater and Brain Valley (C6) Landscape Character Areas between Twinstead Tee and the potential substation study area. The identified corridor crosses the River Colne and Bourne Brook and the intervening higher ground. The identified corridor is close to and includes areas of woodland which would provide opportunities for screening. This option does not avoid woodland as the route is defined by the existing overhead line, although short sections of undergrounding would allow a new overhead line to 'switch sides,' avoiding some losses.
- 8.21 The existing overhead line would run close to Mark's Hall Park and Arboretum which is a visitor attraction area. The overhead line runs through and close to mature woodland and parkland and a new overhead line in this corridor has the potential to have adverse effects on the character of this landscape and on landscape and on landscape features.
- 8.22 The western variant of Option 7.1 takes an alignment approximately 3km to the west of the existing 400kV overhead line between Twinstead Tee and Braintree. This option passes through the same landscape character area as the eastern variant, although this option would potentially avoid woodland as it is not restricted to an existing overhead line route. Whilst it would be possible to avoid local areas of high ground, this corridor crosses some areas of higher ground between valleys, which is likely to add to its prominence in landscape and views. This corridor also runs less than 1km from the historic parkland at Stisted Hall (which although not a registered park and garden does form part of a conservation area). However, the corridor widens at this point to enable alignments to be identified to reduce effects on the historic landscape.
- 8.23 Generally a new 132kV overhead line would give rise to negative effects on landscape character and views. It would also give rise to localised effects on landscape features where vegetation clearance may be required to achieve safety clearances. The eastern variant of Option 7.1 would concentrate effects within the area already affected by the existing 400kV Twinstead Tee to Braintree overhead line, which includes Mark's Hall Park and Arboretum. The western variant would give rise to effects on landscape and views in an area where there is presently no overhead line. Neither of these options would have effects on views from the nationally designated Dedham Vale AONB.

Ecology

- 8.24 Neither variant of Option 7.1 crosses any internationally or nationally designated sites for nature conservation. The eastern variant runs close to the Chalkney Wood SSSI and County Wildlife Site, crosses the Colne Valley Local Nature Reserve and Ansell's Grove County Wildlife Site, and runs close to or through existing ancient woodland and/or County Wildlife Sites, notably Mark's Hall Park.
- 8.25 Although the detailed routeing would potentially avoid some of these features, it is likely that an overhead line on this corridor would result in loss of woodland. This would require detailed consideration and assessment should this option be taken forward. The western variant of Option 7.1 would offer greater opportunity to avoid woodland and other sensitive habitats. It is likely that it would have less effect on ecology than the eastern variant.

Historic Environment

- 8.26 The eastern variant of Option 7.1 passes within 1km of a Scheduled Monument at Alphamstone and between conservation areas at Earls Colne and Wakes Colne. The western variant of Option 7.1 passes within 1km of three Scheduled Monuments and close to the conservation area at Stisted Hall. There are numerous Listed Buildings close to both options. Direct effects on above ground heritage assets would be avoided in detailed routeing. However, overhead lines have the potential to have negative effects on the setting of heritage assets, which would need to be taken into consideration in detailed routeing.
- 8.27 Negative effects on historic hedges would largely be avoided with an overhead line option.
- 8.28 There is potential for effects on buried archaeology in the construction of access tracks and in the construction of pylon foundations. Detailed routeing would seek to avoid areas where there are known or likely buried remains so that they can remain in situ but effects can be resolved through localised mitigation measures where avoidance is not possible.
- 8.29 The western variant offers greater opportunity to avoid heritage assets and archaeological remains than the eastern variant where the alignment is less flexible as it is 'fixed' by the existing overhead line.

Underground Cable Option 7.2

Landscape and Views

- 8.30 As with all of the cable routes under consideration, there would be no long term effect on the landscape following reinstatement, subject to the avoidance of important landscape features such as woodland through routeing or using HDD techniques. This cable route would not cross through any designated landscapes.
- 8.31 Option 7.2 crosses the Colne Valley and Bourne Brook. There is potential to use HDD techniques to avoid effects on these watercourses and associated vegetation.
- 8.32 During construction, there would be a temporary negative effect on views from properties.

Ecology

- 8.33 Option 7.2 does not cross any internationally or nationally designated site for nature conservation. It is assumed that the most sensitive habitats including woodland and waterbodies can be largely avoided in cable routeing. There would be some habitat loss resulting from cable installation, including hedgerow and hedgerow trees, which may also result in negative effects on protected species. There is potential to use HDD techniques to avoid effects on the most sensitive habitats. In addition, wildlife friendly working methods can be used to minimise effects during construction with mitigation techniques such as replanting and translocation used to reduce effects in the long term.

