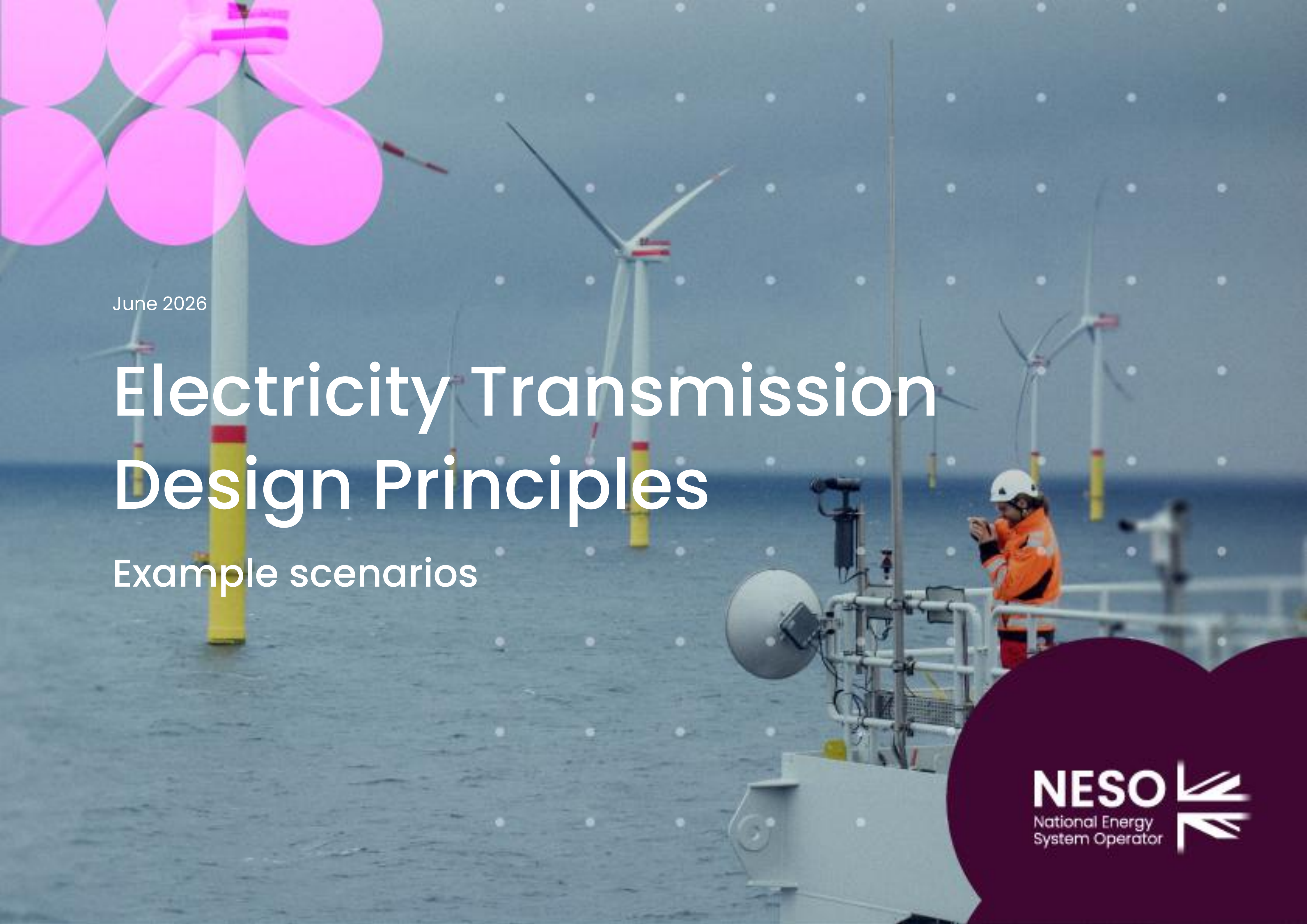


June 2026

Electricity Transmission Design Principles

Example scenarios

NESO
National Energy System Operator

Contents

1. How to use this document

How to use this document

This document has been written for our readers to have either a high-level overview of the example scenarios and how the relevant Electricity Transmission Design Principles (ETDPs) are applied, or a more detailed read for a broader understanding.

The high-level summary will provide a snapshot of the development process of the ETDPs and allow readers to see the basic details of the example scenarios in a quick read. The background section explains why the document exists, the role of the Transmission Acceleration Action Plan (TAAP) and why example scenarios were produced. It also explains how decisions are made when choosing and developing new transmission infrastructure, using example scenarios. There are two example scenarios presented which are independent of one another.

The first example scenario is about a **new overhead line driven by strategic planning**.
It will help to understand:

- how a network need is identified
- how options are compared
- how routeing and technology choices are made
- how trade-offs are balanced across cost, environment, communities, and technical feasibility

The second example scenario is about a **new substation driven by new connections**.
It will help to understand:

- how siting decisions are approached
- how substation principles are applied
- how land, access, flood risk, peatland, and surrounding infrastructure affect design

Navigating through the document

The example scenarios show, at a high level, how new transmission assets are developed through the strategic planning process, and connections-related drivers. At each stage, the example scenarios provide:

- a summary of the key considerations
- figures showing the progression of the various options and key considerations
- the associated Principles

We explain some terms used in this document in 'cut out boxes'.

Throughout the document, we refer to individual Principles. Figure 1 shows the five types of Principles. Each type is given a number and a letter, which shows which category the Principle mainly belongs to.

