GREEN GEN CYMRU

Consultation September 2024

Updated Phase One Grid Connection Strategy

GREEN GEN CYMRU

Contents

Executive Summary

Green GEN Cymru has undertaken an appraisal of grid connection options to determine the most appropriate solution to connect our proposed South Wales Energy Parks to the National Electricity Transmission System (NETS). The scope of this Updated Phase One Grid Connection Strategy includes the general location of the proposed connection substation, as well as the potential connection route from the Energy Parks to the substation.

This document explains the assessment and decision-making process which has led to the selection of the preferred option for the connection of the South Wales Energy Parks to the NETS.

Our initial review considered and assessed 11 potential connection options within three broad geographical zones, which included connections into both new and existing substations in England and Wales. These options were reviewed against how each performed on technical and environmental grounds against the identified need to develop an efficient, co-ordinated, and economic system.

Our appraisal has considered potential environmental impacts that the connection of the South Wales Energy Parks could have, so far as known at this stage of development, and the measures that may be implemented to avoid, minimise or mitigate such impacts.

Our analysis has concluded that a route to a new substation in the Carmarthen area offers the most appropriate solution and is therefore our preferred solution. This has weighed relevant factors, including potential impacts on the environment, technical and cost considerations.

The South Wales Energy Parks, located in Powys, Carmarthenshire, and Ceredigion, would be connected to this new substation via two separate 132kV routes. The starting position for the consideration of grid connection options has been that the entirety of these routes would be made up of overhead lines of steel lattice design. This solution is referred to as Option 11 within this report.

The conclusions presented within this document are preliminary at this stage, reflecting the early stage of development of the proposals. Our optioneering decisions will be kept under review as work on the development of the preferred option continues.

Glossary

Term	Definition
Alternating Current (AC)	A type of electrical current, in which the direction of the flow of electrons switches back and forth at regular intervals. The vast majority of the electrical network in Great Britain consists of AC infrastructure.
Collector substation	An electrical site where generated electricity is combined to enable the more efficient transfer of electricity to the subsequent section of the network.
Connection substation	An electrical site where voltage is increased or decreased to enable connection to the subsequent section of the network.
Designated Areas	Specific sites within the UK that have special status as protected areas because of their natural and cultural importance.
Development Consent Order (DCO)	A form of consent (typically a statutory instrument) which authorises the construction, operation and maintenance, and decommissioning (if appropriate) of Nationally Significant Infrastructure Projects (NSIPs). Development Consent is granted by UK Government and the process is administered by the Planning Inspectorate.
Development of National Significance (DNS)	Large infrastructure projects in Wales that require planning permission from the Welsh Ministers (the process is administered by Planning and Environment Decisions Wales (PEDW) on behalf of the Welsh Government.)
Direct Current (DC)	Electrical current which flows consistently in 1 direction. DC technology is often used to carry electricity over very long distances (hundreds of kilometres).
Distributed Generation	Electricity generation that is located close to the load that it serves, usually connection to the distribution network.
Distribution Network	In England and Wales this is the infrastructure that typically operate at 132kV and below, while in Scotland it is the infrastructure that operates below 132kV. Distribution networks carry electricity from the transmission system and Distributed Generation to industrial, commercial, and domestic users.
Distribution Network Operator (DNO)	DNOs own, operate and maintain the distribution networks. There are 14 licensed DNOs in GB, and each is responsible for a regional distribution services area.
Eastern Cluster	The 4 Energy Parks, Nant Mithil, Bryn Gilwern, Aberedw and Garreg Fawr, that are proposed to be located within East Wales and forming part of the South Wales Energy Parks
Future Wales: the national plan to 2040	The Welsh Government's national development plan for Wales. It provides the policy context against which DNS applications are determined and influences all levels of planning policy in Wales and will help to shape Strategic and

	Local Development Plans prepared by councils and national park authorities.
Independent Distribution Network Operator (IDNO)	IDNOs are companies that can develop, own, operate and maintain local electricity distribution networks within a DNO network.
National Electricity Transmission System (NETS)	Also known as the 'Grid' the 'National Grid' or the 'transmission system,' this is the system of high voltage (132kV or greater in Scotland; greater than 132kV in England and Wales) electric lines owned or operated by transmission licensees within Great Britain. See also "Transmission Network."
National Grid Electricity Distribution (NGED)	The electricity distribution network operator (DNO) for the Midlands, South Wales, and the South West, formerly known as Western Power Distribution (WPD).
National Grid Electricity System Operator (NGESO)	The licensee with the responsibility for the minute-to-minute operation of the GB system and Transmission Network, ensuring it is balanced and stable.
National Grid Electricity Transmission (NGET)	The electricity transmission licensee in England & Wales.
National Park	National Parks are large areas designated by law to protect their special landscape qualities and promote outdoor recreation. National Parks have their own authorities which control planning.
National Landscapes (Formerly Area of Outstanding Natural Beauty)	A National Landscape, formerly known as an AONB, is an area of countryside in Wales, England, and Northern Ireland, which has been designated for conservation due to its significant landscape value. Areas are designated in recognition of their national importance by the relevant public body: Natural Resources Wales, Natural England, and the Northern Ireland Environment Agency, respectively.
Overhead line (OHL)	Electricity lines that are supported above ground through the use of towers or poles.
Planning and Environment Decisions Wales (PEDW)	PEDW manages casework (on behalf of the Welsh Ministers) relating to the development and use of land in the public interest, including applications for Developments of National Significance (DNS).
Span	The section of OHL (see above) between towers or poles.
Special Area of Conservation (SAC)	Special Areas of Conservation (SACs) have been chosen to make a significant contribution to conserving habitats and wildlife species that live there, named in the EC Habitats Directive.
South Wales Energy Parks	The 6 Energy Parks proposed to be located within south Wales.
Special Protection Area (SPA)	Special Protection Areas (SPAs) are areas that have been designated specifically to conserve wild birds that are listed as rare and vulnerable in the Birds Directive. They also

	include sites that migratory birds use as stop-off points on their journeys across the planet.
Site of Special Scientific Interest (SSSI)	SSSIs are sites that are highly protected to safeguard the range, quality and variety of habitats, species, and geological features. They are the cornerstones of conservation work, protecting the core of natural heritage.
Tee-connection	Where a new circuit connects into an existing circuit, so that the combined electricity is able to be transferred along 1 circuit, as opposed to two separate circuits.
Transmission Entry Capacity (TEC)	This is the allowed capacity a larger generator can export onto the Transmission Network, as agreed in the connection agreement.
Transmission Network	See “National Electricity Transmission System (NETS)”
Underground cable (UGC)	Electricity cables that are buried below the ground.
Western Cluster	The two Energy Parks, Lan Fawr and Nant Ceiment, that are proposed to be located within West Wales and forming part of the South Wales Energy Parks.

Introduction

Who are Green Generation Energy Networks Cymru

1. Green GEN Cymru is part of the Windward Energy group of companies, based in and developing green energy projects in Wales to meet the future needs of Welsh people, communities, and businesses.

2. Green GEN Cymru will design, build, and operate a new 132kV distribution network needed to connect new Welsh renewable energy projects to the electricity transmission network, helping to get green energy to homes and businesses across Wales and beyond.

3. On the 5th July 2024, Green GEN Cymru was granted an Independent Distribution Network Operator (IDNO) licence with OFGEM so that it can build, operate and maintain a 132kV network. IDNOs are companies that develop, own, operate and maintain smaller, local electricity distribution networks (up to 132kv) within the regional Distribution Network Operator (DNO) network. In South Wales, the DNO is National Grid Electricity Distribution (NGED). Now the licence has been granted, GGC will have the benefit of the powers within the Electricity Act 1989.

4. Our green grid network can provide a regional network solution for South and Mid Wales. Other energy generators will be able to apply to connect to it, reducing the need for more infrastructure in future. The Welsh Government, the Senedd and energy generators have been looking for ways to unlock this potential for a number of years but have faced challenges due to a lack of electricity grid infrastructure.

5. Green GEN Cymru is taking action now, to help deliver clean green energy to our homes and businesses through developing the energy network in Wales. This will help tackle both the energy crisis and the climate crisis.

6. Our proposals will assist in addressing key national priorities to contribute to decarbonisation and climate-resilience, whilst promoting a vibrant economy and improving the well-being of our communities.

7. Our approach aligns with the Welsh Government's ambitions for renewables in Wales. We will follow best practice in working with local communities throughout the development of our proposals, ensuring that communities have a strong voice in the process and derive maximum benefit from environmental, employment, and social opportunities generated by our project.

8. Bute Energy will establish a Community Benefit Fund for each of its Energy Parks. In an industry first, the fund will benefit not just local people close to the Energy Parks, but people along the route of the Green Gen grid connections too. The Community Benefit Fund could be worth up £800 million across Wales throughout the lifetime of the projects, with an estimated £20 million a year to communities.

9. We are keen to work in partnership with the Welsh Government, Local Authorities, and private sector to see how others can use our infrastructure to the benefit of local communities in Wales.

Who are Bute Energy

10. Bute Energy is set to become a leading developer of onshore renewable energy in the UK and was established to help address the climate crisis by providing low cost, reliable power using proven technologies. Bute Energy's mission is to help unlock Wales' potential for onshore renewable power generation and bring benefits to local communities where Energy Parks are created.

11. Bute Energy is seeking to deliver a package of sustainable benefits and clean energy initiatives. Headquartered in and focused on Wales, the aim is to deliver a portfolio of new Energy Parks, using proven technology to deliver onshore renewable power generation in Wales.

12. Bute Energy is committed to building Energy Parks swiftly and at scale, helping to bring down energy costs and contribute towards achieving net zero. A portfolio of sites has been assembled that would be capable of providing over 2GW of onshore wind and solar power and co-located battery energy storage systems, deploying the latest generation of reliable and proven technologies.

13. Bute Energy want to positively contribute towards a thriving, healthy, wealthy Wales that is independently powered by renewable, sustainable, and decarbonising energy. Our mission is to deliver on this promise – by creating renewable energy projects that provide clean, affordable power whilst fostering local economic growth and social wellbeing. Bute Energy's parks across Wales will deliver 25% of the green energy that the Welsh Government says we need to get to Net Zero, playing a pivotal role in meeting their target for 100% renewable electricity in Wales by 2035.

14. Bute Energy Group is also committed to designing projects to a high standard, working within the framework of latest industry guidance, and following best practice as set out in the Welsh national spatial strategy - Future Wales.

Purpose of this document

15. This document provides an overview of the background and needs case for new grid infrastructure, as well as the process followed to identify a preferred solution to be delivered by Green GEN Cymru for the connection of the South Wales Energy Parks being promoted by Bute Energy to the National Electricity Transmission System (NETS). Green GEN Cymru's preferred option will be taken forward for further development, including the identification of potential corridor and route options to connect the South Wales Energy Parks to the NETS.

16. This document focuses on the connection infrastructure between the Bute Energy South Wales Energy Parks and a single connection point on the NETS, it does not examine the Energy Parks themselves. To do this, the 6 South Wales Energy Parks have been grouped into two clusters, an Eastern Cluster and Western Cluster and we have considered the potential infrastructure that would be required for their connections.

Background and Needs Case

17. In 2008, the Climate Change Act entered into force in UK law[1]. Section 1 of the 2008 Act, which was amended in 2019 when the UK Government declared a climate emergency, requires the Secretary of State to ensure that the net UK carbon account for 2050 is at least 100% lower than the 1990 baseline. This is often referred to as the net zero target. On 20 April 2021, the UK Government announced its commitment to reduce carbon emissions by 78% by 2035 compared to 1990 levels (including, for the first time, those from shipping and aviation). The new target was enshrined in law in June 2021. The 2008 Act also requires the Secretary of State to set at five-year intervals beginning in 2008, legally binding carbon budgets, which place a restriction on the total amount of greenhouse gases the UK can emit over those five-year periods. The underlying objective of these carbon budgets is to set a trajectory towards the achievement of the net zero target by 2050. The 6th carbon budget, which relates to the period 2033-2037, was made in 2021. The UK Government's October 2021 Net Zero Strategy sets out its policies and proposals for decarbonising all sectors of the UK economy in order to meet its net zero target by 2050[2].

18. The Environment (Wales) Act 2016 also requires the Welsh Government to reduce greenhouse gas emissions (GGEs) in Wales to net zero for the year 2050, with a system of interim emissions targets and carbon budgets[3]. In 2017 the Welsh Government set out a target that at least 70% of Wales' electricity consumption would be met from renewable generation by 2030.

19. In April 2019, the Welsh Government declared a climate emergency and set an ambitious target of net zero emissions no later than 2050. In March 2021, new legislation came into force in Wales, amending the 2050 emissions target[4] and the interim emissions targets[5]. As well as amending the 2050 emissions target to net zero, the 2030 target was increased from 45% to 63% below the 1990 baseline, and the 2040 target was increased from 67% to 89% below the 1990 baseline. The Welsh Government and Plaid Cymru have jointly invited an independent group to explore how the country can speed up its transition to net zero, and how amending its target to 2035 from 2050 could be made possible[6].

20. As part of its plan to tackle this emergency, the Welsh Government has brought forward policies to encourage innovative ways of creating energy that are sustainable, secure, and cost effective. This includes Future Wales and the 11th edition of Planning Policy Wales (PPW11)[7]. As part of these new policies, the Welsh Government has confirmed that 'in determining planning applications for renewable and low carbon energy development, decision makers must give significant weight to the need to meet Wales' international commitments and our target to generate 70% of consumed electricity by renewable means by 2030 in order to combat the climate emergency' (Future Wales, Policy 17). Future Wales Policy 17 also confirms that: 'The Welsh Government strongly supports the principle of developing renewable and low carbon energy from all technologies and at all scales to meet our future energy needs' and that 'New strategic grid infrastructure for the transmission and distribution of energy should

[1] Climate Change Act 2008 (legislation.gov.uk)
[2] Net Zero Strategy: Build Back Greener - GOV.UK (www.gov.uk)
[3] Environment (Wales) Act 2016 (legislation.gov.uk)
[4] The Environment (Wales) Act 2016 (Amendment of 2050 Emissions Target) Regulations 2021 (legislation.gov.uk)
[5] The Climate Change (Interim Emissions Targets) (Wales) (Amendment) Regulations 2021 (legislation.gov.uk)
[6] Wales Net Zero 2035
[7] Planning policy Wales | GOV.WALES

be designed to minimise visual impact on nearby communities. The Welsh Government will work with stakeholders, including National Grid and Distribution Network Operators, to transition to a multi-vector grid network and reduce the barriers to the implementation of new grid infrastructure'.

21. In October 2021, the Welsh Government published its second statutory decarbonisation plan (LCDP2) titled Net Zero Wales which sets out policies and proposals across all Ministerial portfolios. These policies include an ambition to install 1GW of additional renewable energy capacity by 2025 and to increase the delivery of renewable energy developments on land through the planning system through the positive policy framework provided by Future Wales.