Historic Environment

- 8.34 Option 7.2 passes close to three Scheduled Monuments. However, there would be no direct effect on this heritage asset and there would be no long term effects on setting following reinstatement.
- 8.35 Detailed routeing would avoid direct effects on Listed Buildings and Conservation Areas and there would be no long term effects on setting following reinstatement.
- 8.36 There is potential for some negative effects on the historic landscape through the removal of sections of historic hedgerow, although mitigation could be used to reduce these effects.
- 8.37 There is high potential for buried archaeology throughout the corridor. The corridor crosses a Roman settlement site adjacent to Stanley Hall scheduled moated site. This

asset is not designated but is of equivalent significance to a designated heritage asset and extends across the entire width of the corridor. There are further crop marks within the corridor that could also on further investigation prove to be of equivalent significance to a designated asset. This connection option would require significant assessment and mitigation.

Summary

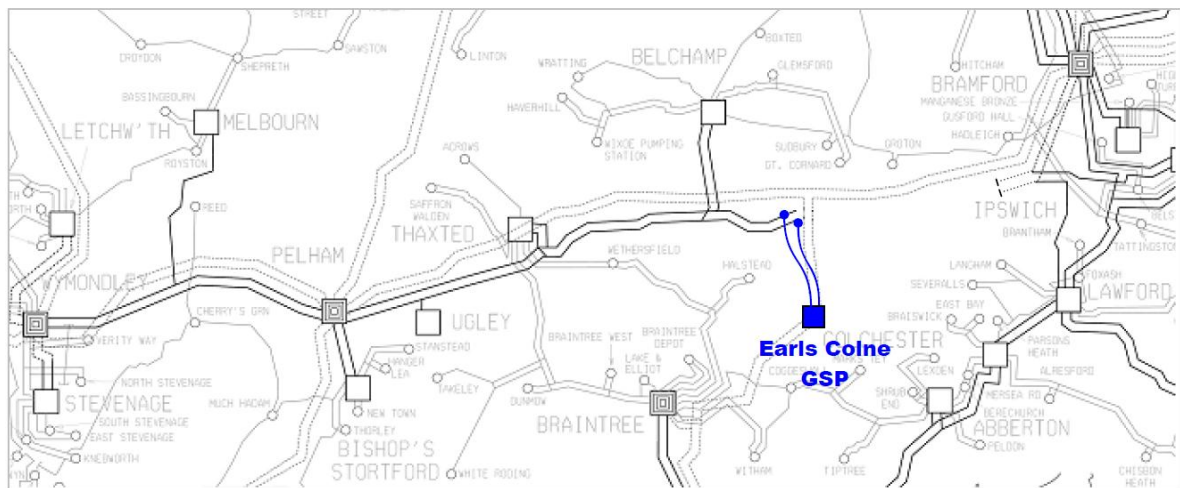
- 8.38 UKPN considered that this option should be discounted due to cost, high risk factor (archaeological and environmental), complex wayleave negotiations and the long timescale. National Grid considers that the overhead line Option 7.1 would result in long term negative effects on landscape, views and the setting of historic assets. The underground options are likely to have a harmful impact, particularly on archaeology and biodiversity in the area. There are also statutory listed buildings and potential for buried archaeology within the substation area which would be affected by the development of a substation. This would not be National Grid's preferred option as it would involve both a substation and an overhead line or underground cable works.

9 UKPN OPTION 8 - NEW SUBSTATION AT EARLS COLNE

Option Summary

- 9.1 The UKPN report identifies this option as a 400/132kV GSP, the installation of a 400/132kV SGT by National Grid and the installation of 132kV feeder circuit breakers. A connection would also be required between the GSP and the overhead line between Twinstead Tee and Pelham. This could be overhead (Option 8.1) or underground (Option 8.2). The UKPN report has identified a number of engineering difficulties associated with a number of crossings and environmental issues including ecology. However, despite these issues, this would be a technically viable option.

Figure 8: Simplified schematic diagram for Options 8.1 and 8.2.



- 9.2 UKPN has provided an estimated capital cost for Option 8.1 of £31.1m and for Option 8.2 of £44.2m, to which must be added the £30.4m cost of National Grid's Grid Supply Point. The approximate route length for this option is 10km.

National Grid Further Appraisal

- 9.3 A substation study area has been identified to the east of Earls Colne, which is close to the existing 400kV overhead line and mature woodland. This option would require a new 132kV connection between the substation and Twinstead Tee.
- 9.4 The overhead line corridor would run from Earls Colne north along the line of the existing 400kV overhead line to Twinstead Tee. It is envisaged that a new 132kV overhead line would closely parallel the existing 400kV overhead line but would need to be

undergrounded for a couple of short sections to avoid oversailing property. This offers the most direct route to Twinstead Tee and would be 9km in length.