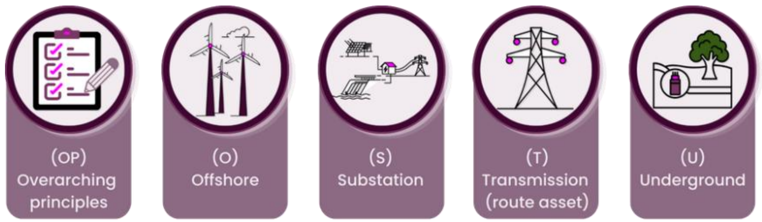


Figure 1: Principle types

Section 4 shows:

- how the Principles connect across different project types
- when different Principles tend to come into play
- that the process is not always step-by-step

This document is not intended to be a strict step-by-step rulebook. It is intended to share the process we used to develop the Principles and to be a practical illustration of how the Principles may be applied. The development of transmission options is often an iterative process and may happen differently to the examples shown here.

Further information

More information on Great Britain's energy system is available on our website, including an *Electricity Networks Explainer* published June 2026 on our Energy 101 pages [1].

[1] https://www.neso.energy/energy-101

Public

2. High-level summary

High-level summary

Why the Principles are needed

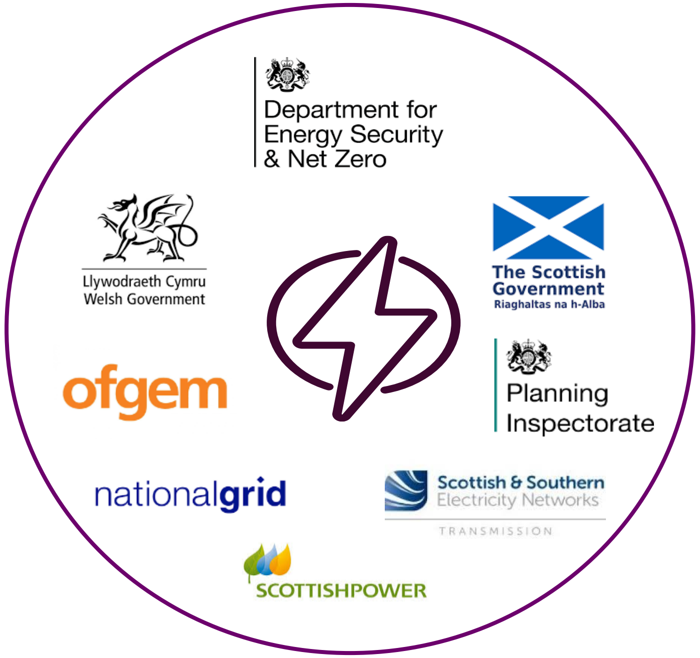
This document presents example scenarios for the Electricity Transmission Design Principles (ETDPs) based on recommendations that form part of the Transmission Acceleration Action Plan (TAAP). One key recommendation (RD1) is to create ETDPs. These Principles help explain what types of assets should be used in different environments.

TAAP is a policy framework designed to:

- speed up the expansion of the onshore electricity grid
- reduce project delivery time from (on average) 14 years to 7 years
- provide clearer guidance on how infrastructure should be designed

Developing the Principles

From June 2024, we worked with the following stakeholders to develop these Principles.



Public consultation Feedback

In October 2025, we consulted the public on the Draft Principles.

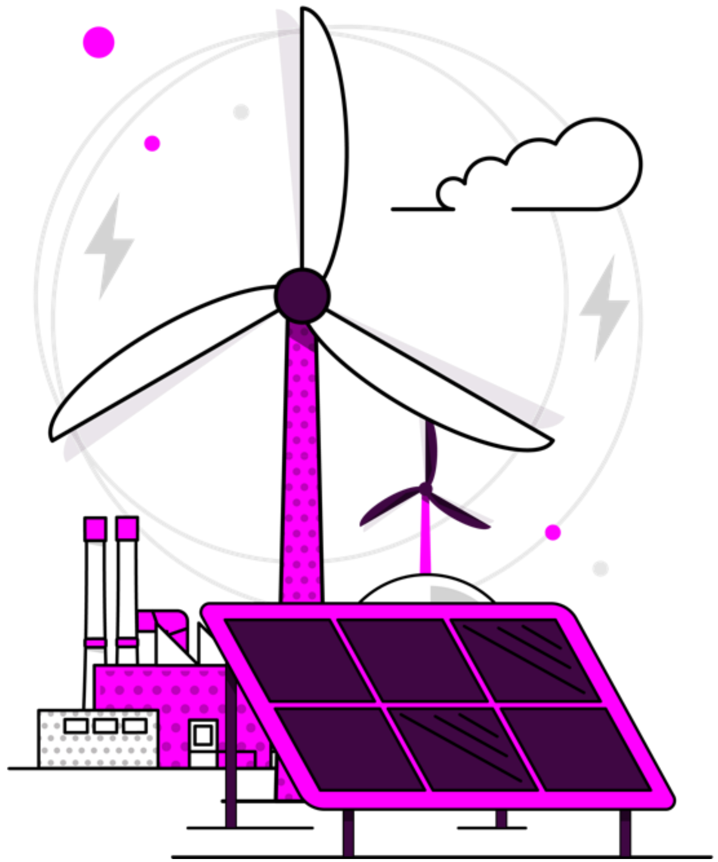
Feedback from stakeholders highlighted that **example scenarios** would help explain how decisions are made. These example scenarios should show how the Principles could be applied in the context of transmission infrastructure projects to balance, among other things:

- cost
- technical needs
- environmental impacts
- community concerns

Purpose of example scenarios

This document contains example scenarios to show how the Principles could be applied in real situations and make complex decisions easier to understand, as the new transmission assets are developed.