22. Onshore wind development will play a critical role in assisting the Welsh Government to meet its renewable targets. Central to this are the Pre-assessed Areas for Wind Energy identified in Future Wales, which comprise those areas where the Welsh Government has already modelled the likely impact on the landscape and has found them to be capable of accommodating development in an acceptable way, subject to the criteria in Future Wales Policy 18. Future Wales Policy 17 confirms that 'there is a presumption in favour of large-scale wind energy development in these areas. Outside of these areas, Future Wales Policies 17 and 18 provide a positive policy framework for the consenting and development of large-scale renewable energy projects and associated infrastructure.

23. It has long been acknowledged by the Welsh Government, energy generators and network operators that a key challenge with respect to delivering Wales's net zero obligations is the fact that the strongest renewable resources are generally in areas that have the lowest existing electricity network capacity, meaning that key strategic opportunities for renewable energy generation are currently sterilised. Without intervention, this lack of grid infrastructure across Wales is likely to have a detrimental impact on achieving the UK Government and Welsh Government's net zero targets. Future Wales notes "The Welsh Government acknowledges the significant challenge that grid infrastructure and capacity will have on the potential for new on-shore and off-shore renewable energy development across Wales[8]" adding that the Welsh Government "are committed to working with energy networks and developers to identify opportunities and barriers as well as working collaboratively to find solutions". There is therefore a clearly identified national need for new renewable energy development and associated grid infrastructure in Wales.

24. The proposed Energy Parks, and associated connection infrastructure, provide a key opportunity to help to address the climate emergency in a timely manner by providing network connection capability for strategic renewable energy generation.

25. In addition to the Energy Parks that will be directly connected to the grid, Bute Energy is proposing to develop new Energy Parks that are geographically remote from existing high voltage (HV) electricity infrastructure.

26. The proposed Energy Parks, of which 6 are located in South Wales (referred to as the South Wales Energy Parks) and the options considered for connecting these Energy Parks to the NETS, including the rationale for the preferred option, are the subject of this document.

[8] Future Wales – the National Plan 2040, Section 4 - Strategic and Spatial Choices: Future Wales' spatial strategy, Policy 18 – Renewable and Low Carbon Energy Developments of National Significance, Page 99, Paragraph 4.

27. Operation of electricity infrastructure at 132kV within England and Wales is classified as 'Electricity distribution'. These assets are in the main owned and operated by Distribution Network Operators (DNOs). However, in order to increase competition in the electricity distribution market, Ofgem, as the GB energy regulator, now licences Independent Distribution Network Operators (IDNOs). IDNOs are able to develop, operate and maintain electricity distribution networks. IDNOs connect their networks onwards into the local distribution network or Transmission Network.

28. Now Green GEN Cymru has an IDNO Licence, and we are now able us to move forward with our plans to develop and construct the most appropriate and effective solution for connecting the new Energy Parks, ensuring the best solutions for the local area. It would also enable Green GEN Cymru to deliver efficient and reliable grid infrastructure in Wales, opening broader opportunities for connections in the future.

29. As with DNOs, an IDNO holds an electricity licence under Section 6(1)(c) of the Electricity Act 1989. DNO and IDNO Licences also share the same Standard Licence Conditions. This places specific requirements on an IDNO, including 'the development, maintenance, and operation of an efficient, co-ordinated, and economical system for the distribution of electricity.'

30. Green GEN Cymru are required to adhere to the provisions of the Electricity Act 1989, including Schedule 9, which confirms that the licensee 'shall have regard to the desirability of preserving natural beauty, of conserving flora, fauna and geological or physiographical features of special interest and of protecting sites, buildings and objects of architectural, historic or archaeological interest; and shall do what he reasonably can to mitigate any effect which the proposals would have on the natural beauty of the countryside or on any such flora, fauna, features, sites, buildings or objects.'

31. With oversight of the development of both the connection infrastructure promoted by Green GEN Cymru as well as the Energy Parks, Windward Energy Group will be able to ensure effective coordination between these two elements, enabling collaboration regarding technical and environmental considerations and delivering the most appropriate solution. As a Welsh-based company, and a IDNO Licence holder, Green GEN Cymru will be able to play a proactive role in the progression towards achieving Net Zero in Wales. Windward Energy Group will support the development of proposed Energy Parks and, through the proposed connection to the NETS promoted by Green GEN Cymru, will also be able to support the efficient and timely connection of future renewable energy project across Wales, demonstrating the benefits of the IDNO framework.

32. In Wales, the consenting of an overhead electric line that has a nominal voltage of 132kV or less and is associated with the construction or extension of a devolved Welsh generating station is a devolved matter under the Development of National Significance (DNS) consenting regime[9].

33. The purpose of the DNS consenting regime is to ensure timely decisions are made on those planning applications that are of the greatest significance to Wales, because of their potential benefits and impacts. DNS applications are submitted to Planning and Environment Decisions Wales (PEDW) who will appoint an Inspector to examine the application and determine the procedure to be followed. The appointed Inspector will consider evidence from the applicant, the Local Planning Authority(ies) (LPA)

[9] The Developments of National Significance (Specified Criteria and Prescribed Secondary Consents) (Wales) Regulations 2016 (legislation.gov.uk)

and other statutory consultees and interested parties and thereafter write a report to the Welsh Minister setting out recommendations for the Minister to consider in determining the application.

Planning Policy

Future Wales: The National Plan 2040 (February 2021)

34. Future Wales is the Welsh Government's National Development Framework and is the highest tier of the Development Plan in Wales. It states that *'as set out in legislation, applications for Developments of National Significance must be determined in accordance with Future Wales.'*

35. As the most recent expression of national planning policy, Future Wales is considered to have primacy in the planning policy hierarchy. Its purpose is to ensure the planning system at all levels is consistent with, and supports the delivery of, Welsh Government strategic aims and policies (including those in Planning Policy Wales, the Wales Infrastructure Investment Plan and Regional Economic Frameworks). It was prepared with regard to various Welsh Government policies and legislation, including:

- Well-being of Future Generations (Wales) Act 2015;
- Environment (Wales) Act 2016;
- Prosperity for All: A Low Carbon Wales (March 2019);
- Policy Statement: Local ownership of energy generation in Wales – benefitting Wales today and for future generations (February 2020); and
- Future Energy Grids for Wales (FEW) (June 2023).

36. Future Wales provides the spatial direction for development in Wales and the policy framework for SDPs and LDPs at the regional and local level. These plans are required to conform to Future Wales and planning decisions at every level must be taken in accordance with the Development Plan.

37. Future Wales states:

'Wales is abundant in opportunities to generate renewable energy and the Welsh Government is committed to maximising this potential. Generating renewable energy is a key part of our commitment to decarbonisation and tackling the climate emergency.'

'Wales can become a world leader in renewable energy technologies. Our wind and tidal resources, our potential for solar generation, our support for both large and community scaled projects and our commitment to ensuring the planning system provides a strong lead for renewable energy development, mean we are well placed to support the renewable sector, attract new investment, and reduce carbon emissions.'

38. Section 2 of Future Wales sets out how it has been informed by climate change issues, including projections showing an increased chance of milder more wet winters and hotter, drier summers, rising sea levels and an increase in the frequency and severity of extreme weather events. It further states:

'It is vital that we reduce our emissions to protect our own well-being and to demonstrate our global responsibility. Future Wales together with Planning Policy Wales will ensure the planning system focuses on delivering a decarbonised and resilient Wales through the places we create the energy we generate, the natural resources and materials we use and how we live and travel.'

Planning Policy Wales (Edition 12, February 2024)

39. The Welsh Government published Planning Policy Wales Edition 12 (PPW) in February 2024[10]. PPW provides the key principles for the planning system in Wales, in terms of what development plans and decisions must achieve and how development should deliver the best possible outcomes. According to Future Wales, this is a material consideration in the planning process.

40. The primary objective of PPW is to ensure that the planning system contributes towards the delivery of sustainable development and improves the social, economic, environmental, and cultural well–being of Wales, as required by the Planning (Wales) Act 2015, the Well–being of Future Generations (Wales) Act 2015 and other key legislation.

41. Paragraph 3.61 of PPW States that "adequate and efficient infrastructure, including services such as education and health facilities along with transport, water supply, sewers, sustainable waste management, electricity, and gas (the utilities) and telecommunications, is crucial for economic, social, and environmental sustainability. It underpins economic competitiveness and opportunities for households and businesses to achieve socially and environmentally desirable ways of living and working."

42. Section 5.7 details the policy in relation to the electricity grid network, paragraphs 5.7.8 to 5.7.11 state that:

'An effective electricity grid network is required to fulfil the Welsh Government's renewable and low carbon ambitions. An integrated approach should be adopted towards planning for energy developments and additional electricity grid network infrastructure. In certain circumstances, additional electricity grid network infrastructure will be needed to support the Pre-Assessed Areas in Future Wales, but also new energy generating developments more generally.'

'The Welsh Government's preferred position on new power lines is that, where possible, they should be laid underground. However, it is recognised that a balanced view must be taken against costs which could render otherwise acceptable projects unviable. Where undergrounding of lines is not possible or applicable, proactive engagement with energy companies and the public to mitigate the visual impact of any potential new transmission lines should take place.'

'Planning authorities should plan positively for grid infrastructure. Development plans should facilitate the grid infrastructure required to support the renewable and low carbon energy potential for the area, particularly areas identified for such development. Planning authorities should support appropriate grid developments, whether or not the developments to be connected are located within their authority.'

'Planning authorities and the energy industry, including National Grid and Distribution System Operators, should engage with each other to ensure development plans take grid infrastructure issues into account. This can also ensure investment plans for transmission and distribution align with the identified potential for renewable and low carbon energy as well as the future challenges of increasing electrification of transport and heat.'

[10] Planning Policy Wales 12 (2024)

43. It is identified in PPW that a positive approach to grid infrastructure should be taken to support low carbon emissions. The proposals of Green GEN Cymru and Bute Energy would make a significant contribution to these ambitions by both unlocking and delivering the renewable energy potential in areas that are not currently serviced by sufficient grid infrastructure.

44. It is acknowledged that it is the preferred position of Welsh Government that new power lines should be placed underground where possible unless this could render otherwise acceptable projects unviable. This position has been considered within this report under the 'Considered Technologies' section.

National Policy Statements

45. Should the connection be brought forward partly in Wales and partly in England, the project would be classed as an NSIP and would require a Development Consent Order (DCO). It is also worth noting that if the proposed grid connection wholly in Wales is over 132kV the application would fall outside the criteria for a DNS and a DCO would be required. In these cases, the National Policy Statements would provide the policy framework for decision making.

46. The relevant NPSs are:

- Overarching National Policy Statement for Energy (EN-1)10
- National Policy Statement for Electricity Networks Infrastructure (EN-5)11

47. In 2020 the UK Government released the Energy White Paper 'Powering our net zero future'. In response to this a series of revised NPSs were produced as drafts and consulted on between September and November 2021. Since then, the UK Government has published two further documents including the Net Zero Strategy: Build Back Greener (published October 2021) and the British Energy Security Strategy (BESS) (published April 2022). In response to these the 2021 draft NPSs have been further amended, the new draft NPSs were issued for consultation in March 2023. Consultation on the draft NPSs closed in May 2023.

48. The revised NSPs have now been published and are due to be formally designated in early 2024. They have been strengthened to make clear that the planning system must treat low carbon energy infrastructure as a Critical National Priority. The updated NPSs outline a commitment from the UK Government to accelerate the co-ordination of the development of the grid network to facilitate the UK's net zero energy generation development and transmission.

49. NPS EN-1 sets out the need for new nationally significant infrastructure to achieve energy security and reduce greenhouse gas emissions. The policy statement identifies the need for more electricity capacity to meet future demand and support an increased supply from renewable sources.[11]

50. Section 3.7 of EN-1 highlights that new electricity infrastructure will be required in places where there is no existing network infrastructure, as is the case in the locations of a number of energy parks proposed across Wales.

51. EN-1 also sets out detailed polices in relation to topics such as air quality and emissions, biodiversity, dust and odour, flood risk, historic environment, landscape and visual, land use, noise, and vibration, socio-economic, traffic and transport and waste management.

[11] Overarching National Policy for Energy (EN-1) (November 2023)

52. NPS EN-5 covers above ground electricity lines, with voltages that are expected to be 132kV or above. EN-5 sets out the factors that should be taken into account during site/route selection and the potential impacts that are specific to electricity networks infrastructure.[12]

53. Paragraph 2.2.10 of EN-5 states that "As well as having duties under Section 9 of the Electricity Act 1989, (in relation to developing and maintaining an economical and efficient network), applicants must take into account Schedule 9 to the Electricity Act 1989, which places a duty on all transmission and distribution licence holders, in formulating proposals for new electricity networks infrastructure, to "have regard to the desirability of preserving natural beauty, of conserving flora, fauna and geological or physiographical features of special interest and of protecting sites, buildings and objects of architectural, historic or archaeological interest; and …do what [they] reasonably can to mitigate any effect which the proposals would have on the natural beauty of the countryside or on any such flora, fauna, features, sites, buildings or objects."

[12] National Policy Statement for Electricity Networks Infrastructure (EN-5) (November 2023)

Project Overview

Proposed Energy Parks

54. Green GEN Cymru is a subsidiary of Bute Energy but will be a licensed Independent Distribution Network Operator. Green GEN Cymru will establish connection agreements with Bute Energy to link its Energy Parks (EPs) in South Wales. The primary objective has been to determine the optimal infrastructure for establishing a connection to Bute Energy's proposed EPs in South Wales. The South Wales EPs have been grouped into two clusters, an Eastern Cluster which consists of four energy parks (Nant Mithil, Bryn Gilwern, Aberedw, and Garreg Fawr); and the Western Cluster which consists of two energy parks (Lan Fawr and Nant Ceiment).

55. The South Wales Energy Parks have a total contracted generation capacity (known as Transmission Entry Capacity - TEC) of 859MW. The proposed locations of these Energy Parks are shown in Figure 1, with the individual capacities for each of the parks then described in Table 1.