- 9.5 This is a relatively short overhead line route; however, it requires a new substation to be constructed as part of the option as outlined above.
- 9.6 An underground cable corridor has been identified which takes the most direct route to Twinstead Tee along the line of the existing 400kV overhead line route which is approximately 9km.
- 9.7 The substation study area and corridors are shown on Figure 9.

Technical Complexities

- 9.8 The installation of a connection between Twinstead Tee and Earls Colne is not expected to add any additional technical complexities to the UKPN system. Substation reinforcement works would be required.
- 9.9 Short cable sections may be required on Option 8.1 to avoid oversailing properties where the route would run parallel to the existing 400kV overhead line.
- 9.10 Option 8.2 would necessitate a number of crossings of A roads and environmentally protected areas which could be achieved by horizontal directional drilling (HDD). These crossings would not present significant issues in terms of buildability. The majority of the underground cable route would be across open fields.
- 9.11 The connection would only require system outages on the UKPN system at the later stage of construction for the installation of the two new terminal towers and commissioning. This should fall within routine system outage requirements. A sequence of outages would also be required on the National Grid system to accommodate the connection of the substation.

Cost

- 9.12 National Grid, has undertaken a lifetime cost assessment based upon the loss cost of the 132kV circuits proposed, along with the operational and maintenance costs used by National Grid to assess its transmission circuits. The cost estimates including the UKPN capital costs are shown in Table 8 below.

Table 8: Costs for Options 8.1 and 8.2.

Option	Description	Capital cost including wider transmission works	NPV of cost of losses over 40 years	NPV of operation and maintenance cost over 40 years	Lifetime cost
8.1	New Grid Supply Point at Earls Colne (New 132kV OHL circuit)	£61.50m	£6.1m	£0.6m	£68.2m
8.2	New Grid Supply Point at Earls Colne (New 132kV UG circuit)	£74.60m	£4.4m	£1.0m	£80.0m

9.13 There is an opportunity to build a substation to the east of Earls Colne, close to the existing 400kV overhead line where woodland could assist with screening a substation.

Environment

Substation Site

Landscape and Visual Amenity

9.14 The substation study area is to the east of Earls Cone on lower lying ground along the River Colne. It is within Essex County Council’s Colne Valley (C7) Landscape Character Area and effects on the wider landscape would be reduced as topography and large blocks of woodland, including Chalkney Wood offer opportunity to provide screening. The area is on relatively low ground and is close to the existing Twinstead Tee to Braintree 400kV overhead line which would further reduce effects on the landscape.

9.15 There are properties on the eastern edge of Earls Colne and in White Colne from which views of a substation could be possible, depending on its siting and design. A new substation would also appear in views from several public rights of way in the area, a public parking area at Chalkney Wood and the Colne Valley Nature Reserve. Effects on landscape and visual amenity could be lessened by additional woodland planting within the substation site.

Ecology

- 9.16 Chalkney Wood is a SSSI and an Ancient Woodland. It is assumed that a substation would be sited adjacent to this woodland to utilise its value for screening views of a proposed substation. There would be no removal of woodland. The Colne Valley Nature Reserve is to the northern part of this search area, although it would be possible to avoid this if this option were taken forward.

Historic Environment

- 9.17 There are 3 Grade II Listed Buildings within the substation study area and there are numerous Grade II Listed Buildings and 1 Grade II* Listed Building within 1km of the study area. There is a Conservation Area at Earls Colne to the immediate west of the substation study area. Given the distribution of heritage assets, it is unlikely to be possible to avoid effects on the settings of some of these assets, though siting and design could help to minimise such effects.
- 9.18 There is a high potential for buried archaeology in this substation study area. This study area is immediately adjacent to the find spot of multi-period remains from gravel pits at White Colne including Palaeolithic finds, material from the Mesolithic period, and Bronze Age and Iron Age remains. In addition, a circular enclosure is visible as crop marks on aerial photographs in the immediate vicinity of the study area. Linear and curvilinear features within a meadow adjacent to the River Colne (immediately to the south of the study area) appear contemporary but are very irregular in their appearance. They may be related to some form of water management associated with the mill. The study area does not appear to lie within the setting of any local designated heritage assets. Detailed cable routeing would seek to avoid areas where there are known or likely buried remains so that they can remain in situ. However, mitigation may be an option if avoidance is not possible.