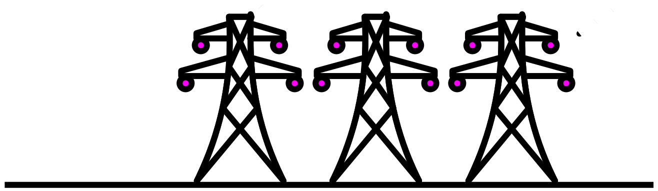
We start by explaining where the Principles fit in the energy sector. Then we show how they can be used as projects develop. We also include a flow diagram that shows which Principles apply at each stage of planning and for different types of assets. The flow diagram is intended to give a visual aid to the application of the principles. It's not a rigid process every project has to follow. Also some projects may iterate through stages as things develop.



The first scenario is driven by a strategic need for a new part of the network. We identify a need for more capacity across a network boundary.

The area includes:

- existing transmission lines
- a major town
- an environmentally protected area

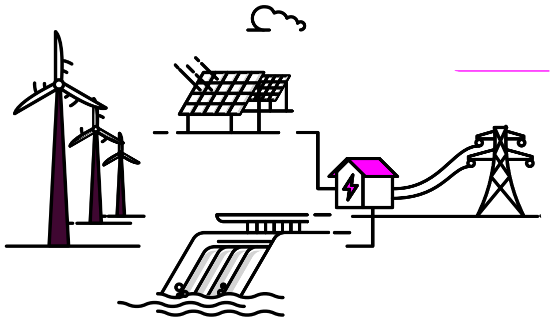


Strategic planning is one of the stages in the development of an electricity transmission infrastructure project. It is typically part of the Centralised Strategic Network Plan (CSNP), Connections, or Business Plan process and defines the high-level characteristics of future transmission infrastructure. It sets broad parameters such as technology type, connection points to the existing network, and capacity requirements.

The second scenario is driven by a connection need for a new substation required to connect renewable energy and offshore links to the transmission network.

The area includes:

- an existing transmission line
- a substation
- river and woodland
- peatland



When new energy projects apply to connect to the electricity transmission network, new equipment may be needed, such as a substation, cables, overhead lines, or upgrades to existing infrastructure.

3.How the Principles support project decision making

How the Principles support project decision making

The Principles are intended to support effective engagement and consultation, where relevant, and to form part of a broader set of measures aimed at streamlining and accelerating decision making and delivery to support the energy transition. The Principles should be read as a whole and are designed to sit alongside, rather than replace, existing policy, guidance and regulatory frameworks.

Figure 2 explains how the Principles work alongside these with the relevant stakeholders at each stage of the development process. It also shows how and where Electricity Transmission Design Principles (ETDPs) would apply while developing these assets.

These example scenarios also reference the Holford and Horlock rules. These are existing rules that preserve amenity, minimise environmental impact of new transmission proposals, and inform the siting and design of new substations. They are routinely applied across the sector in environmental assessments, and specifically landscape and visual impact assessments. The ETDPs are not intended to replace these, but sit alongside them, and provide more guidance around their application and use in development of the electricity transmission network.

These Principles are referenced in the Department for Energy and Net Zero's (DESNZ's) National Policy Statement for Electricity Networks Infrastructure (NPS EN-5), December 2025. This states that developers should have regard to the ETDPs for nationally significant infrastructure in England and Wales.

While recognising that some planning law is devolved, NPS EN-5, and therefore the ETDPs, may become increasingly relevant as cross-border transmission links are developed to meet future energy needs.