Figure 1 - Location of Bute Energy's proposed South Wales Energy Parks

Energy Park	TEC (MW)
Nant Mithil	205
Bryn Gilwern	84
Aberedw	108
Garreg Fawr	112
Lan Fawr	264
Nant Ceiment	86

Table 1 – Individual capacities of Bute Energy's South Wales Energy Parks

Connecting the Energy Parks

56. New energy generation projects, such as the proposed South Wales Energy Parks, can connect to either the Transmission Network (the higher voltage network owned and operated by National Grid Electricity Transmission, NGET, in Wales) or the local lower voltage distribution network (now also owned and operated by National Grid in south Wales, through its National Grid Electricity Distribution, NGED, business). Connecting to one of these networks is necessary to allow our power to be transported to the National Grid, and ultimately through to homes and Businesses. In North Wales, SP Energy Network operate, which transmit, distribute, and connect electricity throughout Central and Southern Scotland, North Wales, Merseyside, Cheshire, and North Shropshire

57. Bute Energy's site selection strategy for the South Wales Energy Parks was based upon looking for opportunities to acquire sites predominantly within or in proximity to Pre-assessed Areas for Wind Energy identified in Future Wales. We've also identified some sites outside the Pre-assessed Areas for wind as identified in Future Wales. The presumption in favour of large-scale renewable energy development in these areas would support the efficient and timely development of the South Wales Energy Parks, maximising value for money for energy consumers. However, the majority of these pre-assessed areas are geographically distant from the limited existing grid infrastructure within Wales (see figure 2 below).

58. Typically, smaller capacity projects (e.g. <100MW) connect to the distribution networks, with larger capacity projects connecting to the Transmission Network. This is because the lower operating voltage of the distribution networks means their circuits cannot carry the same levels of power as the higher voltage Transmission Network. For clarity, circuits are the wires that connect different points on the electricity network together, allowing power to be transported from generators to peoples' homes and businesses. There are several different technologies that could be used for new circuits, which are described within the 'Considered Technologies' Section of this document.

59. The existing lower voltage (mainly 11kV, 33kV and some 66kV) electricity distribution network is not capable of transporting the quantity of power that the Energy Parks will be generating in an economic or efficient manner. The most appropriate distribution voltage capable of transporting electricity generated by the Energy Parks is at 132kV, as at this voltage it strikes the balance between electrical distribution capacity and visual impact of required infrastructure. There is currently a lack of existing 132kV grid connections in the vicinity of the proposed Energy Parks. While it is technically feasible for the Energy Parks to connect into an existing 132kV substation, following meetings with NGED and SPEN it is understood that there is insufficient capacity on the existing DNO (132kV, 66kV and 33kV)

network to accommodate the power proposed to be generated, hence the need for new distribution infrastructure being proposed by Green GEN Cymru.

60. Amongst the proposed South Wales Energy Parks, 5 exceed 100MW TEC, and Nant Ceiment has a TEC of approximately 80MW. This, combined with the lack of capacity within existing neighbouring 132kV infrastructure, means there is a requirement for those parks to connect to the Transmission Network.

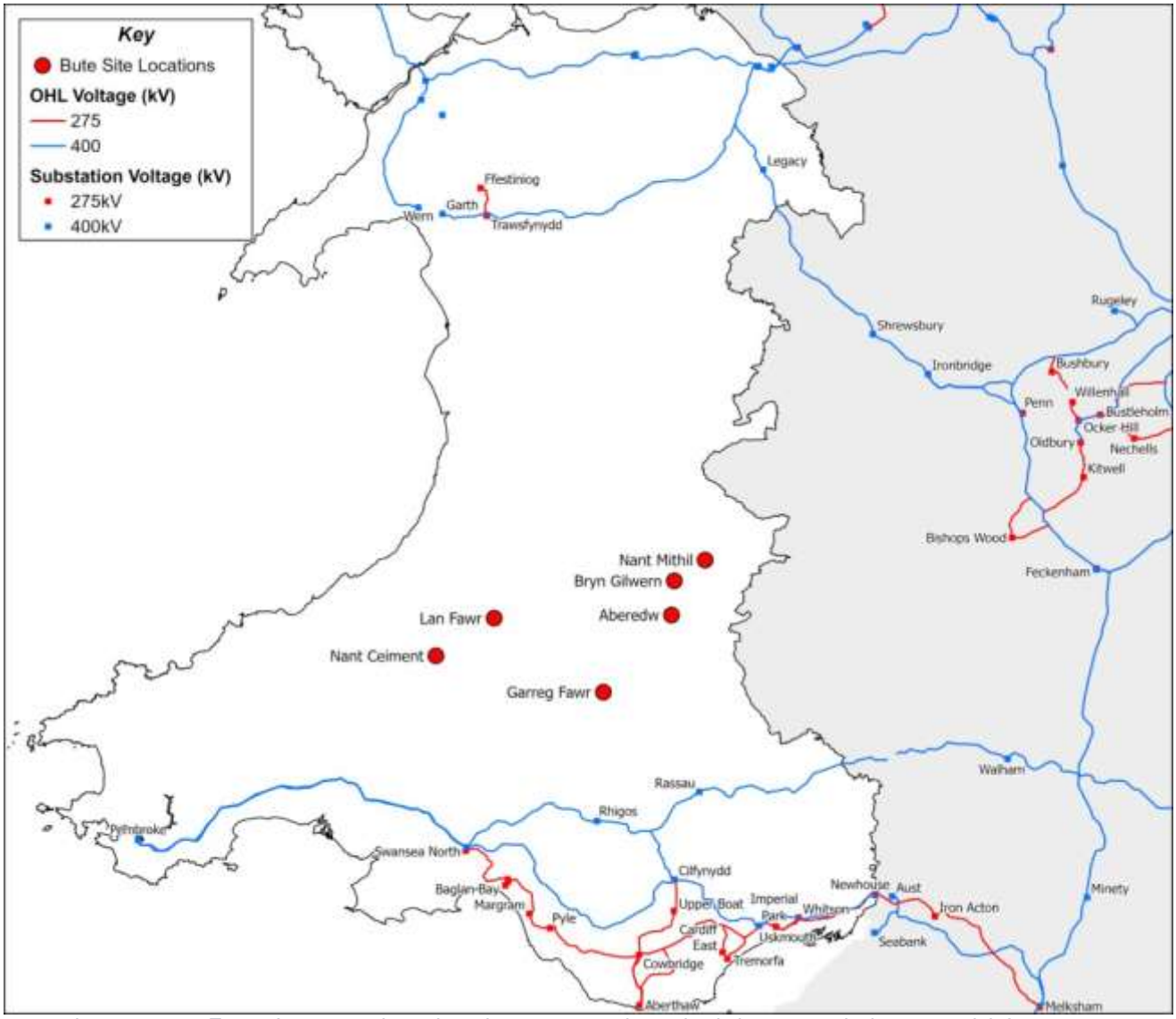

Figure 2 - Bute Energy's proposed South Wales Energy Parks and existing Transmission Network infrastructure

61. Figure 2 shows that the Bute Energy proposed Energy Parks are geographically distant from the existing Transmission Network.

62. Individual connections to the distribution and/or Transmission Network from each of the South Wales Energy Parks would multiply environmental and community impacts. This, combined with the obligation to develop and operate our network in an economic, efficient, and coordinated manner mean that the approach taken has been to consider the combined capacity of the South Wales Energy Parks as whole (c. 921.5MW) and the desirability of connecting those Energy Parks via shared circuits before

connecting to the wider electricity network. At that level of power, connections to the Transmission Network are necessary.

63. As such, the need for new electricity connections between the proposed South Wales Energy Parks into the Transmission Network through either an existing or new transmission substation, via shared infrastructure corridors, was identified.

64. Green GEN Cymru are therefore proposing 132kV connections from our Energy Parks to the NETS as these connections would provide sufficient capacity to accommodate the power generated at the Energy Parks and also to provide flexibility for future connections (by Bute Energy or others) in circumstances where it would be economic and efficient to do so.

Considered Technologies

65. Prior to undertaking an assessment of the identified feasible options for the connections, we firstly considered the technologies that would be available to Green GEN Cymru to deliver the connections. This section explains the technology options considered to connect the South Wales Energy Parks to the Transmission Network and how these technologies may be used to deliver the solution.

66. There are a number of different technologies that could be utilised for the new connections required to transport the electricity from the South Wales Energy Parks to a Connection Substation on the NETS. These are:

- Gas Insulated Lines (GIL)
- Direct Current (DC) solutions
- Alternating Current (AC) underground cables and overhead lines (OHLs)

67. The electricity network in Great Britain predominantly operates using an AC system (although DC connections are used in instances where power is transported over extremely long distances), the majority of which is made up of AC overhead line (OHL) circuits. For each of the proposed solutions discussed within this report, due to the required capacity, the majority of the route would need to consist of two circuits, each likely to contain two conductors per phase.

Gas Insulated Lines

68. GILs provide a means of burying high-voltage cables. GIL technology consists of a tubular aluminium conductor to carry the current, enclosed in a rigid metallic tube that is filled with an insulating gas. Due to this enclosure, GIL offers high safety and reliability, as well as low electrical losses. However, there are environmental concerns with GIL as the gas currently used in the insulating gas mixture, Sulphur Hexafluoride (SF6), is a potent ‘greenhouse gas’, and SF6-free solutions have not been developed to a sufficient level of maturity at this stage. In addition, the use of GIL technologies has been limited within the UK, with the majority of instances being within substations and of short lengths.

69. In addition, for a wholly GIL solution there could be increased impacts on local biodiversity when compared with alternative technologies attributable to excavating trenches and installing GIL technology. While excavations would naturally recover over time, additional significant excavation works could be required for on-going line maintenance.

70. Based on these factors, the use of GIL technology has been discounted at this stage and this has not been subject to further consideration as part of the appraisal of options undertaken.

Direct Current (DC) solutions

71. DC circuits are generally used when high volumes of power are required to be transported over very long distances, such as for the 420 km Western HVDC Link between Hunterston in Western Scotland and Flintshire Bridge in North Wales. DC circuits use converter stations to convert the power from AC to DC at one end of the circuit and then from DC back to AC at the other end. These converter stations use highly complex high voltage power electronics to achieve this conversion process; the cost involved would be in the region of £50m - 100m per converter station. It is anticipated that the potential cost of converter stations could make this option unviable compared to the cost of an AC solution.

72. In some cases, the reduced energy losses incurred in the DC circuits and better technical performance (compared to an AC equivalent) can compensate for the high costs of the converter stations, especially where power needs to transported over very long distances.

73. In addition to high costs, converter stations are large structures and could increase the visual and environmental impacts compared to AC alternatives where they are sited. Having regard to the distance between the proposed South Wales Energy Parks and the Transmission Network (detailed in the options section below), as well as the power capacity requirements being contemplated, DC solutions are not considered to represent a suitable technology for the proposed connection. It is also important to note that HVDC OHL is an unproven/unused technology in the UK and only HVDC UGC has been used to date.

74. Significant benefits from reduced energy losses would not materialise over the distances associated with the proposed connection. Therefore, the higher costs associated with DC solutions would not be justified. For these reasons, the use of DC technology has been discounted at this stage and this has not been subject to further consideration as part of the appraisal of options undertaken.

Alternating Current (AC) Underground Cables and Overhead Lines

75. The UK Transmission and Distribution systems typically use AC technology to transfer power around the nation from points of generation to homes and businesses. AC is an electric current which periodically reverses direction and changes its magnitude continuously with time. AC is the form in which electric power is delivered to businesses and residences, and it is the form of electrical energy that consumers typically use in homes and businesses.

76. OHLs are electricity lines that are supported above ground through the use of towers or poles. Underground cables (UGCs) offer an alternative to OHLs by installing the conductors underground but at a considerably higher cost. Therefore, in order to ensure that the proposals are economic and efficient in accordance with the Electricity Act duties of the IDNO holder, underground cable technology is generally only used in instances when an OHL could be technically unsuitable (e.g. in heavily built-up areas) or where the use of OHL is considered to give rise to significant environmental impacts. UGCs have different technical requirements and environmental considerations than those for an OHL. For example, UGCs have less visual impact, once installed, than OHLs but could have a potentially greater impact on ecological habitats and species and on archaeological remains, given the increased level of ground disturbance required during construction and maintenance. It is fully recognised that there are

specific circumstances in which the use of UGCs could be appropriate and this will be assessed on a project-by-project basis.

77. The estimated additional cost of placing a 132kV HV electrical connection underground could be approximately six to ten times the cost of an over-head connection. Since publication of an earlier iteration of this report, we have reviewed the latest available cost information, as can be seen in Table 3 below, and carried out further assessment of likely costings based on best available industry practice. The respective costings of each of OHL and UGC technologies will likely change and, potentially, both may increase throughout the lifetime of these proposals. We will regularly review the best available and up to date cost information as the projects develop further.

78. Green GEN Cymru has considered a wholly underground solution for the connections, and deemed this unsuitable as the additional cost would severely impact the viability of the proposals, take more years to build, increase ecological impacts during construction and not comply with our obligations to be economic and efficient. If, in certain circumstances, it is determined that a section of UGC is required instead of OHL, the approach would be to define the length of UGC necessary to overcome the constraint to OHL routeing, consistent with a balance between technical and economic viability, deliverability and environmental considerations. Accordingly, the starting point of development is that AC OHL technology would be proposed.

79. In addition to traditional UGC trench installation, a recent technology has emerged that utilises the process of cable ploughing. This approach enables the simultaneous installation of UGC, ducting, backfill, marker tiles, and warning tape without the need for extensive trenches. This can minimise disruption along cable sections by reducing ground disturbance and heavy equipment use. Cable ploughing can offer benefits, however the ground conditions and geology of the area needs to be suitable to be able to accommodate the process. Currently it is unclear what the what the cost savings would be against traditional UGC techniques but it's unlikely to be comparative to an OHL.

80. The ploughing method could enhance program efficiency but could introduce risks of weather-related downtime and unknown site-specific constraints (e.g. ground conditions), particularly in rocky or wet areas.

81. At this stage, Green GEN Cymru would assume the undergrounding of a 132kV overhead line within a designated landscape such as a National Park or National Landscape and this has been taken into account in the consideration of the connection options below. Consideration of undergrounding in other areas will be determined on a specific project basis and will be considered in subsequent stages of project development.

Supporting structures

82. There are a number of different structures available to support OHL conductors (wires) that can operate at 132kV. Single circuit structures are able to support the three wires in each circuit and these are typically of single or double wood pole design and are circa 14m in height. A range of conductors can be installed on single circuit wood pole structures, however in order to maintain a spacing of approximately 100m between the supporting structures, the realistic limit of power that can be transferred on wood poles at 132kV is approximately 200MVA.

83. There are also double circuit structures that are capable of supporting two circuits consisting of 6 or 12 wires. Double circuit structures operating at 132kV typically consist of steel lattice design (such as an L4 or L7) and are able to support larger conductors and are therefore able to distribute more power than the equivalent single circuits.

84. The standard height for an L7 tower is 27m, with the possibility of increments in height using 3m extensions and, on rare occasions, lowering the height as needed. This variability is determined by the topography, ensuring clearance from the terrain or other obstacles by altering the span length between towers which on average is 250m. The use of extensions is essential to maintain span lengths and minimise the need for additional towers. Steel lattice towers at 132kV offer the ability to support conductors with realistic limit of power distribution of 400MVA per circuit (or 800MVA per OHL route).

85. Larger standard steel lattice structures (such as an L8 design) are able to carry 132kV conductors, however these are much higher in height. L8 towers are normally used for 275kV and 400kV transmission connections.