Other

- 9.19 An area of identified flood risk runs along the River Colne through the centre of this substation search area. In addition access to parts of the substation study area would only be possible via the minor road network, which could result in the need for road improvements and wider environmental effects. These factors would require detailed consideration in identifying feasible substation sites should this option be taken forward.

Local Economic Activity

- 9.20 The substation search area lies on the edge of Earls Colne which is an attractive and historic village used as a base by visitors to the area. A substation has the potential to have a negative effect on its setting and on the tourism offer. All options would benefit the local economy to a degree but the locations benefitting and the extent of such benefits are difficult to quantify when assessing strategic options.

Overhead Line Option 8.1

Landscape and Visual Amenity

- 9.21 Option 8.1 is over 5km from the Dedham Vale AONB at its closest point where it parallels the existing 400kV overhead line and would not give rise to effects on views to or from the AONB.
- 9.22 The overhead line runs alongside the existing 400kV overhead line through Essex County Council's Stour Valley (C8), Blackwater/Stour Farmland (B3) and the Colne Valley (C7) Landscape Character Areas. The identified corridor is close to and includes areas of woodland which would provide opportunities for screening. This option does not avoid woodland as the route is defined by the existing overhead line although short sections of undergrounding would allow a new overhead line to 'switch sides' avoiding some losses.
- 9.23 Generally a new 132kV overhead line would give rise to negative effects on landscape character and views. It would also give rise to localised effects on landscape features where vegetation clearance may be required to achieve safety clearances. Option 8.1 would concentrate the effects within the area already affected by the existing 400kV Twinstead Tee to Braintree overhead line.

Ecology

- 9.24 Option 8.1 does not cross any internationally or nationally designated sites for nature conservation. It runs close to Chalkney Wood SSSI and County Wildlife Site; and crosses the Colne Valley Local Nature Reserve and Ansell's Grove County Wildlife Site.
- 9.25 The construction and operation of an overhead line on this corridor would be likely to result in the loss of some woodland. In general, County Wildlife Sites and/or woodland could be avoided through detailed routeing. However, at one location just south of the Twinstead Tee County Wildlife Sites and woodland extends across the full width of the corridor. In this location habitat loss is likely.

Historic Environment

- 9.26 Option 8.1 passes between Conservation Areas at Earls Colne and Wakes Colne and within 1km of a Scheduled Monument at Alphamstone and there are numerous Listed Buildings within and in close proximity. Direct effects on above ground heritage assets would be avoided in detailed routeing; however, overhead lines have the potential to have negative effects on the setting of heritage assets which would need to be taken into consideration in detailed routeing.
- 9.27 Negative effects on historic hedges would largely be avoided with an overhead line option.
- 9.28 There is potential for effects on buried archaeology in the construction of access tracks and in the construction of pylon foundations. Detailed routeing would seek to avoid areas where there are known or likely buried remains so that they can remain in situ, although effects could be resolved through localised mitigation measures where avoidance is not possible.

Local Economic Activity

- 9.29 There is potential for localised temporary impacts on some agricultural operations during construction and pylons on agricultural land would also affect operations. The disturbance in each case would not compromise the operation of individual farming units.

Underground Cable Option 8.2

Landscape and Visual Amenity

- 9.30 This is a relatively short cable route. However, it requires a new substation to be constructed as part of the option as outlined above. The cable installation would result in short term effects during installation, although as with all of the cable routes under consideration, there would be no long-term effect on the landscape following reinstatement subject to the avoidance of important landscape features such as woodland through routeing or using HDD techniques. This cable route does not cross through any designated landscapes.
- 9.31 This option would need to cross the Colne Valley if a substation site is identified to the south of the river. There is potential to use HDD techniques to avoid effects on these watercourses and associated vegetation.

- 9.32 During construction there would be temporary negative effects on views from properties, although with reinstatement these would not be long term effects.

Ecology

- 9.33 Option 8.2 does not cross any internationally or nationally designated sites for nature conservation. The corridor does cross the Colne Valley Nature Reserve and Ashgrove/Ansell's Grove woodland which is a County Wildlife Site. These linear features would need to be addressed in detail and require potential use of HDD techniques or other mitigation to avoid effects on these features.
- 9.34 Other sensitive habitats including woodland and waterbodies can be largely avoided in cable routeing. There would be some habitat loss resulting from cable installation, including hedgerow and hedgerow trees, which may also result in negative effects on protected species. There is potential to use HDD techniques to avoid effects on the most sensitive habitats. In addition, wildlife friendly working methods can be used to minimise effects during construction with mitigation techniques such as replanting and translocation used to reduce effects in the longer term.