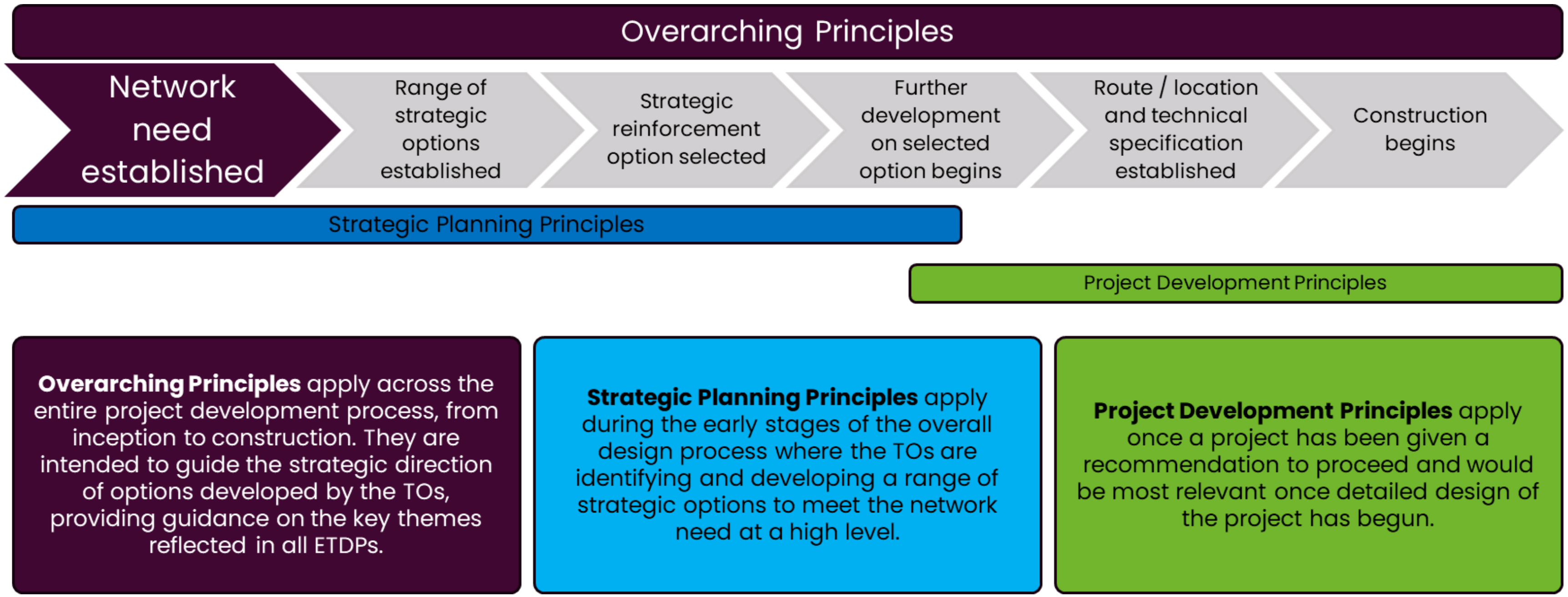


Figure 2: Process map

Figure 3 explains how the principles may be used to guide decisions for different types of transmission projects. It signposts which Principles relate to the different planning stages and different asset types. The order that Principles are shown is not prescriptive and due to the complex and iterative nature of asset development they may be used in a different order.