86. Although lattice towers would be taller than using wood pole alternatives, standard wooden poles can only carry three wires meaning that three – four parallel sets of wooden poles could be required to hold the same number of wires that can be contained on one L7 tower. A substantial lateral separation distance between parallel wooden poles would need to be maintained for safety, which could materialise into a swathe width of approximately 75m. In most cases, wood poles can be spaced 100- 150m apart longitudinally. In contrast, L7 steel lattice towers are typically spaced 250m apart. This, alongside the lateral spacing requirements, could lead to greater impacts on the environment and greater restrictions on future land use.

87. Each structure type is intended for use in specific scenarios or conditions. Green GEN Cymru has sought to choose supporting structures that could enable the OHLs to distribute the required power generation from each of the South Wales Energy Parks in the most appropriate manner, balancing our obligations to develop an economic, efficient, and coordinated network.

88. Due to the combined generating capacity of the Energy Parks, the majority of the main OHL routes would need to consist of double circuits towers each containing 6 or 12 wires. It is assumed that steel lattice towers could be employed for the majority of the main OHL routes. However, the use of wood poles for carrying conductors will be considered where appropriate.

89. The use of steel lattice structures balances the need to transmit high levels of electricity while reducing the landscape and visual impacts in the locations they are installed through routeing and potential mitigation measures. Alternative steel or composite structures (such as T-pylon) have not been considered as they have not been designed for 132kV technology and / or will require significant time and investment to comply with electricity safety standards.

90. Nevertheless, where the conductor capacity is expected to be lower, for example when distributing the generated electricity from the smaller capacity South Wales Energy Parks, we expect to use a single 132kV circuit on either single or double wood pole structure.

Voltage level

91. We propose to distribute the electricity from the South Wales Energy Parks to the selected transmission connection point at a voltage of 132kV. If the Connection Circuits were to be proposed at a higher voltage level (>132kV), the infrastructure would be classified as transmission. This would mean that responsibility for designing and delivering the assets would lie with National Grid Electricity Transmission (NGET) as this scale of infrastructure is not deliverable by Green GEN Cymru under the IDNO Licence.

92. As the operating voltage of OHLs increases, the infrastructure becomes larger due to the increased electrical clearance needed between each circuit, from the ground, other structures, and from people to ensure safety. Figure 3 compares the heights of a typical 132kV tower (L7 model – left) and a typical tower for 275kV and 400kV voltages (L8 model – right), both towers in this case are designed to carry two circuits (each consisting of three phases).

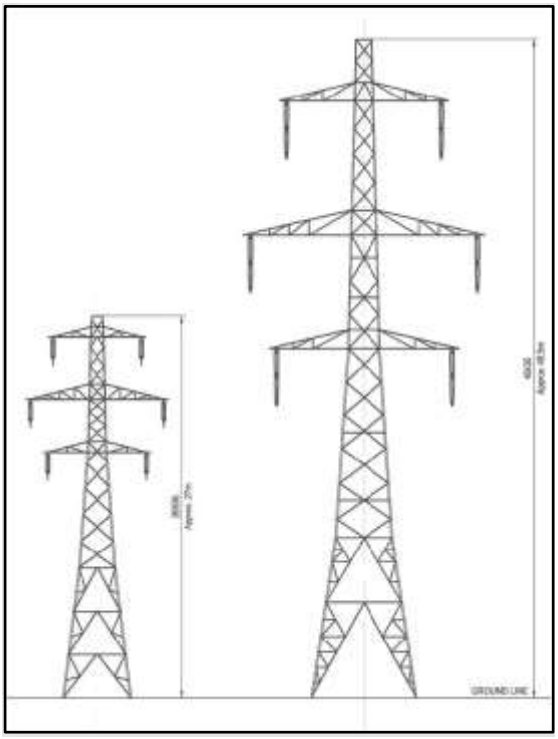

Figure 3 – L7 and L8 tower comparison [source: https://www.ssen-transmission.co.uk/media/2432/ssen-lairg-project-a4-12pp-web-hres.pdf]

93. The larger (height and width) L8 tower shown in figure 3 mean that it is capable of supporting conductors capable of operating at 400kV. Operating at 400kV enables much higher power transfer than 132kV and spacings between structures increase to typically 350m, meaning fewer are needed over the same distance.

94. The larger towers used for 400kV conductors require a larger footprint, as well as additional steel when compared to the L7 tower, used for 132kV conductors. The additional height and width of the L8 structures has a greater landscape and visual impact.

95. As circuits operating at 132kV would be sufficient to enable the full capacity of the South Wales Energy Parks to be transported to a Connection Substation with the existing NGET network, the development

of a transmission-level (400kV) network from the South Wales Energy Parks is not considered appropriate, having regard to the additional environmental impacts as it is not considered that the increase in additional capacity that a 400kV connection would provide is necessary at this time.

96. This, coupled with the fact that the 400kV towers and conductors would likely exacerbate environmental effects (particularly landscape and visual) and are not necessarily the most economical solution, means that 132kV towers strike the right balance in terms of deliverability, economics, likely environmental impacts, efficiency and would provide sufficient flexibility to deliver green energy to Wales in the short and longer term.

The Grid Connection Options

Methodology

97. Our appraisal process identified and compared the feasible options to provide the connections from our South Wales Energy Parks to the NETS. These options have then been developed and investigated to a level that enabled a comparative assessment to be undertaken. The appraisal included the following elements: consideration of different technologies, cost estimation, and desk-top investigation of options to identify key technical and environmental constraints.

98. A preferred connection option was selected on the basis of the comparative appraisal, which balances engineering constraints, economic viability, community impacts and the environment.

99. This document explains the assessment and decision-making process which has led to the selection of the preferred option to connect the South Wales Energy Parks to the Transmission Network. The following table identifies the key infrastructure that will be required to deliver the proposed new connection and explains the extent to which each element has informed the appraisal process:

Table 2 – Project infrastructure elements

Project Element	Description	Included in Scope?
Connection Substations	New or existing substations on the Transmission Network, owned by NGET, to which circuits would connect. These assets would be developed, delivered, and owned by NGET.	**YES** The potential for new and / or existing available connection points on the NGET network heavily influence our choice of options for our Connection Circuits and hence our decision making regarding these elements are described in this document.
Connection Circuits	The new circuits that would provide a connection between Energy Parks and the NETS. These assets would be developed, delivered, and owned by Green GEN Cymru.	**YES** These new circuits represent the largest element of the proposed connection and so formed a key focus of the appraisal undertaken
Collector Substations	The substations at which our individual Energy Park projects would be combined before being connected to the NGET Transmission Network via shared Connection Circuits. These assets would be developed, delivered, and owned by Green GEN Cymru.	**NO** The location of the Collector Substation would not be a differentiator in the decision of a preferred option due to the scale and ability to identify a suitable location.
Energy Parks	The individual Energy Park projects (see Table 1 and Figure 1). These assets would be developed, delivered, and owned by Bute Energy.	**NO** The individual Energy Parks will be the subject of a separate planning and development process and hence optioneering around these elements

Project Element	Description	Included in Scope?
		is not reported in this document. However, key factors such as the intended locations and capacities of the South Wales Energy Parks have informed the appraisal of options undertaken.

100. The initial stage of the optioneering was to identity feasible grid connection points (i.e. locations for Connection Substations), as well as the connection circuits required in each case. These grid connection points, including circuits were then compared. The identified options fell within three geographical zones, a North Zone, South-east Zone, and South-west Zone.

Assessment Framework

101. To support the evaluation, an assessment framework was put in place. This allowed us to compare the long list of identified feasible options in a consistent and fair manner.

102. Under Section 9(2) of the Electricity Act 1989, Green GEN Cymru, as an IDNO, are required to 'develop and maintain as efficient, co-ordinated and economical system of electricity'. Schedule 9 of the Electricity Act 1989 will impose a statutory duty on Green GEN Cymru to take account of the following factors in formulating proposals for the installation of overhead lines:

'(a) the desirability of preserving natural beauty, of conserving flora, fauna and geological or physiographical features of special interest and of protecting sites, buildings, and objects of architectural, historic, or archaeological interest; and,

(b) to do what it reasonably can to mitigate any effects which the proposals would have on the natural beauty of the countryside or any such flora, fauna, features, sites, buildings or objects.'

103. These duties and considerations were imperative in the development of the assessment framework that was utilised to undertake analysis of feasible options. We identified connection options which are, at a strategic level, economically and technically viable and, on balance, cause the least disturbance to the environment and the people who live, work, or enjoy recreation within it. This is of particular relevance for this proposed connection, where there are numerous nationally designated areas, for example the Bannau Brycheiniog National Park, within the vicinity of the proposed Energy Parks.

104. Our assessment was focused on the following key factors. It should be noted that there is no specific hierarchy or weighting applied to these factors:

- **Environmental:** we identified the environmental factors that differentiate options. At this stage of appraisal, this has principally been on the potential for the OHL to impact on:
    - Landscape areas that benefit from the highest level of protection (National Parks and National Landscapes);
    - Internationally designated ecological sites (e.g. SACs, SPAs and Ramsar sites);

- Cultural heritage features that benefit from the highest level of protection (e.g. World Heritage Sites).

- **Technical:** at this stage of our process, our technical appraisal focused on the technology available to deliver each option (outlined above), as well as further technical considerations for each solution, such as the expected electrical losses. For example, the greater the length of the electrical circuit, the greater the electrical losses would be. The 'Considered Technology' section provides further details on our technical appraisal.

- **Cost:** for each option considered, using an anticipated scope of works relevant for each option, we prepared an indicative capital cost estimate. This enabled us to undertake a high level cost comparison of each option, with a view to balancing the most economic and efficient option with other factors as required under the Standard License Conditions.

105. To inform our assessment of each of the options, we undertook an indicative cost assessment of the proposed solutions. This cost assessment took into account key assumptions that have been outlined above, such as the potential need for sections of undergrounding or OHL diversions.

106. Since the publication of an earlier iteration of this report, we have reviewed the latest available cost information, as can be seen in Table 3 below, and carried out further assessment of likely costings based on best available industry practice. The respective costings of each of OHL and UGC technologies will likely change and, potentially, both may increase throughout the lifetime of the project. We will regularly review the best available and up to date cost information as the projects develop further.

107. For the purposes of optioneering at this stage, the cost estimates are based on generalised unit costs for the main elements of each option, most notably, OHLs, underground cables and substation assets. This is considered sufficient at this stage, to allow us to develop an estimate for each option, and for this to inform a comparison of relative costs. Table 3 presents the unit costs that informed our assessment and comparison of options.

Cost category	Estimated unit cost
132kV Double circuit OHL	£1m/km
132kV Double circuit underground cable	£6.8m/km
Extension of existing substation	£10m
Development of new substation	£25m

Table 3 – Indicative unit costs

- **Deliverability:** for each option, we considered key factors in relation to the timely delivery of the proposed connection, such as the associated planning and consenting requirements, noting how these factors may impact on the expected completion date, and alignment with the commissioning of the proposed Energy Parks.

Initial Grid Connections Review

108. Prior to considering the options for our connection circuits it was necessary to understand where a connection to the NETS could feasibly be achieved from both the Western Cluster and Eastern Cluster of Energy Parks. Due to the generation output from the Energy Parks and the capacity of steel lattice OHL circuits operating at 132kV, it is proposed that two connections are developed – one connection to each cluster of Energy Parks.

109. Figure 4 shows the location of the South Wales Energy Parks and the NETS infrastructure in this area. Substations are represented by the named squares shown along the transmission circuit routes. In addition, Figure 4 shows the location of key sensitive areas such as National Park, National Landscapes, and other designations.

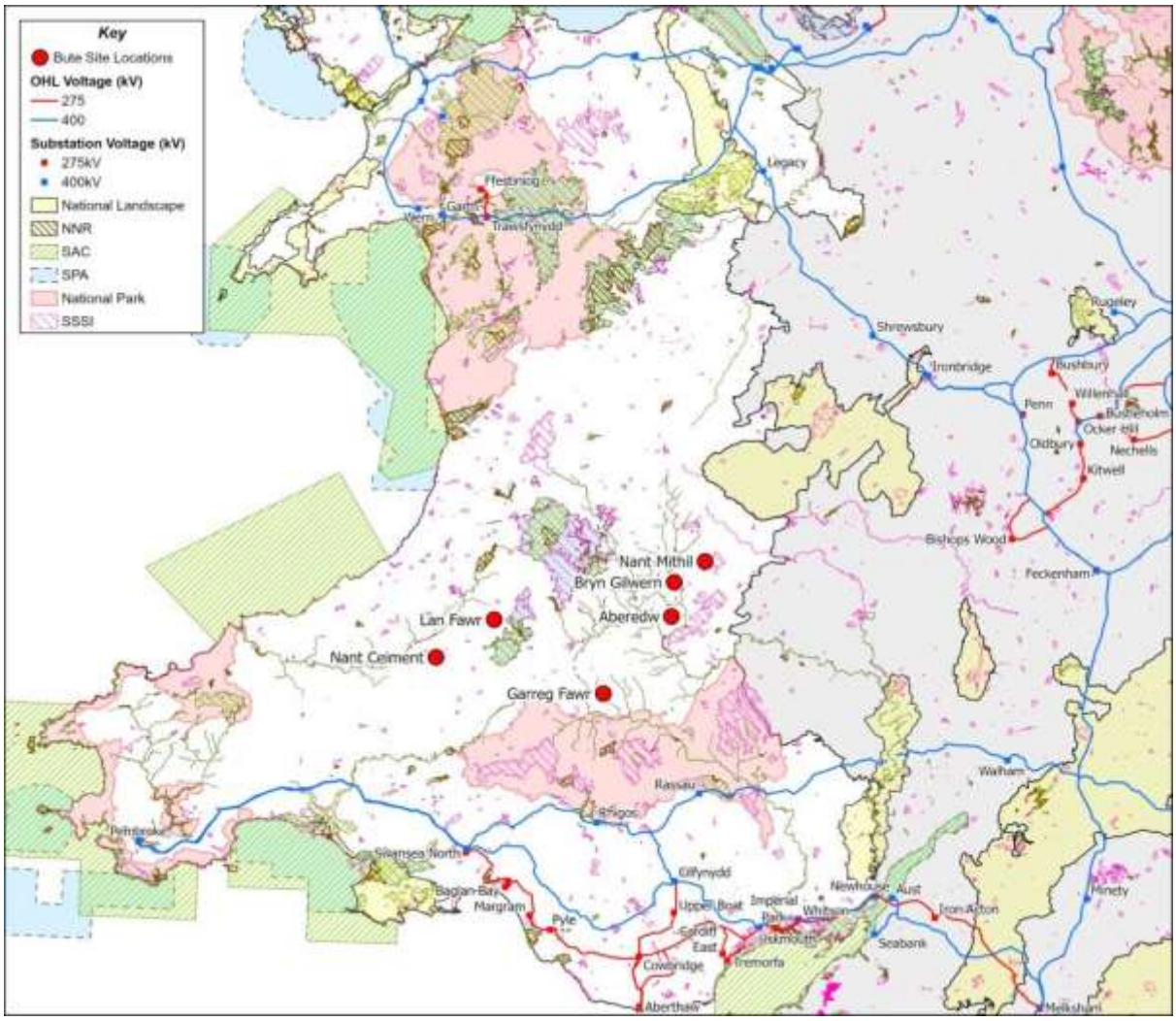

Figure 4 – Bute Energy's proposed South Wales Energy Parks, existing Transmission Network infrastructure and nationally designated areas.