Historic Environment

- 9.35 Option 8.2 passes within 1km of a Scheduled Monument at Alphasstone. However, there would be no direct effect on this heritage asset and there would be no long term effects on setting following reinstatement.
- 9.36 Detailed routeing would avoid direct effects on Listed Buildings and Conservation Areas and there would be no long term effects on setting following reinstatement.
- 9.37 There is potential for some negative effects on the historic landscape through the removal of historic hedgerows, although mitigation could be used to reduce these effects.
- 9.38 There is potential for effects on buried archaeology, evidenced by cropmarks throughout the area that indicate prehistoric settlement and the prehistoric remains excavated at Earls Colne (described above). Detailed cable routeing would seek to avoid areas where there are known or likely buried remains so that they can remain in situ; however, mitigation may be an option if avoidance is not possible.

Local Economic Activity

- 9.39 The underground cable option is unlikely to have long term impacts on the local economy. Effects on agricultural operations would be temporary.

Summary

- 9.40 UKPN considered that this option should be discounted due to cost, high risk factor (archaeological and environmental), complex wayleave negotiations and the long timescale. National Grid considers that the overhead line Option 8.1 would result in long term negative effects on landscape, views and the setting of historic assets. The underground options are likely to have a harmful impact, particularly on archaeology and biodiversity in the area. There are also statutory listed buildings and potential for buried archaeology within the substation area which would be affected by the development of a substation. This option, like Option 7 would involve both a substation and an overhead line or underground cable works and would also not be preferred for this reason.

10 CONCLUSIONS

- 10.1 This report reviews UKPN's options following the National Grid proposals to remove the existing 132kV circuit between Twinstead Tee and Burstall Bridge. The removal of this section of 132kV overhead line will enable the construction of the proposed 400kV circuit between Bramford and Twinstead Tee.
- 10.2 The UKPN report identified eight strategic options, six of which would secure local electricity supplies which would be compliant with UKPN licence obligations and meet the requirements of ER P2/6.
- 10.3 The following sections summarise the key impacts on topics appraised within this and the UKPN Report and reach a conclusion as to which option should be taken forward.

Technical

- 10.4 None of the six compliant options would introduce particular technical complexities in either the UKPN or National Grid networks. However, some options would require additional system reinforcement works. This would apply particularly to Options 2 and 3. Option 6 would require the least in terms of additional system reinforcement works.

Environment

Overhead Line Connections

- 10.5 The overhead line connection Options 3.1.1 and 3.2.1 would result in long term negative effects on landscape character and views. They would also have long term negative effects on the setting of heritage assets and biodiversity. They would be the least favoured options from an environmental point of view. As the shortest route, the eastern variant of Option 5.1.1 would be likely to have the least negative environmental effect of the overhead line connection options. The western variant would be routed along higher ground compared with the eastern variant. Both variants of Option 5.1.1 would potentially impact upon the conservation area of Stisted and Castle Hedingham. Effects on the landscape character, effects on private and public views (including intervisibility with the 400kV overhead line) and effects on the setting of heritage assets would require detailed consideration if an overhead line option was taken forward.

Underground Cable Connections

- 10.6 The underground cable options would have only a temporary effect on views, landscape character and the setting of above ground heritage assets, prior to landscape re-establishment and subject to the avoidance of important landscape features such as woodland. Both variants of 5.1.2 cross locally designated wildlife sites and Option 3.2.2 has the potential to have effects on the internationally designated Abberton Reservoir. These designated sites would need to be considered further should any of these options be taken forward.
- 10.7 The underground cable options are most likely to have an impact on areas of buried archaeology although there would normally be scope to avoid areas where high concentrations of archaeological sites are known to be present. Where avoidance is not possible mitigation can be achieved but preservation in situ is preferred. The shortest cable routes (Option 5.1.2 eastern and western variants) would result in the least environmental effects of all the underground cable options given that the main features affected by underground cables are fairly evenly distributed throughout the area and given the assumption that there would be the opportunity to avoid known buried archaeology. If a western variant of Option 5.1.2 could be routed for a proportion of the route in carriageway, this underground connection option would have the least environmental effect, even though it is a slightly longer route.

Substation options

- 10.8 A substation would give rise to effects on landscape, views, biodiversity and heritage assets (and to a lesser extent the setting of above ground heritage assets and below ground archaeology), which would be more localised when compared with the overhead line or underground connection options.
- 10.9 Option 6 incorporates three potential substation study areas. All of the substation study areas have been identified to allow scope to avoid designated sites and other specific areas of environmental constraint. Two of the study areas have been identified adjacent to mature woodland for screening and filtering purposes to minimise effects on the wider landscape and views. All options avoid areas of concentrated settlement but some are close to individual properties, and some have the potential to affect the setting of heritage assets.
- 10.10 The substation study areas for Option 6 are close to the existing 400kV and 132kV overhead lines and would require only short connections to these lines in each case. Options 7 and 8 would require lengthy 132kV connections to the PCB overhead line

which would increase the environmental effects of these options whether these connections are made by overhead lines or underground cables. Option 6 would therefore give rise to fewer overall environmental effects. Option 7 has the potential to give rise to the greatest effects as it would require a connection at least 16km in length.