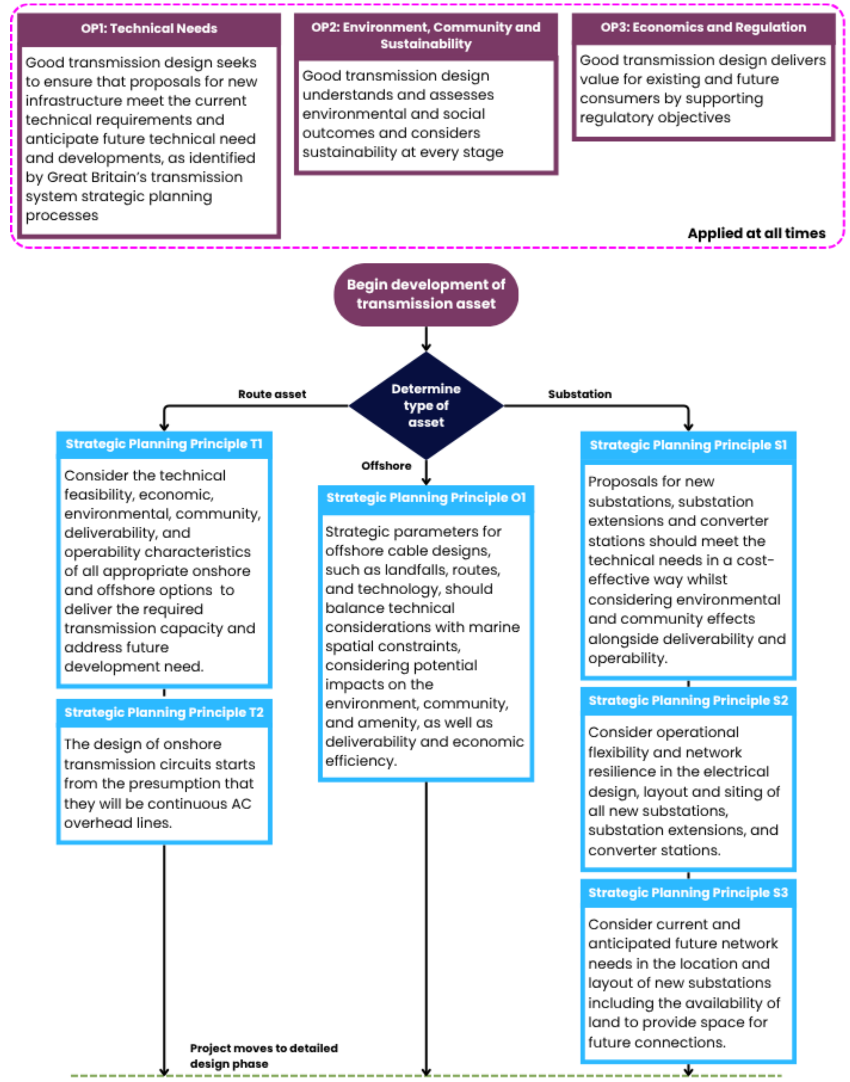


Figure 3: Flow chart, overarching and Strategic Principles

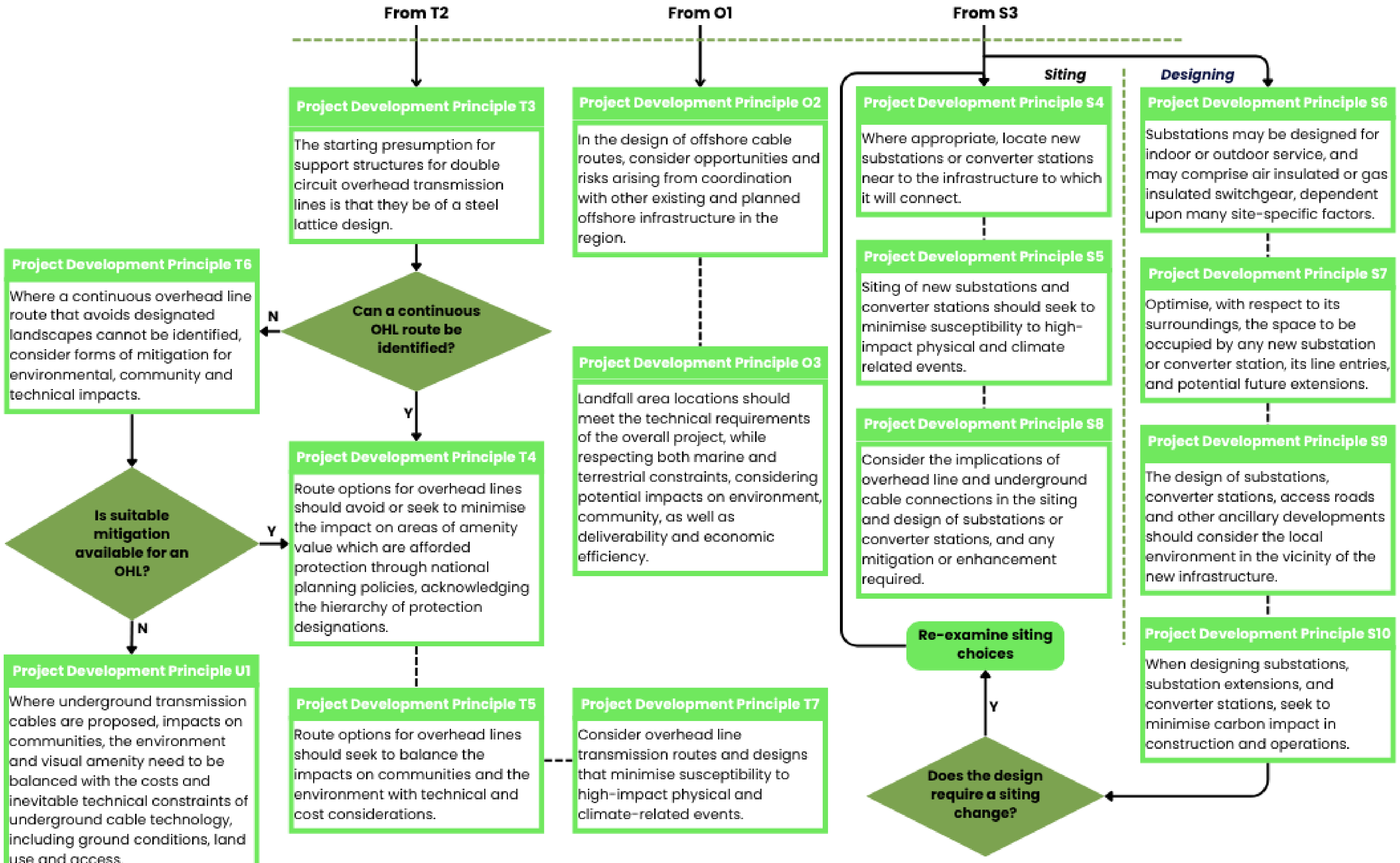


Figure 4: Flow chart, project development Principles

4. First scenario

Example scenario: New network driven by a strategic planning process

In this example scenario, our network analysis has concluded that there will be a shortfall of network capacity across an area of a fictional network shown as boundary "BX". This is due to an increase in connected generation to the north of this network. For the purposes of the example, an extra 4 GW of capacity is required. This is called a strategic driver. The fictional network presented in this example has two 400 kV transmission circuits that cross the area of boundary BX. Within the area that this boundary covers, there is also a major town and an environmentally protected area.

Network capacity is the term used to define how much power the grid can safely transmit and distribute at any given time without overloading. Network reinforcements are infrastructure upgrades that increase the capacity of the grid, for example, building new transmission lines or a new substation.

This example shows where the Principles could be considered as an indicative project is developed. In reality, the Principles could be considered at multiple stages of development, as it may not be a step-by-step process. For the purposes of this example, there is only space available for development inside the diagram

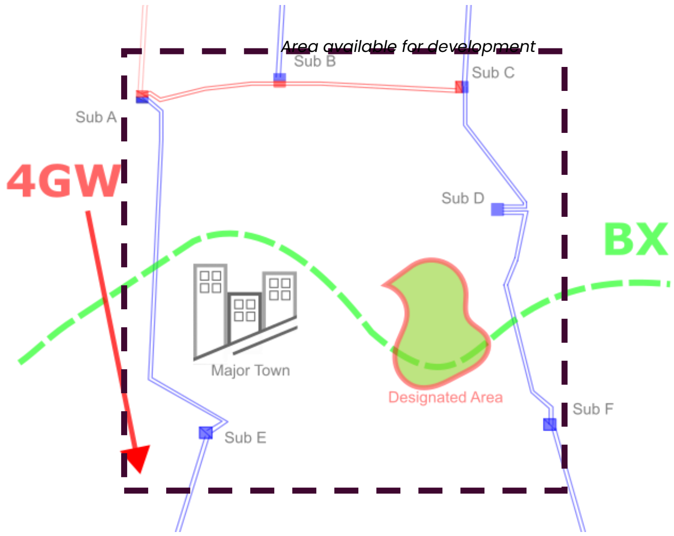


Figure 5: Area available for development

As the design of this fictional project progresses, we will provide:

- a summary of the key considerations
- diagram(s) showing the progression of the various options
- the associated Principles

Overarching Principles

Key considerations: the relevant Transmission Owner (TO) will start drafting a series of suitable network reinforcements.

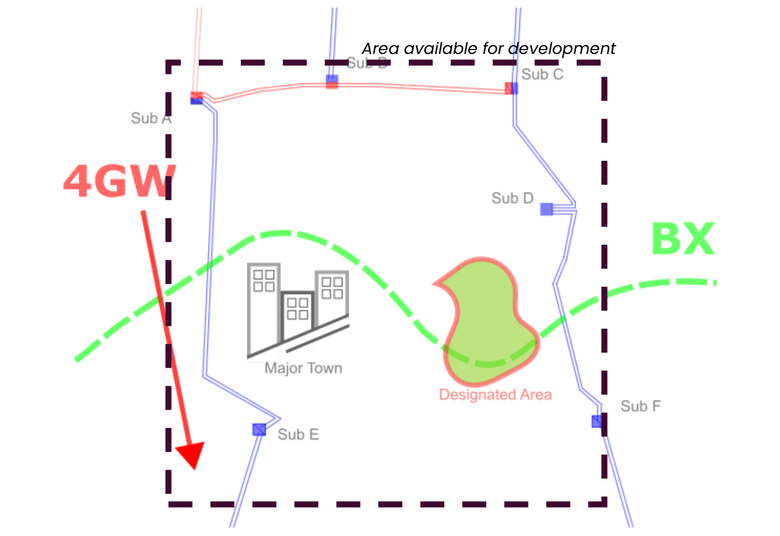


Figure 6: Area available for development

Associated Principles: As reinforcements are developed, all three Overarching Principles should be considered.