110. Figure 4 demonstrates that the closest NGET transmission circuit routes are:

- to the south – the 400kV circuit that runs from Pembroke substation in the west to Walham substation in the east. On this southern transmission circuit, the closest existing NGET substations to the South Wales Energy Parks are Swansea North, Rhigos and Rassau; and

- to the north – the 400kV circuit that runs from Trawsfynydd substation in the west to Ironbridge substation in the east. On this northern transmission circuit, the closest existing NGET substations to the South Wales Energy Parks are Trawsfynydd, Shrewsbury and Ironbridge.

111. Following the identification of these areas, it was considered that there were 11 reasonable alternative options for a feasible connection from the South Wales Energy Parks, contained within three geographic 'zones'. In each zone a potential 'new substation' location was identified based on either shortest route length and / or ability to avoid nationally designated sites. These were and is shown in Figure 5 below:

North Zone

1. Trawsfynydd – Existing Substation
2. Shrewsbury – Existing Substation
3. Ironbridge – Existing Substation
4. Lower Frankton – New Substation

South-East Zone

5. Walham – Existing Substation
6. Rhigos – Existing Substation
7. Rassau – Existing Substation
8. Abergavenny – New Substation

South-West Zone

9. Swansea North – Existing Substation
10. Pembroke – Existing Substation
11. Carmarthen – New Substation

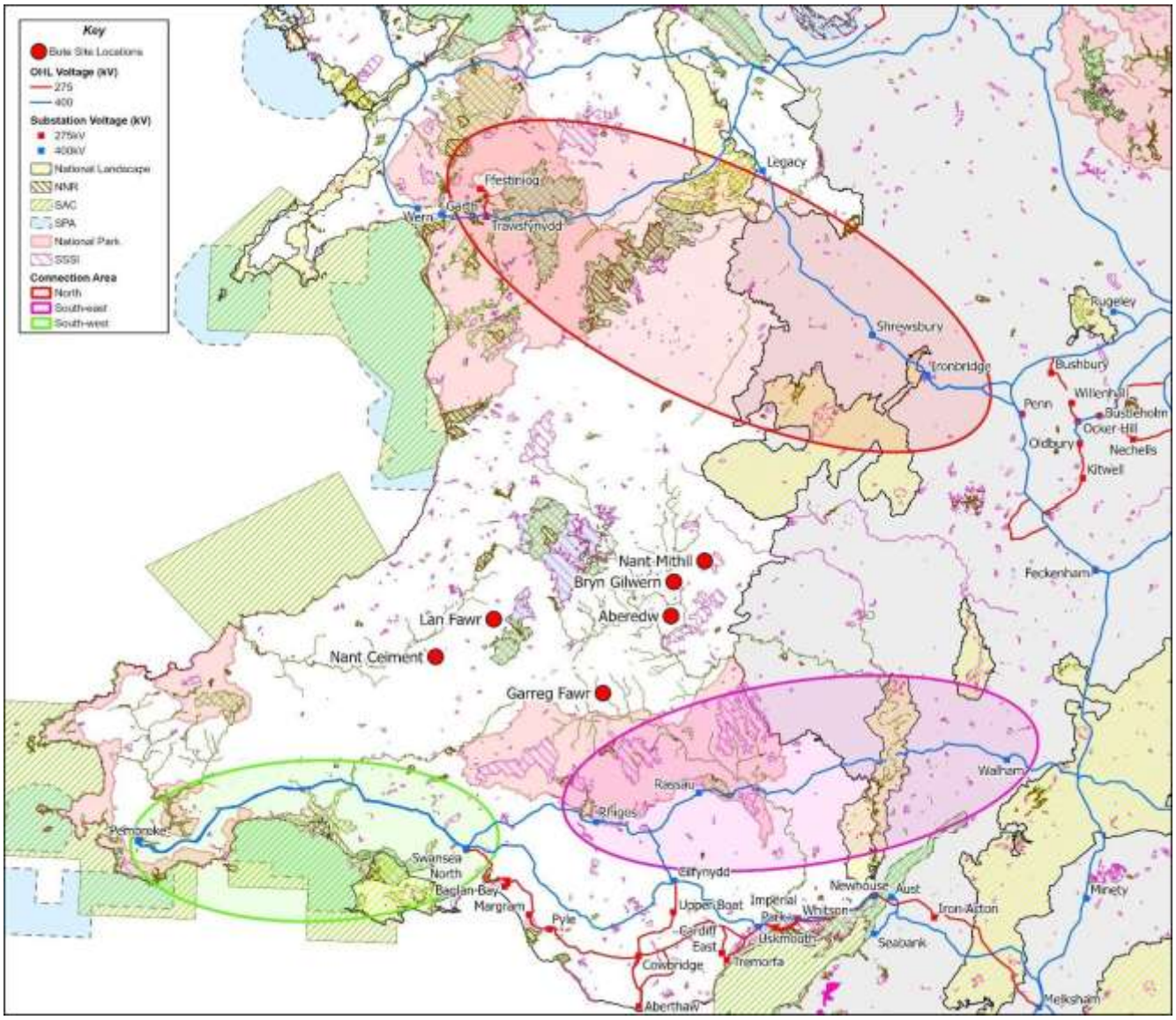

Figure 5 – The considered connection zones overlaid against nationally designated constraints.

112. Employing the assessment criteria explained earlier within this document, we considered the implications of connecting both the Western Cluster and Eastern Cluster of Energy Parks via separate routes into each of the 11 connection options. We considered connecting into the existing NGET substations within each zone, and where appropriate, into potential new substations.

113. A summary of each of the 11 connection options considered, including the potential distance of the proposed connection in each case[13] and an outline of the key anticipated environmental or technical constraints at this stage is provided below.

[13] The 'point-to-point' measurements used within this section refers to the total distance from the central point of the Western Cluster Energy Parks to the Connection Substation combined with the total distance from the central point of the Eastern Cluster of Energy Parks to the Connection Substation.

Options within the North Zone

Option 1 - Trawsfynydd (Existing Substation)

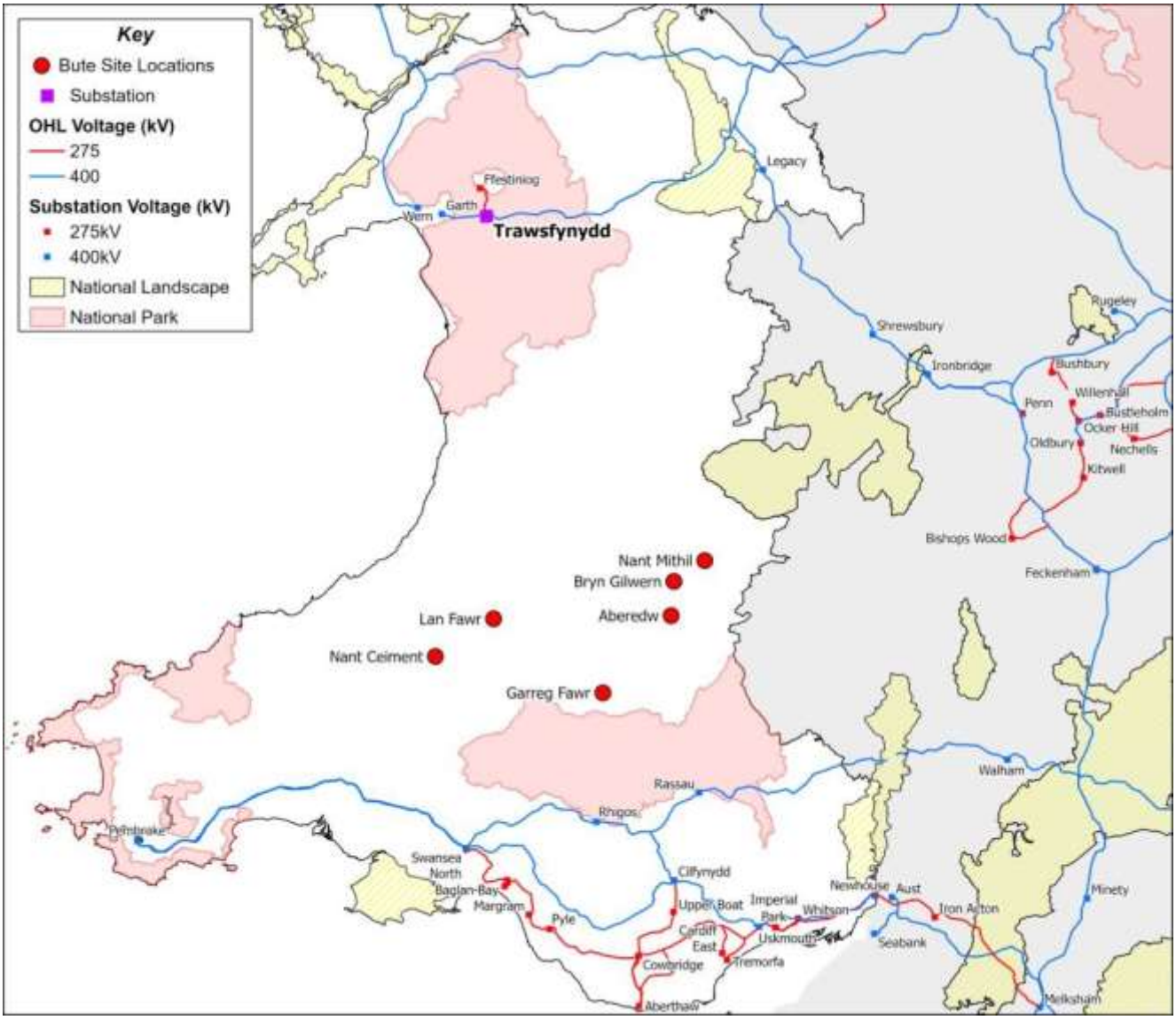

Figure 6 - Option 1 - Trawsfynydd (Existing Substation)

114. Trawsfynydd 400kV substation is located within Gwynedd, North Wales approximately 15 km east of the town of Porthmadog. There is a single 400kV circuit that connects Trawsfynydd to Pentir substation, near Bangor, as well as a double 400kV circuit from Trawsfynydd to Connah's Quay in the north-east and Shrewsbury, via Legacy, to the south-east. The Trawsfynydd substation is located within the Snowdonia National Park.

Technical Requirements

115. A direct point to point connection from the Eastern Cluster of Energy Parks to the Trawsfynydd substation would require approximately 90 km of OHL. A point-to-point connection from the Western

Cluster of Energy Parks would require approximately 80 km of OHL. The combined total anticipated direct connection length would be approximately 170 km.

116. From a technical perspective, this combined connection length could lead to significantly higher electrical losses compared to other options located closer to the South Wales Energy Parks. In addition to the increased length of the line, an extension to the existing Trawsfynydd substation (within the National Park) would be required for this connection option.

Environmental Considerations

117. A prospective connection into Eryri National Park would give rise to significant planning and environmental risks, given the great weight given to statutory purposes of a National Park in planning policy and the desirability of avoiding, where possible, development within National Parks. Within the National Park there are several SSSIs SACs and SPAs that the route would potentially have to pass through or would run adjacent to such as the Migneint-Arenig-Dduallt SSSI.

118. Assuming a new connection into the Trawsfynydd substation, it would be assumed that any connection infrastructure located in the Eryri National Park would need to be undergrounded. It is anticipated that for the connections from both the Eastern and Western Clusters of Energy Parks, this could be up to approximately 50km of underground cable out of the total 170 km combined connection length. This option could therefore lead to significant additional environmental impacts and costs. The Trawsfynydd substation is also screened from entry from the south by Ancient Woodland.

119. The length of the two combined lines also increases the number of environmental designations it would have to pass through or be diverted, with pockets of SSSIs and Ancient Woodland scattered throughout the potential routes. The Western cluster of EPs would have to be fed between Cors Caron National Nature Reserve, Ramsar site and SAC to the west and Elenydd Malaen – SPA to the right which would direct the route through particularly dense and frequent Ancient Woodland.

120. We have mentioned several environmental designations above, but we have listed below a number of key designations, that a proposed connection could also interact with, including (but not limited to):
    - Eryri - National Park and SAC
    - Llandeilo, Rhulen and Llanbedr Hills SSSI
    - Maelienydd SSSI
    - River Wye SSSI and SAC
    - River USK SSSI and SAC
    - Cwm Doethie - Mynydd Mallaen SSSI
    - Elenydd Malaen – SPA
    - Cors Caron National Nature Reserve, Ramsar site and SAC
    - Llyn Mawr SSSI
    - Migneint-Arenig-Dduallt SSSI, SAC and SPA
    - Afon Eden - Cors Goch Trawsfynydd SSSI and SAC
    - Meirionnydd Oakwoods and Bat Sites SAC
    - Dyfi Biosphere – Biosphere Reserve
    - Berwyn and South Clwyd Mountains – SAC
    - Berwyn – SPA
    - Plynlimon - SSSI

Cost Assumptions

121. Based on the anticipated point to point connection distance from the Eastern and Western Cluster of Energy Parks to the Trawsfynydd substation and the assumed mitigation required for undergrounding in the Eryri National Park, the following high level cost assumption has been applied to this option.

Substation	Direct point-to-point distance[14]	Mitigations required	Indicative cost estimate
Trawsfynydd	c.170 km	Undergrounding (approximately 50km) and substation extension	c. £470m

[14] The point-to-point distance covers the total distance from the Western Cluster Energy Parks to the substation, as well as from the Eastern Cluster Energy Parks to the substation.