- 10.11 Option 6 would be the preferred substation option on environmental grounds. Mitigation measures would, however, be required in order to minimise localised negative effects on landscape character and views.

Local Economic Activity

- 10.12 All options would potentially affect best and most versatile agricultural land and have an impact on farming operations, although this would be mainly temporary in nature. The overhead line options would affect the landscape and views which are valued by tourists, as well as residents, and may therefore result in adverse socio-economic impacts.
- 10.13 Underground options would have the least effect on the local economy, although some disruption would be experienced during construction.
- 10.14 Of the substation options, Option 6 would have the shortest connection route from the 400kV overhead line and would therefore result in the least impact on views for visitors to the wider area. Option 6.3 could affect important tourism assets, although following mitigation, effects could be reduced.

Cost

- 10.15 The table below summarises the lifetime cost for each of the options identified within the UKPN report.
- 10.16 Option 6 would have the lowest capital and lifetime cost when compared to all other options, as shown in Table 10 above. Option 6 would therefore be the preferred option from a cost point of view. The cost of establishing and connecting a substation at Coggeshall (Option 7) or Earls Colne (Option 8) would be greater than for Option 6 and could not be justified, particularly given that the environmental effects would also be greater due to the need for a long overhead line or underground cable connection.
- 10.17 The costs of underground cable options would exceed those of equivalent overhead line connections. Option 2 would have the highest capital and lifetime cost and although there is the potential for some savings to be achieved by laying 132kV and 400kV cables together, this would only apply if National Grid proposed full undergrounding of the new 400kV connection between Bramford to Twinstead Tee at significant increased cost. This is not the case.

Table 10. Lifetime cost for each Option.

Option Description		P2/6 Compliant Design	Overall Cost including wider transmission works	NPV of Cost of Losses over 40 years	NPV of Operation & Maintenance Costs over 40 years	Lifetime Costs included Circuit/SGT Losses, Operation & Maintenance Cost
1	Do Nothing	Not Compliant	N/A	N/A	N/A	N/A
2	Replace 132kV circuits between Twinstead and Burstall Bridge (132kV UG cable circuits)	Compliant	£103.00m	£4.4m	£1.1m	£108.5m
3	Extension of the 132kV PCB overhead line from Twinstead					
	3.1.1 Twinstead - Lawford 132kV Substation (New 132kV OHL circuits)	Compliant	£80.50m	£8.3m	£1.1m	£89.9m
	3.1.2 Twinstead - Lawford 132kV Substation (New 132kV UG cable circuits)	Compliant	£98.00m	£4.0m	£2.1m	£104.1m
	3.2.1 Twinstead - Abberton Grid (New 132kV OHL circuits)	Compliant	£75.00m	£7.6m	£1.0m	£83.6m
	3.2.2 Twinstead - Abberton Grid (New 132kV UG cable circuits)	Compliant	£92.50m	£3.7m	£1.9m	£98.1m
4	33kV Reinforcement					
	4.1 Resolve 33kV constraints	Not Compliant	N/A	N/A	N/A	N/A
	4.2 Increase 33kV interconnection	Not Compliant	N/A	N/A	N/A	N/A
5	Reinforce Braintree GSP and install new 132kV circuits to Rushley Green					
	5.1.1 132kV Braintree - Rushley Green (New 132kV OHL circuits)	Compliant	£49.00m	£8.9m	£0.9m	£58.8m
	5.1.2 132kV Braintree - Rushley Green (New 132kV UG cable circuits)	Compliant	£62.40m	£5.7m	£1.7m	£69.8m
	5.2.1 132kV Braintree - Abberton teed off to Twinstead (New 132kV OHL circuits)	Compliant-Reliant on additional UKPN scheme	£46.50m	£8.8m	£0.9m	£56.2m
	5.2.2 132kV Braintree - Abberton teed off to Twinstead (New 132kV UG cable circuits)	Compliant-Reliant on additional UKPN scheme	£63.00m	£5.7m	£1.7m	£70.4m
6	New Grid Supply Point at Twinstead	Compliant	£34m	£2.7m	£0.1m	£36.8m
7	New Grid Supply Point at Coggeshall					
	7.1 New Grid Supply Point at Coggeshall (New 132kV OHL circuits)	Compliant	£68.20m	£8.9m	£0.9m	£78.0m
	7.2 New Grid Supply Point at Coggeshall (New 132kV UG cable circuits)	Compliant	£82.70m	£5.7m	£1.7m	£90.1m
8	New Grid Supply Point at Earls Colne					
	8.1 New Grid Supply Point at Earls Colne (New 132kV OHL circuits)	Compliant	£61.50m	£6.1m	£0.6m	£68.2m
	8.2 New Grid Supply Point at Earls Colne (New 132kV UG cable circuits)	Compliant	£74.60m	£4.4m	£1.0m	£80.0m