- **OP1** - The new reinforcement should provide the required increase in capacity across the boundary, in a manner that would be compliant with the Security and Quality of Supply Standards (SQSS).
- **OP2** - Development of the reinforcement options, both at this early stage and across the entire process, should be conscious of the local environment and communities within the wider area that it may be built in.
- **OP3** - Reinforcement options should deliver value for current and future energy consumers.

Strategic Planning Principles

Key considerations: The TO will start development of the new reinforcement, considering a broad range of options to fulfil the network need set out by us, as shown below. The TO will consider many options, but for the purposes of this example, three potential options are shown in Figures 7-9 . The TO may choose to submit multiple options (generated at this stage) to us for analysis and comparison in a strategic planning process. For the purposes of this example, we will focus on a single solution: a new onshore transmission circuit (called New Circuit A).

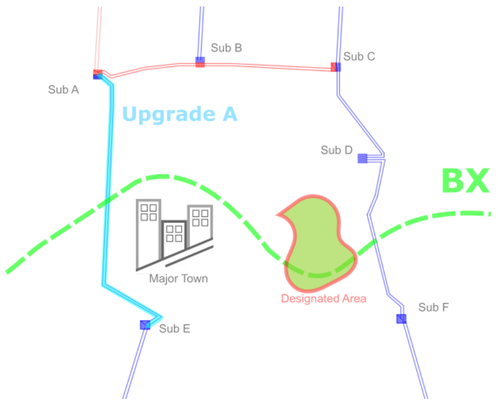


Figure 7: Upgrading the existing line

Upgrading the existing line provides a small amount of capacity increase, has the lowest impact on the local environment and community, and is potentially easier to deliver. While this is a good option for increasing capacity, it does not provide enough of an increase in capacity for this example scenario.

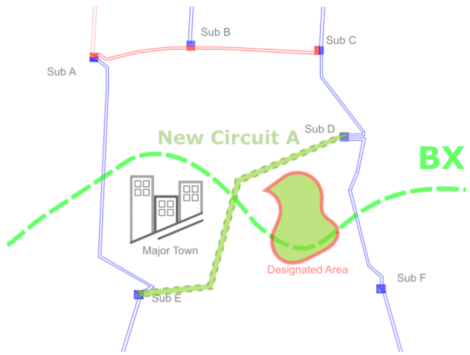


Figure 8: New Circuit A

New Circuit A provides a large capacity increase but comes at a potentially higher impact on the local environment and community. Routeing of this line would need particular care due to the designated area and major town.

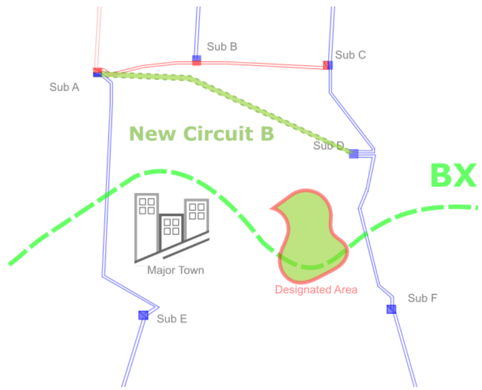


Figure 9: New Circuit B

New Circuit B would not have as much risk when carrying out the routeing of this line but does not cross boundary BX and would therefore not provide a capacity increase in the right place for this example scenario.

(T) Transmission (route asset)

Associated Principles: The Transmission Owner (TO) considers the different options against the design considerations listed in the Strategic Planning Principles **T1** and **T2**.

Project Development Principles (1)

Key considerations: The circuit is submitted to us for consideration in a strategic planning process, supplying information about the circuit, such as start and end point, approximate distance, cost data, capacity data and estimated delivery date.

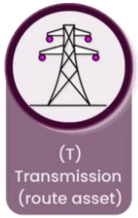
We compare:

- the performance of the option alongside a range of alternatives, such as upgrading existing lines
- commercially driven solutions and offshore circuits where suitable

We then evaluate the performance of these options across economics, environment, community, deliverability and operability objectives.

Following this process, New Circuit A is shown to be optimal when considering all network design objectives and is selected to be developed further by the Transmission Owner (TO). Once a strategic driver and regulatory funding are in place, the TO begins further developing the option.

Using the Holford Rules, the TO proposes initial routeing options. The TO should be aware of designated areas or buildings, and the priority levels for protected land. The TO also considers the trade-offs associated with lengthening routes to avoid such areas.



Associated Principles:
Further development of the new circuit begins with the presumption that:

- Initial routeing work for the circuit begins, considering the Transmission **(T)** Project Development Principles.
- As the reinforcement is an onshore transmission circuit, the presumption is taken that it will be a continuous alternating current (AC) overhead line **(T2)**.
- The supporting towers will be a steel lattice design **(T3)**.
- From here the TO plans the initial route, with the aim of balancing the impacts on communities, landscape and visual amenity (views) with other environmental and technical considerations **(T5)**.
- Looks to avoid or minimise the impact on local green spaces and views, known as areas of protected amenity value **(T4)**.