Option 2 - Shrewsbury (Existing Substation)

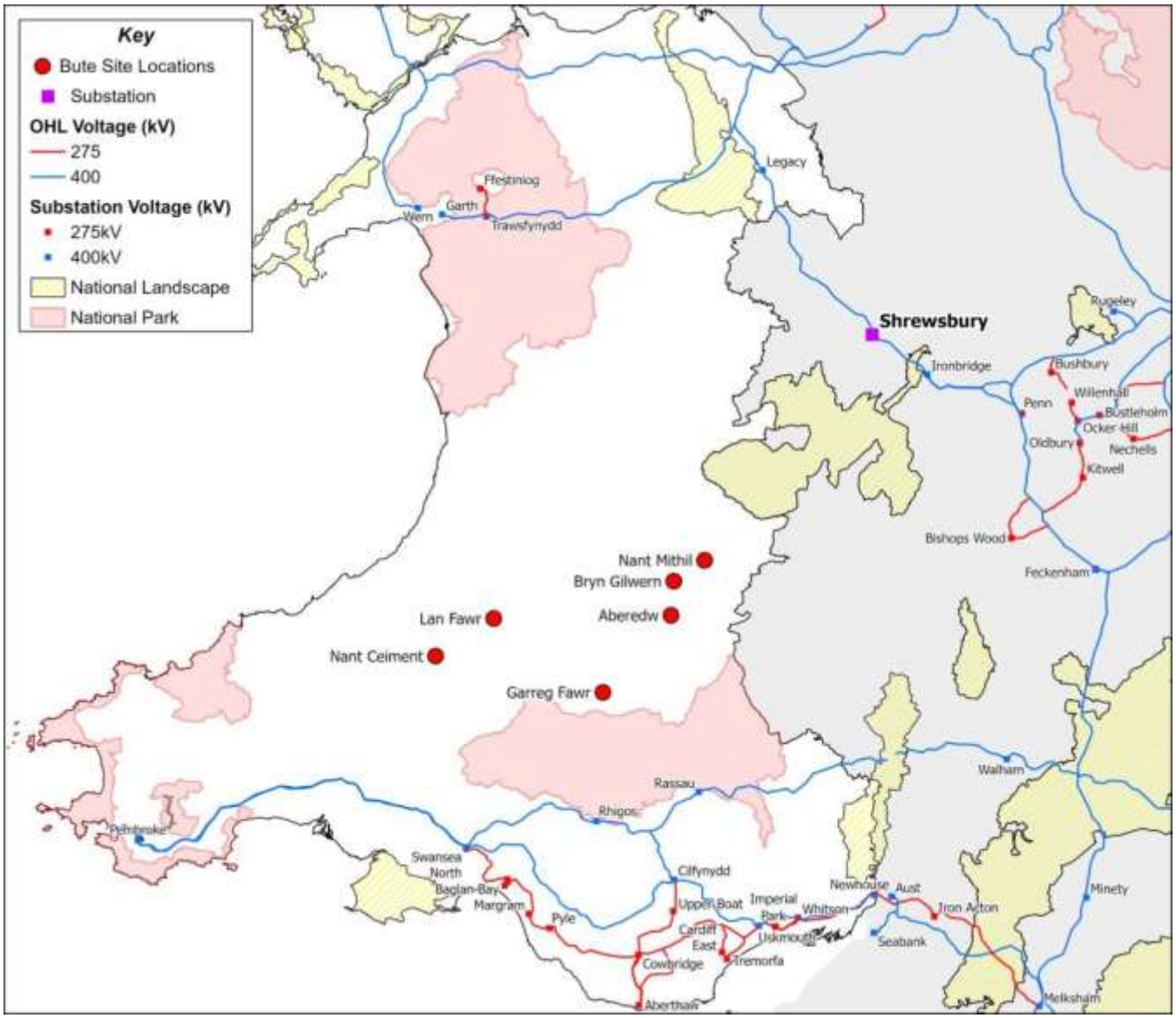

Figure 7 - Option 2 - Shrewsbury (Existing Substation)

122. Due to both Shrewsbury and Ironbridge 400kV substations being geographically proximate, these connection options are discussed together below.

Option 3 - Ironbridge (Existing Substation)

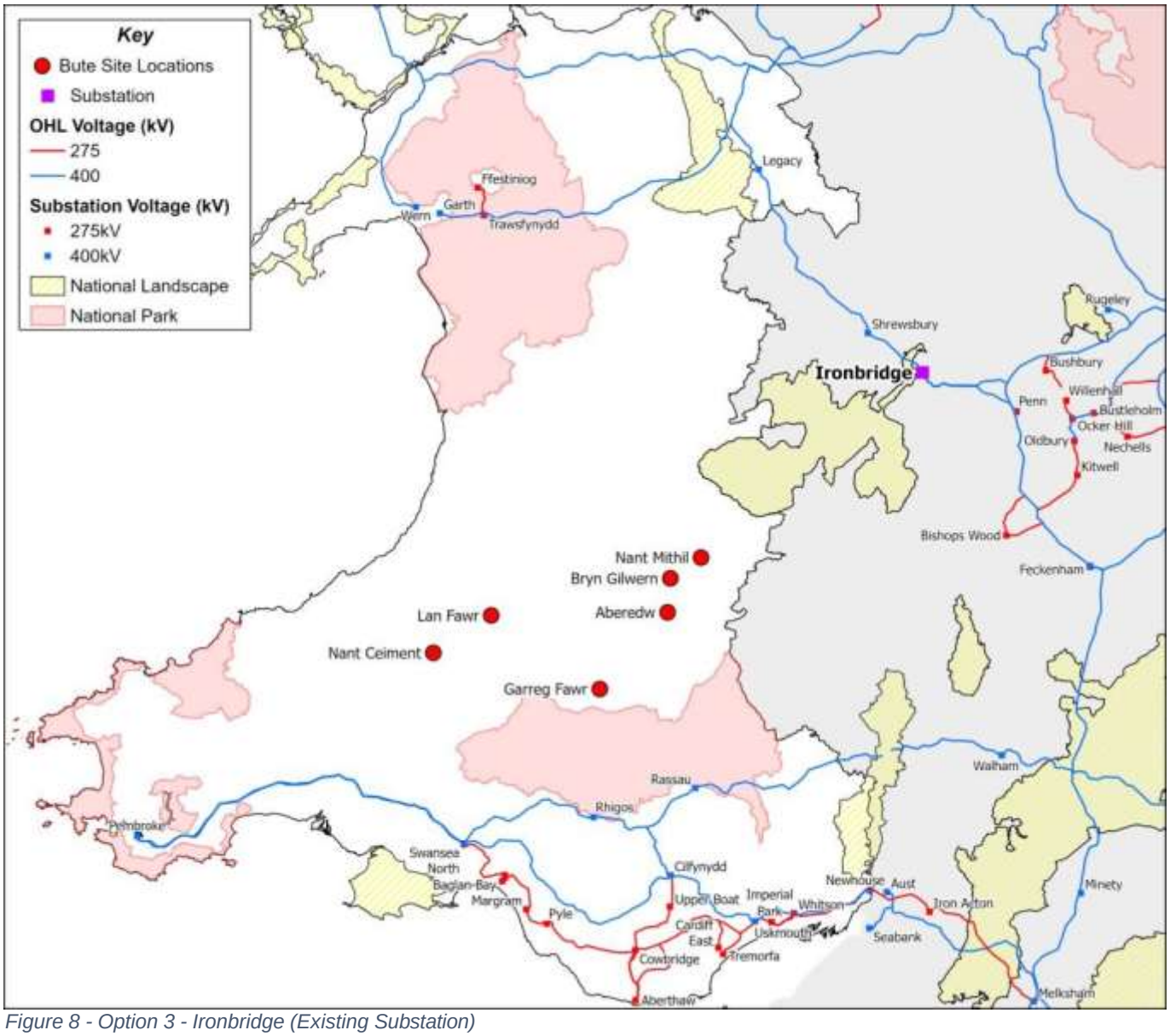

Figure 8 - Option 3 - Ironbridge (Existing Substation)

123. Shrewsbury 400kV substation is located within Shropshire, England approximately 4 km to the east of the town of Shrewsbury. Shrewsbury is connected via a double 400kV OHL to Trawsfynydd, Connah's Quay, and Legacy Substations to the northwest and Ironbridge 400kV in the east. Ironbridge 400kV substation is located approximately 6 km to the south of the town of Telford. Both Shrewsbury and Ironbridge substations are located in close proximity to the Shropshire Hills National Landscape.

Technical Requirements

124. A direct point to point connection from the Eastern Cluster of Energy Parks to either the Shrewsbury or Ironbridge substations would be approximately 75 km and 80 km, respectively. A direct connection from the Western Cluster of Energy Parks would be approximately 100 km and 110 km, respectively. The combined total anticipated connection length to Shrewsbury would be approximately 175 km and approximately 190 km to Ironbridge.

125. There would therefore be a significant combined distance between the proposed South Wales Energy Parks and both of these substations. From a technical perspective, this could lead to higher electrical losses compared to other options located closer to the Energy Parks.

126. An extension to the existing Shrewsbury or Ironbridge substations would be required for these connection options.

Environmental Considerations

127. Any Connection Circuit would need to minimise impacts on the Shropshire Hills National Landscape, as well as the Ironbridge Gorge UNESCO World Heritage Site, both of which are located a short distance from the existing connection substations and act as a barrier from the EPs to the potential connection points.

128. It is considered feasible that any connection from the Eastern or Western Cluster of Energy Parks could be routed without the requirement to traverse the Shropshire Hills National Landscape itself. This however would lead to the potential for significant route diversions of the connection in order to avoid potential direct impacts on this highly protected landscape. It is considered that to avoid direct impacts on the National Landscape, a connection from the Eastern Cluster to Shrewsbury would need to be approximately 85km and approximately 95km to Ironbridge. A connection from the Western Cluster could be subject to more significant routeing diversions, particularly for a connection to Ironbridge which is anticipated to require up to a 155km connection route to avoid directly impacting on the National Landscape.

129. Even considering any potential routeing diversions to avoid direct impacts, the connection could still possibly affect the setting of the Shropshire Hills National Landscape to reach the Connection Substations.

130. Ironbridge substation is particularly well shielded from any potential grid route from the EPs: Tick Wood and Benthall Edge SSSI and the Ironbridge Gorge UNESCO World Heritage Site shield it from the south; Shropshire Hills National Landscape from the west and north; and the outskirts of Telford screen it from any possibly grid route to the east.

131. Any connection from the Energy Parks would also need to be carefully routed in order to avoid potential impacts on a range of key environmental designations, including (but not limited to):

- Shropshire Hills National Landscape
- Tick Wood and Benthall Edge SSSI
- Montgomery Canal SSSI and SAC
- Ironbridge Gorge UNESCO Word Heritage Site
- Clarewen National Nature Reserve
- Elenydd SSSI and SPA
- Llandeilo, Rhulen and Llanbedr Hills SSSI
- Maelienydd SSSI
- River Wye SSSI and SAC
- River Usk SSSI and SAC
- Cwm Doethie - Mynydd Mallaen SSSI

- Elenydd Malaen – SPA
- Cors Caron National Nature Reserve, Ramsar site and SAC

132. The proximity of the two connection substations to the town of Shrewsbury is also noted. This could lead to the need for further OHL diversions and routeing challenges to avoid heavily populated areas as well as key infrastructure.

Cost Assumptions

133. Based on the anticipated point to point connection distance from the Eastern and Western Cluster of Energy Parks to the Shrewsbury or Ironbridge substations and the assumed mitigation required for routeing around the Shropshire Hills National Landscape, the following high level cost assumption has been applied to these options.

Substation	Direct point-to-point distance[15]	Mitigations required	Indicative cost estimate
Shrewsbury	c. 175 km	OHL routeing diversion (c. 10km) and substation extension	c. £195m
Ironbridge	c. 190 km	OHL routeing diversion (c. 60km) and substation extension	c. £260m

[15] The point-to-point distance covers the total distance from the Western Cluster Energy Parks to the substation, as well as from the Eastern Cluster Energy Parks to the substation.

Option 4 - Lower Frankton (New substation)

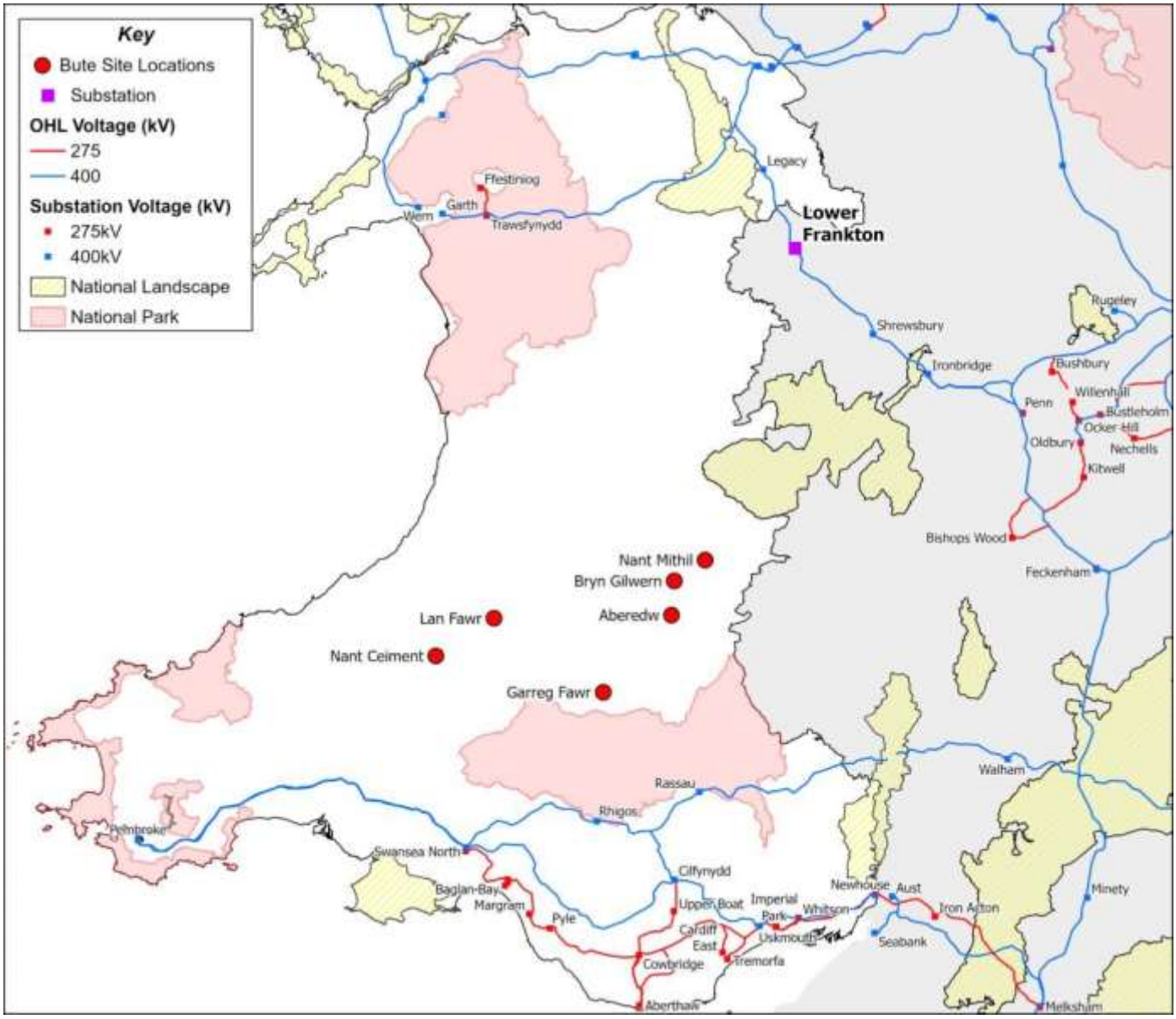

Figure 9 - Option 4 - Lower Frankton (New substation)

134. This option considers the possibility of connecting into a prospective new connection substation located in Shropshire. This is referred to as the new 'Lower Frankton' substation within this document as it could be located close to the village of Lower Frankton, England. It is approximately 8km north-east of the town of Oswestry, and approximately 13 km east of the Welsh-English border.