Overall Conclusions

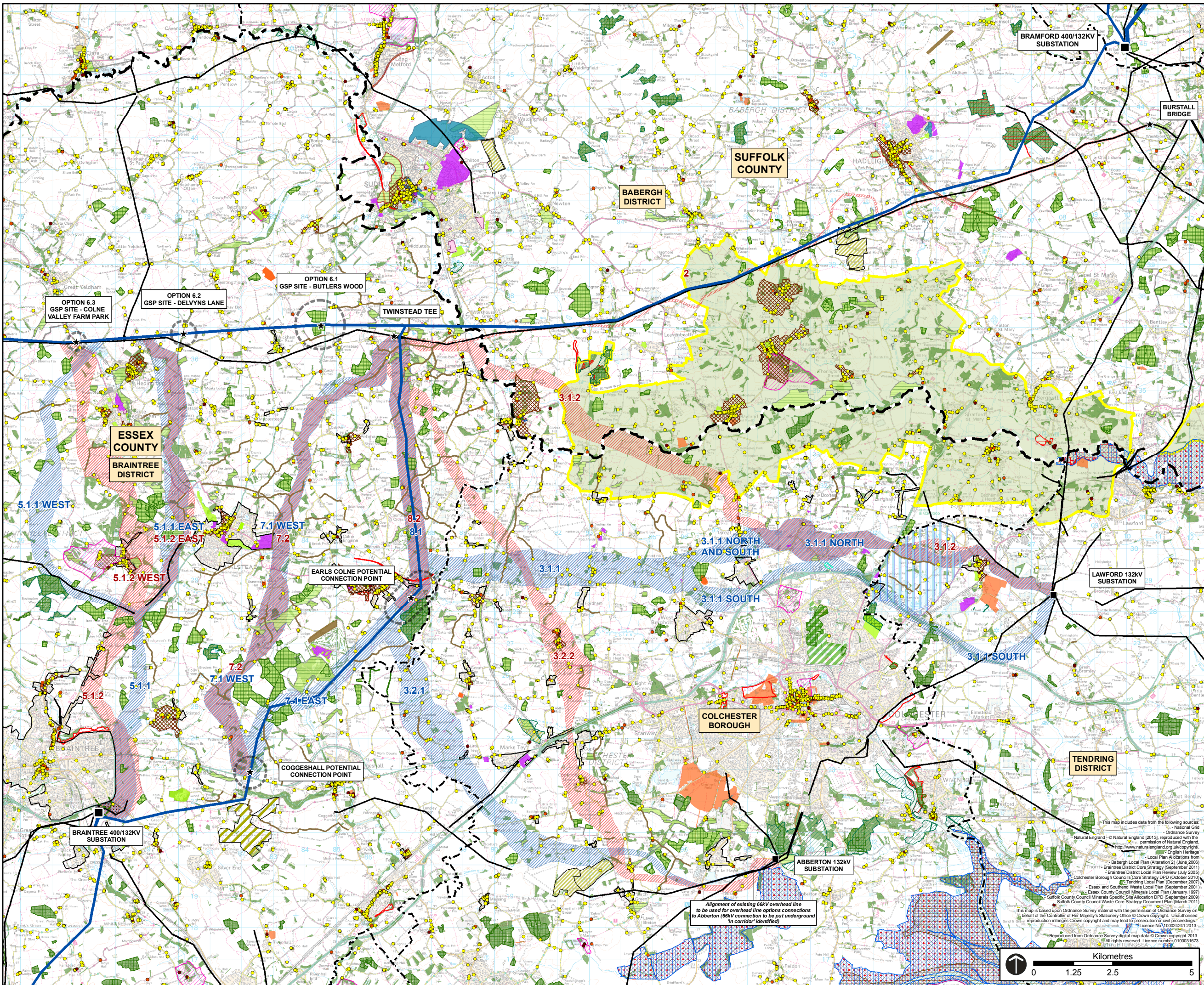
10.18 National Grid has assessed technical, environmental, socio-economic and cost factors in appraising each of the compliant options put forward by UKPN. All options except Option 6 require long lengths of either overhead line or underground cable and would potentially result in environmental and socio-economic effects over a wider area and greater costs.