The Holford and Horlock Rules are existing rules that preserve amenity, minimise environmental impact of new transmission proposals and inform the siting and design of new substations. They are routinely applied across the sector in environmental assessments, and specifically landscape and visual impact assessments.

Possible routes for consideration

Figures 10 -12 show: a potential point-to-point route, a route that avoids all constraints entirely, and a balanced approach that considers careful routeing between the constraints. The Transmission Owner (TO) would consider the Principles when examining different routeing options.

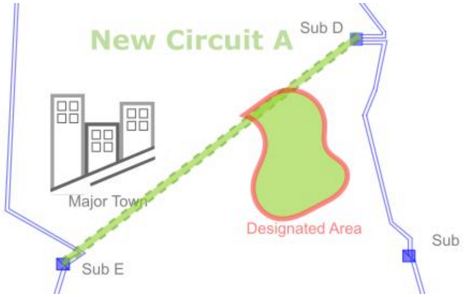


Figure 10: Point-to-point route

A point-to-point route may be the most economic and efficient route but would result in the circuit passing through the designated area. This route has not considered principles T4 and T5, as it does not seek to avoid or minimise the impact on this designated area.

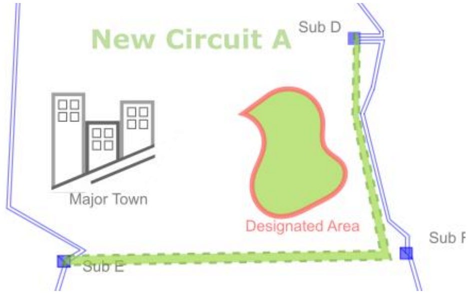


Figure 11: Longer route

A longer route that avoids both the designated area and the major town would consider T4, but careful considerations would need to be taken to assess the cost and technical implications of building a much longer line.

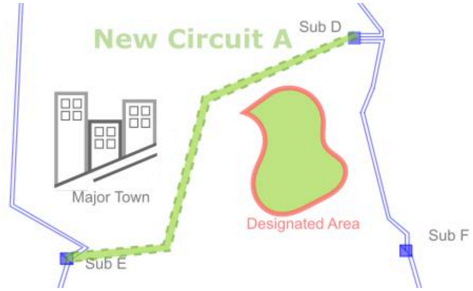


Figure 12: Balanced approach

A balanced approach would see an overhead line carefully routed between the designated area and the major town. This does increase the length slightly when compared to a point-to-point route, however the impact of this is offset by the reduced impact on communities and landscapes.

Project Development Principles (2)

Key considerations: Along the proposed route, the Transmission Owner (TO) should identify any areas prone to natural hazards, such as high winds and storm, extreme heat or flooding, or other risks to transmission infrastructure and propose mitigations. Any additional constraints present that meant that the TO could not identify a continuous route that does not impact any protected areas. For the purposes of this example scenario, we now present an additional constraint along the route of the planned reinforcement that means the TO cannot identify a continuous route that does not impact any protected areas.

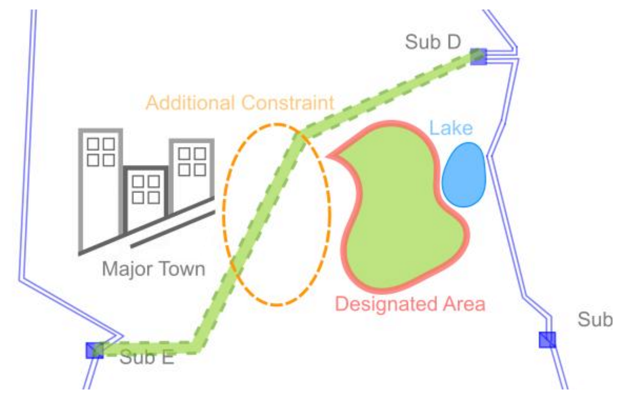
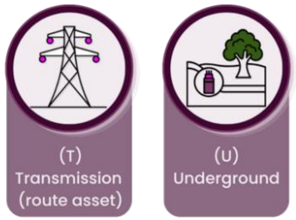


Figure 13: Additional constraint present on the route

Alternative tower designs could reduce landscape disruption and lessen visual impacts, but this may come at a higher cost and technical complexity, as they may be more difficult to construct and maintain, with higher levels of embodied carbon.

If the effects of the route on the area are suitably significant[2], then undergrounding (putting power lines underground) may be the only viable alternative to proceed with the planned network reinforcement. Care must be taken when considering undergrounding.



Associated Principles:

- If there were additional constraints present that meant that the TO could not identify a continuous route that does not impact any protected areas, then the TO would need to review the likely adverse effects as part of Environmental Impact Assessment, and consider forms of mitigation for environmental, community or technical impacts **(T6)**.
- When drafting routeing options, the TO should also consider potential routes that minimise susceptibility to high-impact physical and climate-related events. This makes it less vulnerable to severe weather **(T7)**.
- The potential visual improvements of undergrounding must be balanced against the increased costs and technical issues. associated with undergrounding. The planned route must respect the constraints of underground technology **(U1)**.

[2] Where the effects on a particularly sensitive receptor or group of receptors, in cognisance of stakeholder feedback, are assessed by the relevant professional as being over and above the thresholds of significance defined in relevant EIA legislation and guidance

5. Second scenario

Example scenario: New substation driven by new connections

The example shows where the Principles could be considered as an indicative project is developed, but the Principles could be considered at multiple stages of development, as it may not be a step-by-step process. For the purposes of this example, there is only space available for development inside the diagram.