135. We have considered this new Lower Frankton substation as it would be located nearby to the existing transmission circuits between Ironbridge and Trawsfynydd, and it is not located within, or immediately adjacent to, Eryri National Park, Clwydian Range and Dee Valley National Landscape or the Shropshire Hills National Landscape.

Technical Requirements

136. A direct point to point connection from the Eastern Cluster of Energy Parks to a new substation at Lower Frankton would be approximately 85 km in length. A direct route from the Western Cluster of Energy Parks would be approximately 95 km. The combined total anticipated connection length would be approximately 180 km.

137. There would therefore be a significant combined distance between the proposed South Wales Energy Parks and this substation. From a technical perspective, this could lead to higher electrical losses compared to other options located closer to the Energy Parks.

Environmental Considerations

138. A direct route the new Lower Frankton substation from the Eastern and Western Clusters of Energy Parks may need to pass close to or through designated areas, such as the Montgomery Canal SSSI and SAC or the Llanymynech and Llynclys Hills SSSI.

139. It is also likely that the grid route would need to pass within close proximity to the western boundary of the Shropshire Hills National Landscape which could affect landscape viewpoints from within the National Landscape. In addition to the National Landscape, there are a number of winding water bodies some of which have SSSI status. To avoid affecting the setting of the Shropshire Hills National Landscape, a route to the west of Montgomery Canal SSSI and SAC could be taken. However, there is a high density of Ancient Woodland over a significantly wide area.

140. As similar for the previous route options, the Western cluster of EPs would have to be fed between Cors Caron National Nature Reserve, Ramsar site and SAC to the west and Elenydd Malaen – SPA to the right which would direct the route through particularly dense and frequent Ancient Woodland. Any connection from the Energy Parks would also need to be carefully routed in order to avoid potential impacts on a range of key environmental designations, including (but not limited to):

- Shropshire Hills National Landscape
- Montgomery Canal SSSI and SAC
- Llanymynech and Llynclys Hills SSSI
- Llyn Mawr SSSI
- Trefonen Marshes SSSI
- Clarewen National Nature Reserve
- Elenydd SSSI and SPA
- Llandeilo, Rhulen and Llanbedr Hills SSSI
- Maelienydd SSSI
- River Wye SSSI and SAC
- River USK SSSI and SAC
- Cwm Doethie - Mynydd Mallaen SSSI
- Elenydd Malaen – SPA
- Cors Caron National Nature Reserve, Ramsar site and SAC

141. All options involving a new connection substation would involve a degree of environmental impact, additional cost, and deliverability risk, when compared to connecting into an existing NGET substation.

Cost Assumptions

142. Based on the anticipated point to point connection distance from the Eastern and Western Cluster of Energy Parks to a new potential substation at Lower Frankton, including the potential for OHL routeing around sensitive designations and the development of a new substation, the following high level cost assumption has been applied to this option.

Substation	Direct point-to-point distance[16]	Mitigations required	Indicative cost estimate
Lower Frankton	c. 180 km	OHL routeing diversion (c.5 km) and new substation	c. £210m

[16] The point-to-point distance covers the total distance from the Western Cluster Energy Parks to the substation, as well as from the Eastern Cluster Energy Parks to the substation.

Options within in the South-East Zone

Option 5 - Walham (Existing Substation)

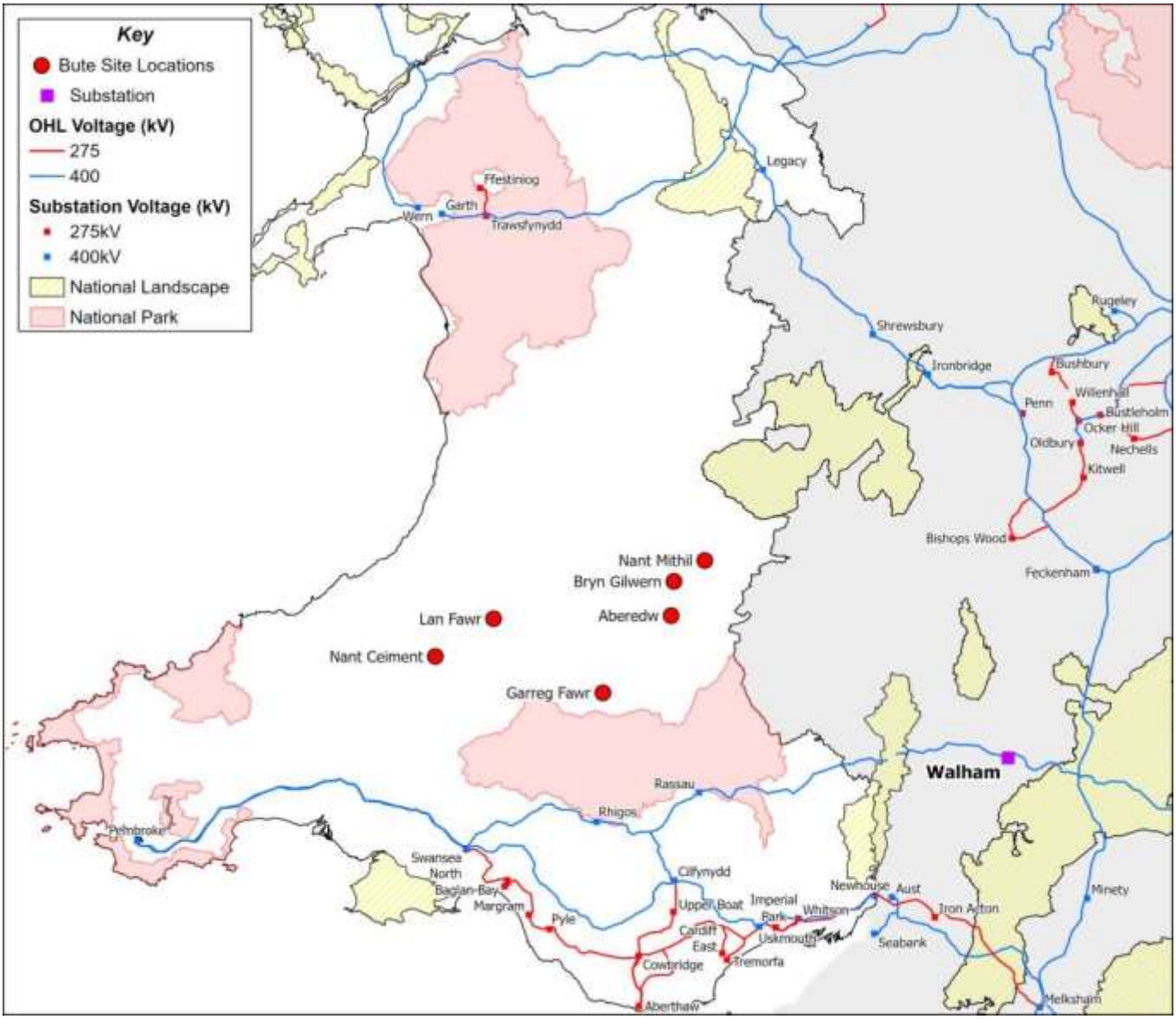

Figure 10 - Option 5 - Walham (Existing Substation)

143. Walham 400kV substation is located within Gloucestershire, England to the north of the town of Gloucester. There is a double 400kV circuit that connects eastwards from Rhigos to Walham.

Technical Requirements

144. A direct point to point connection from the Eastern Cluster of Energy Parks to the Walham substation would require approximately 85 km of infrastructure. A direct connection from the Western Cluster would be approximately 120 km in length. The combined total anticipated length of connections would be approximately 205 km.

145. There would therefore be a significant combined distance between the proposed South Wales Energy Parks and this substation. From a technical perspective, this could lead to higher electrical losses compared to other options located closer to the Energy Parks and would also increase the amount of land affected by the pylons and grid route. An extension to the existing Walham substation would be required for this connection option.

Environmental Considerations

146. A connection to Walham substation from the Eastern Cluster and Western Cluster of Energy Parks would need to be sensitively routed to avoid direct impacts on both the Wye Valley and Malvern Hills National Landscapes. It is considered feasible that a connection could be routed to avoid interacting directly with these designations, however this would require diverting the routes by approximately 10 km for the Eastern Cluster and 30 km from the Western Cluster. These diversions would lead to additional cost and impacts on more land and environmental receptors.

147. Due to the relatively narrow gap between the two National Landscapes (approximately 10 km), it is considered that any route through here could potentially lead to impacts on the settings of the designations. Careful routeing would be required in view of the proximity of River Lugg SSSI, Hill Woods SSSI and Wellington Woods SSSI. Through the National Landscape pinch point, there are several more SSSIs that will need to be avoided and the entry to Walham substation could pose issues due to the River Severn and a couple of tributaries congregating to the north west of the substation.

148. Another key environmental constraint for both of the EP clusters would be the River Wye which is a SAC and SSSI in parts. All routes would have to cross the River whilst trying to limit any impact on the river itself or the surrounding vista.

149. In addition to the potential impacts on these protected landscapes, the connections would need to be routed sensitively to reduce potential impacts on a number of key designations, including (but not limited to):

- Wye Valley National Landscape
- Malvern Hills National Landscape
- River Lugg SSSI
- Hill Woods SSSI
- Wellington Woods SSSI
- River Wye SSSI and SAC
- River USK SSSI and SAC
- Elenydd SSSI and SPA
- Llandeilo, Rhulen and Llanbedr Hills SSSI
- Maelienydd SSSI
- Cwm Doethie - Mynydd Mallaen SSSI
- Elenydd Malaen – SPA

Cost Assumptions

150. Based on the anticipated point to point connection distance from the Eastern and Western Cluster of Energy Parks to the Walham substation, including the potential OHL routeing around sensitive designations, the following high level cost assumption has been applied to this option.

Substation	Direct point-to-point distance[17]	Mitigations required	Indicative cost estimate
Walham	c. 205 km	OHL routeing diversions (c. 40 km) and substation extension	c. £255m

[17] The point-to-point distance covers the total distance from the Western Cluster Energy Parks to the substation, as well as from the Eastern Cluster Energy Parks to the substation.

Option 6 - Rhigos (Existing Substation)

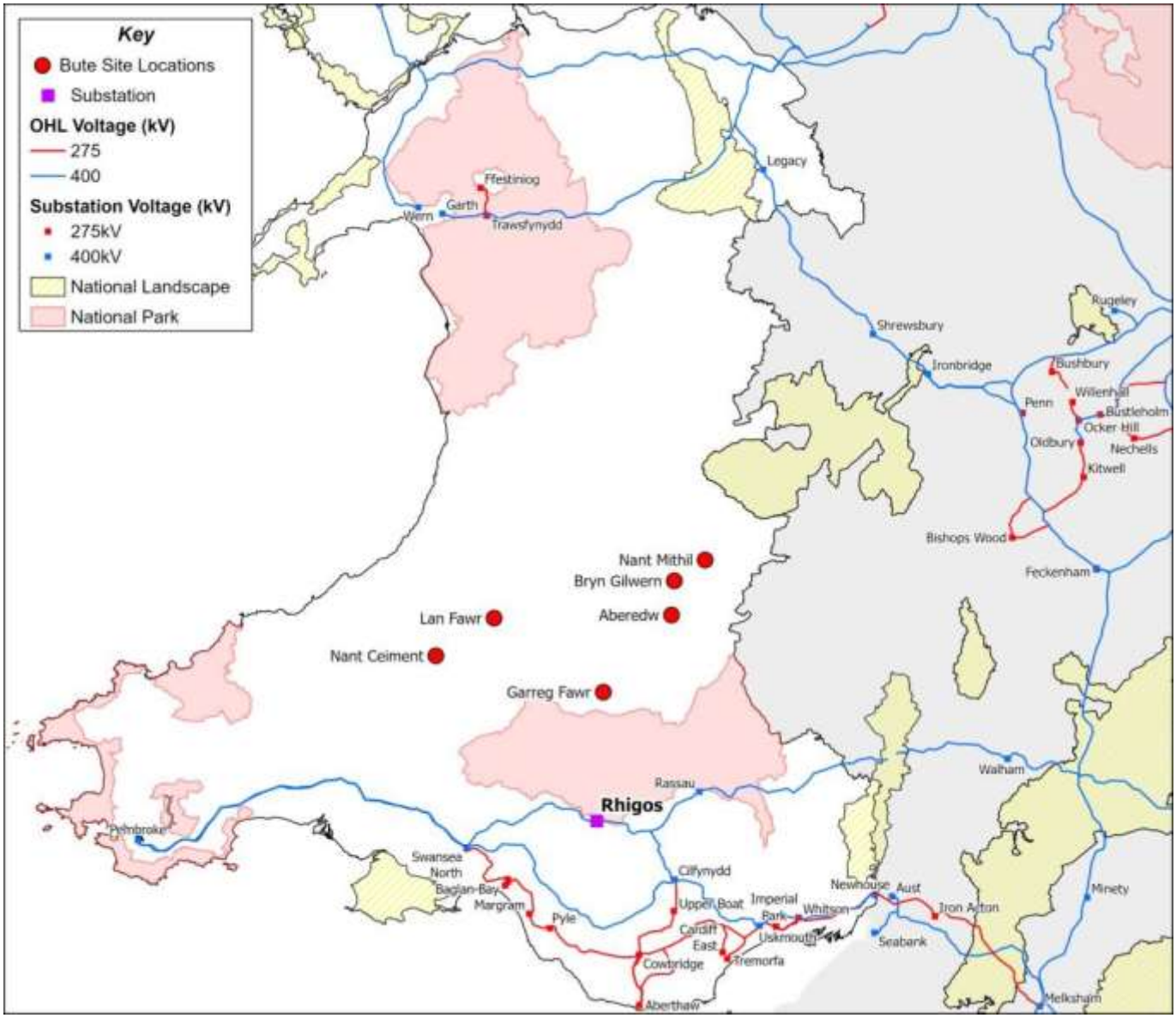

Figure 11 - Option 6 - Rhigos (Existing Substation)

151. Due to both Rhigos and Rassau 400kV substations being geographically proximate, these connection options are discussed together below.