Given the nature of the areas over which the likely corridors would run (for all options other than Option 6), overhead lines and underground cables would impact upon areas of national or local environmental importance and could have indirect effects on local businesses and visitors to the area, although for the underground cable options, this would be temporary. The effects of a substation in Option 6 would be more localised. Whilst there would be no particular technical difficulties with any of the options, Option 6 would require the least additional system reinforcement works. Of all options, Option 6 has the lowest capital and lifetime costs.

- 10.19 The proposed option of a connection at a substation to the west of Twinstead replaces almost identically the capacity lost through the removal of the 132kV circuit between Twinstead Tee and Burstall Bridge. A single SGT at this location would be sufficient to supply demand in the area based on the current UKPN forecasts to 2021 and its current system running arrangements. Any future changes to the UKPN network or demand requirements are a matter for UKPN and would be addressed if and when any need arises.
- 10.20 Taking all the factors set out in this report into consideration, National Grid considers that Option 6, for a new Grid Supply Point substation to the west of Twinstead, would be the most appropriate distribution network reinforcement in the context of transferring the existing 132kV overhead line between Twinstead Tee and Burstall Bridge. This is also in line with the UKPN assessment of the compliant options.
- 10.21 Option 6 represents the most efficient, co-ordinated and economical option, with environmental effects which are not anticipated to be unacceptable.
- 10.22 A further Substation Siting Report will assess specific options for the siting of a new substation, looking at the three study areas associated with Option 6, as identified in this report, and addressing technical, environmental, socio-economic and cost issues.

ABBREVIATIONS

AONB	Area of Outstanding Natural Beauty
CPRE	Council for the Protection of Rural England
CWS	County Wildlife Site
DCO	Development Consent Order
DPD	Development Plan Document
EIA	Environmental Impact Assessment
GIL	Gas Insulated Line
Ha	Hectare
HDD	Horizontal Directional Drilling
HGV	Heavy Goods Vehicle
HVDC	High Voltage Direct Current
IPC	Infrastructure Planning Commission
Km	Kilometre
kV	Kilovolt
LDF	Local Development Framework
LNR	Local Nature Reserve
LWS	Local Wildlife Site
m	metre/million
MVA	Mega Volt Ampere
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Project
OHL	Overhead Line
PILs	Persons with an Interest in Land
PINS	Planning Inspectorate
PROW	Public Right of Way
SLA	Special Landscape Area
SSSI	Site of Special Scientific Interest
TEP	The Environment Partnership
TPO	Tree Preservation Order
UKPN	United Kingdom Power Networks



Key

Potential Infrastructure

- Potential Connection Point
- Potential Substation Study Area
- Potential Overhead Route Corridors
- Potential Underground Route Corridors

Existing Infrastructure

- Existing Substation
- Existing 400kV Overhead Line
- Existing 132/66/33kV Overhead Line

Local Authority Boundary

- County Boundary
- District Boundary

Environmental Constraints

- Area of Outstanding Natural Beauty
- Ramsar
- Special Protection Area
- Special Area of Conservation
- Site of Special Scientific Interest
- National Nature Reserve
- Local Nature Reserve
- Important Bird Area
- RSPB Reserve
- Scheduled Monument
- Registered Park and Garden
- Listed Building (Grade I)
- Listed Building (Grade II*)
- Listed Building (Grade II)
- Conservation Area
- Woodland
- Ancient Woodland
- Country Park
- Airport/Airfield

Local Plan Allocations

- Employment/Development Allocations
- Open Space Allocations
- Housing Allocations
- Mixed Use/ Community Use
- Educational Establishments
- Cemeteries
- Traveller Site Allocation
- Ardleigh reservoir Catchment Area
- Special Policy Area
- Development Boundary/ Village Envelope
- Proposed Local Nature Reserve
- Minerals or Waste Safeguarding Site/Area
- Local/County Wildlife Site
- Green Link
- Cycleway
- Access
- Protected Lane

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- Braintree District Core Strategy (September 2011)
- Braintree District Local Plan Review (July 2005)
- Colchester Borough Council's Core Strategy DPD (October 2010)
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Project: Bramford to Twinstead Tee Connection Distribution System Options Report

Title: Environmental Constraints and Potential UKPN 132kV Connection Options

Drawing No: Figure 9

Date: 28-01-13

TEP Ref No: G1980.04.017

Drawn: CB

Checked: CH

Approved: UG