In this example scenario, to support the wider connection of both onshore and offshore renewables and a new connection to an offshore cable link there is a requirement to build a new substation.

The fictional network presented in this example has an existing 275 kV transmission line, and an existing substation that is situated on an access road. It is situated between a river and some woodland. Further along the existing transmission line there is an area of peatland.

Substations are the 'junction boxes' on the electricity network. Substations provide places for circuits to connect to each other, equipment to control, protect and monitor those circuits and transformers to lower the high voltage power to make it safer to connect homes and businesses.

Figure 12: Area available for development

As for the first example, as the design of this fictional project progresses, we will provide:

- a summary of the key considerations
- diagram(s) showing the progression of the various options and key considerations
- the associated Principles

Overarching Principles

Key considerations: The relevant Transmission Owner (TO) will begin drafting a series of suitable options for a new substation in response to this requirement.

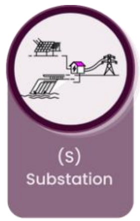
Associated Principles: As such options are developed, the Overarching Principles should be considered:

- The new substation should provide the required increase in capacity across the boundary, in a manner that would be compliant with the Security and Quality of Supply Standard (SQSS) **(OP1)**.
- Development of the substation options, both at this early stage and across the entire process, should be conscious of the local environment and communities within the wider area that it may be built in **(OP2)**.
- Substation options should deliver value for current and future energy consumers **(OP3)**.

Figure 15: Area available for development

Strategic Planning Principles

Key considerations: The relevant TO would consider the Strategic Planning Principles in the early siting of the new substation, considering the state of the current surrounding network and current known future connections in the local area.

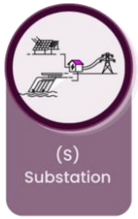


Associated Principles: When drafting initial options, the Transmission Owner (TO) considers the following Strategic Principles:

- **S2** - impact of any new substation on the operation of the network
- **S3** - known future connections that may connect to the network

Project Development Principles

Key considerations As the project progresses, the siting of the substation begins. In addition to having regard for the Principles, using the Horlock Rules the Transmission Owner (TO) assesses substation location options considering amenity, land use, landscape context, access, and the siting of substations in relation to the transmission system.



Associated Principles:

- The designer plans options that are close to the infrastructure which it will connect to, to reduce turn in works and associated impacts **(S4)**.
- The sites considered for the substation should be less susceptible to high-impact physical and climate related events **(S5)**.
- The substation technology should be selected based on site-specific factors **(S6)**.

Air insulated switchgear (AIS) uses air as the insulating medium between electrical components. It generally requires a larger site area than gas insulated switchgear (GIS) but may be suitable where space is available and site constraints are lower.
Gas insulated switchgear (GIS) uses insulating gas as the insulating medium between electrical components. It generally requires less site area than air insulated switchgear (AIS), which can make it suitable where space is limited, or site constraints are greater.

- The substation layout is planned to be optimised with respect to its surroundings through an understanding of local issues and consultation with local stakeholders **(S7)**.
- Careful consideration is given to the siting to mitigate cumulative 'wirescape' issues in combination with existing infrastructure as a result of the substation and the new connections into it **(S8)**.
- The design of the substation and ancillary developments (such as the access roads) should consider the local environment around the potential site **(S9)**.
- Minimise carbon impacts from any earthworks required **(S10)**.

A **wirescape** is the overall visual effect of electricity network infrastructure in the landscape - especially the combined presence of overhead lines, pylons/towers, substations, gantries, and connecting wires. Careful consideration in planning is important because the issue is often cumulative, not just about one asset in isolation. A new substation or line might be acceptable on its own, but together with existing infrastructure it can create a lot of visible infrastructure.

Figures 16 -18 show the potential sitings that may be tested by the TO for a new substation using the Principles mentioned above.

Figure 16: Substation located on the edge of peatland

This option has the substation located on the edge of peatland. The substation layout optimised and consideration could be given to the use of Gas Insulated switchgear (GIS) as it has smaller overall footprint to minimise the earthworks required but may come at an additional capital cost.

Figure 17: Substation located next to existing substation

This option requires less additional work to enable access for construction and maintenance as it is already sited on an access road. Proposed site next to existing substation is likely to be exposed to similar climate and physical events increasing their severity if one occurs, as it will impact both substations.

Figure 18: Substation located outside of a flood risk zone

This option has the substation located outside of a flood risk zone as it is further from the river. There are also fewer space constraints for the proposed site so consideration could be given to air insulated switchgear (AIS), while optimising the layout for the community and the land uses into which it is placed, to minimise disruption.

6. Legal notice

Legal notice

For the purposes of this document, the terms "NESO", "we", "our", "us" etc. are used to refer to National Energy System Operator Limited (company number 11014226).

This document has been prepared in good faith by NESO (the National Energy System Operator Limited, company number 11014226) pursuant to its statutory duties. It represents the output from the working group it convened pursuant to the Department of Energy Security and Net Zero's Transmission Acceleration Action Plan. NESO's role in respect of the Electricity Design Transmission Principles includes convening and leading the working group and co-developing and consulting on the Principles. NESO's role in respect of the Principles is not policymaking, endorsing into planning law (into the NPS or otherwise), and/or decision-making in respect of consenting specific projects.

The content of this document is not intended to constitute legal, financial, or other professional advice and nothing within this document alters or supersedes applicable policy and law. Readers and/or any party interpreting, considering and/or applying the Principles should not act, refrain from acting, and/or place any reliance upon the contents of this document, should make independent enquiries as to the legal and practical implications of applying the Principles in any specific context, and should seek their own independent professional advice tailored to their specific circumstances and applicable policy and law.

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