Option 7 - Rassau (Existing Substation)

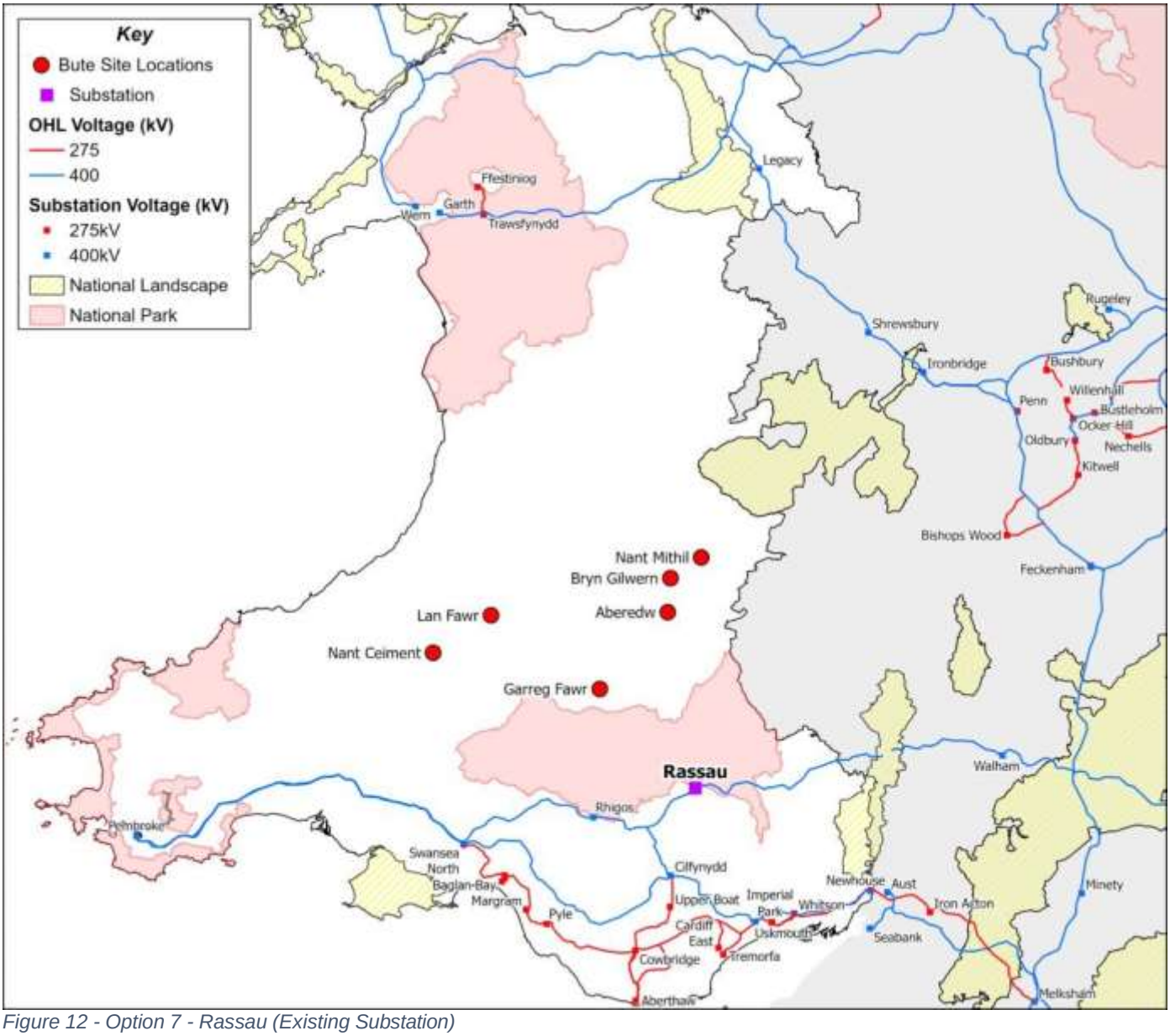

Figure 12 - Option 7 - Rassau (Existing Substation)

152. These substations are located adjacent to the southern edge of the Bannau Brycheiniog National Park and are located within Rhondda Cynon Taff and Blaenau Gwent, respectively. There is a double 400kV circuit that connects Rhigos in the west to Walham, via Rassau.

Technical Requirements

153. A direct point to point connection from the Eastern Cluster to Rhigos or Rassau substations would require a route of approximately 40-45 km in length. A direct connection from the Western Cluster to these substations would be approximately 60-65 km. The total anticipated connection length would be approximately 100-110 km.

154. When considering a direct point to point distance only, this is a comparatively shorter distance compared to other options considered within the North and south eastern zones. An extension to the existing Rhigos or Rassau substations would be required for these connection options.

Environmental Considerations

155. The key environmental consideration when considering the Rhigos and Rassau substation locations is the presence of Bannau Brycheiniog National Park. The direct point to point distance required to connect the Eastern and Western Clusters of Energy Parks would run directly through this protected landscape and therefore should be avoided.

156. A prospective connection through the National Park would give rise to potentially significant environmental impacts, given the weight given to the statutory purposes of the National Park and the desirability of avoiding, where possible, new infrastructure within National Parks. Within the National Park there are several SSSIs SACs and SPAs that the route would potentially have to pass through or would run adjacent to such as Ogof Ffynnon Ddu SSSI.

157. Furthermore, assuming a new connection into the National Park could be justified, it is expected that approximately 50 km of the proposed connection would need to be undergrounded cumulatively for the connection options, which could lead to potentially significant additional environmental impacts, technical routeing difficulties and costs associated with these connection circuits. This significant amount of UGC could also have a detrimental effect on the environment within the Bannau Brycheiniog National Park, including impacts on habitats and species associated with the laying of UGCs.

158. In order to avoid these direct impacts on the Bannau Brycheiniog National Park, it would be necessary to divert the route around the designation, and therefore include a significant routeing diversion of approximately 65 km from the Eastern Cluster and approximately 30 km from the Western Cluster.

159. Furthermore, should a diversion of this length be proposed to avoid direct impacts, there remains the potential for the route to have impacts on the setting of the National Park. Any route would also pass via potential connection options in both the south east and south west zones and is therefore not considered a viable alternative for a grid connection.

160. In addition to the potential impacts on these protected landscapes, the connections would need to be routed sensitively to reduce potential impacts on a number of key designations, including (but not limited to):

- Bannau Brycheiniog National Park, SSSI and SAC
- Ogof Ffynnon Ddu SSSI
- Black Mountain SSSI
- Mynydd Llangattock SSSI
- Penderyn SSSI
- River Tywi SSSI and SAC
- River Wye SSSI and SAC
- River USK SSSI and SAC
- Elenydd SSSI and SPA
- Llandeilo, Rhulen and Llanbedr Hills SSSI
- Maelienydd SSSI

- Cwm Doethie - Mynydd Mallaen SSSI
- Elenydd Malaen – SPA

Cost Assumptions

161. Based on the anticipated point to point connection distance from the Eastern and Western Cluster of Energy Parks to the Rhigos and Rassau substations, including the potential for a significant routeing diversion around the Bannau Brycheiniog National Park to avoid direct impacts on this designation, the following high level cost assumption has been applied to this option.

Substation	Direct point-to-point distance[18]	Mitigations required	Indicative cost estimate
Rhigos	c. 105 km	OHL routeing diversion (c.95km) and substation extension	c. £210m
Rassau	c. 105 km	OHL routeing diversion (c.95km) and substation extension	c. £210m

[18] The point-to-point distance covers the total distance from the Western Cluster Energy Parks to the substation, as well as from the Eastern Cluster Energy Parks to the substation.

Option 8 - Abergavenny (New Substation)

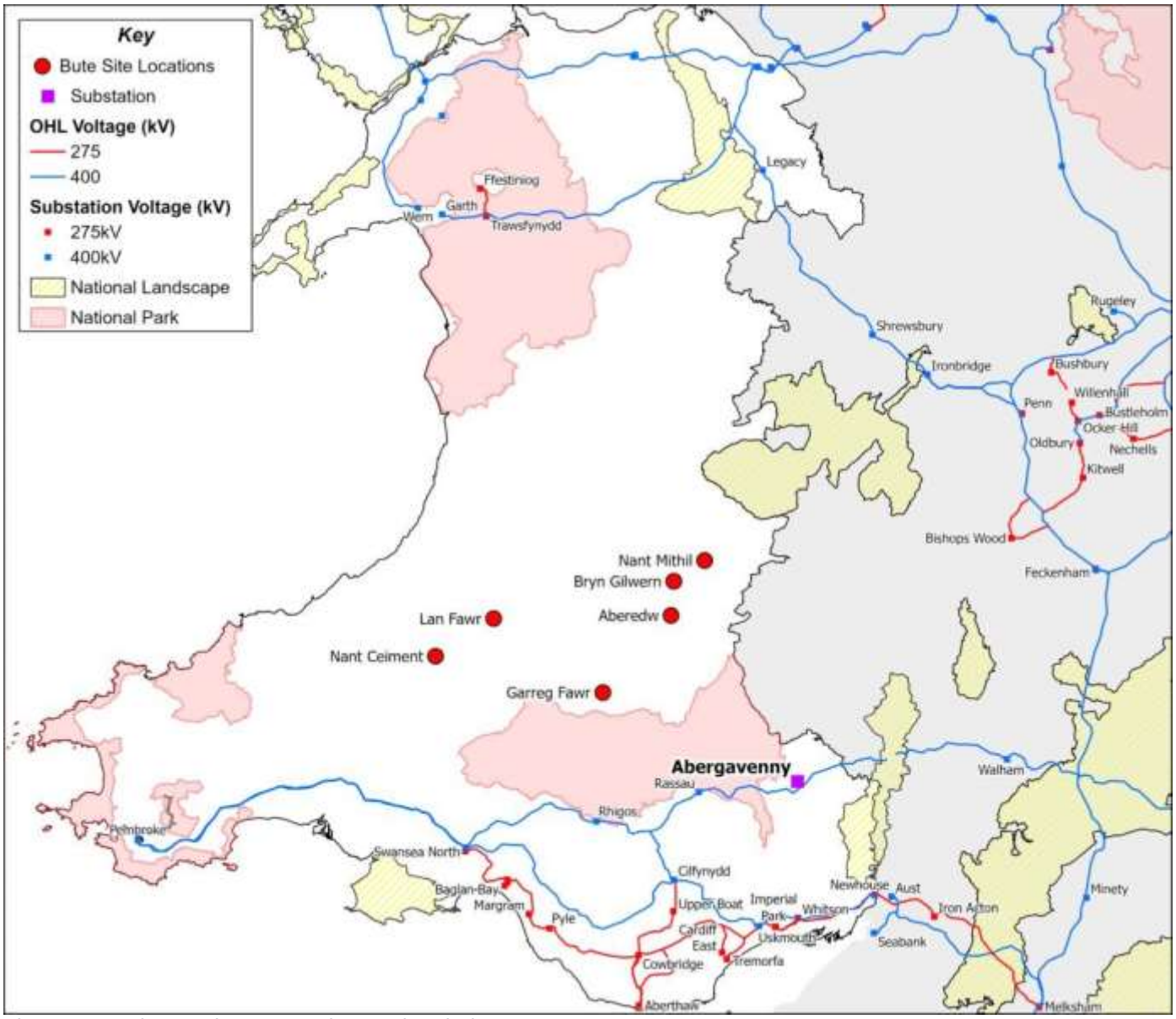

Figure 13 - Option 8 - Abergavenny (New Substation)

162. As an alternative to the Rhigos and Rassau substations, which would require routeing through or around the Bannau Brycheiniog National Park, a potential connection into a prospective new connection substation located in Monmouthshire is also considered. This is referred to as the 'new Abergavenny substation' within this document as it would be located in the vicinity of the town of Abergavenny at a point along the Walham to Rassau existing 400kV OHL.

Technical Requirements

163. A direct point to point connection from the Eastern Cluster of Energy Parks to a new Abergavenny substation would be approximately 50 km in length. A connection from the Western Cluster of Energy Parks would require a connection of approximately 75 km. The total anticipated connection length to this substation would be approximately 125 km.

Environmental Considerations

164. A direct point to point connection from both the Eastern and Western Clusters of Energy Parks to a new Abergavenny substation would pass directly through the Bannau Brycheiniog National Park and raise the same issues as discussed under Options 6 and 7.

165. To avoid direct impacts on the Bannau Brycheiniog National Park, an OHL routeing diversion would be required that would likely need to head east along the northern edge of the National Park before travelling south along the Welsh-English border and south towards any potential substation location. This would lead to a significant increase in the length of the route and would increase environmental impacts due to the number of receptors and designations that would be interacted with. It is anticipated that a route diversion would be approximately 45 km.

166. Should a route diversion to this connection option be taken forward to avoid direct impacts on the National Park, there remains the potential for impacts on the setting dependent on the proximity that the route would take. The route travelling south along the Welsh-English border could not only affect the setting of Bannau Brycheiniog but also the Black Mountains SSSI. As the potential route crosses back into Wales it will reach two SSSIs, Gaer House Woods and Blaentrothy Meadows SSSI, which could cause a potential pinch point and direct the line closer to the National Park.

167. Another key environmental constraint for both of the EP clusters would be the River Wye which is a SAC and SSSI in parts. All routes would have to cross the River whilst trying to limit any impact on the river itself or the surrounding vista.

168. Any route from the Eastern and Western Clusters of Energy Parks would need to be carefully routed and considered to reduce potential impacts on a number of key designations, including (but not limited to):

- Bannau Brycheiniog National Park, SSSI and SAC
- Black Mountains SSSI
- Gaer House Woods SSSI
- Blaentrothy Meadows SSSI
- River Tywi SSSI and SAC
- River Wye SSSI and SAC
- River USK SSSI and SAC
- Elenydd SSSI and SPA
- Llandeilo, Rhulen and Llanbedr Hills SSSI
- Maelienydd SSSI
- Cwm Doethie - Mynydd Mallaen SSSI
- Elenydd Malaen – SPA

169. In addition, a proposal involving the construction of a new connection substation would involve a degree of additional land take, cost, and deliverability risk, together with potentially greater environmental impact, in comparison to a connection into an existing NGET substation.

Cost Assumptions

170. Based on the anticipated point to point connection distance from the Eastern and Western Cluster of Energy Parks to a new substation in the vicinity of Abergavenny, including the potential OHL routeing around sensitive designations and development of a new substation, the following high level cost assumption has been applied to this option.

Substation	Direct point-to-point distance[19]	Mitigations required	Indicative cost estimate
Abergavenny	c. 125 km	OHL routeing diversion (c.45km) and new substation	c. £195m

[19] The point-to-point distance covers the total distance from the Western Cluster Energy Parks to the substation, as well as from the Eastern Cluster Energy Parks to the substation.

Options within the South-West Zone

Option 9 - Swansea North (Existing Substation)

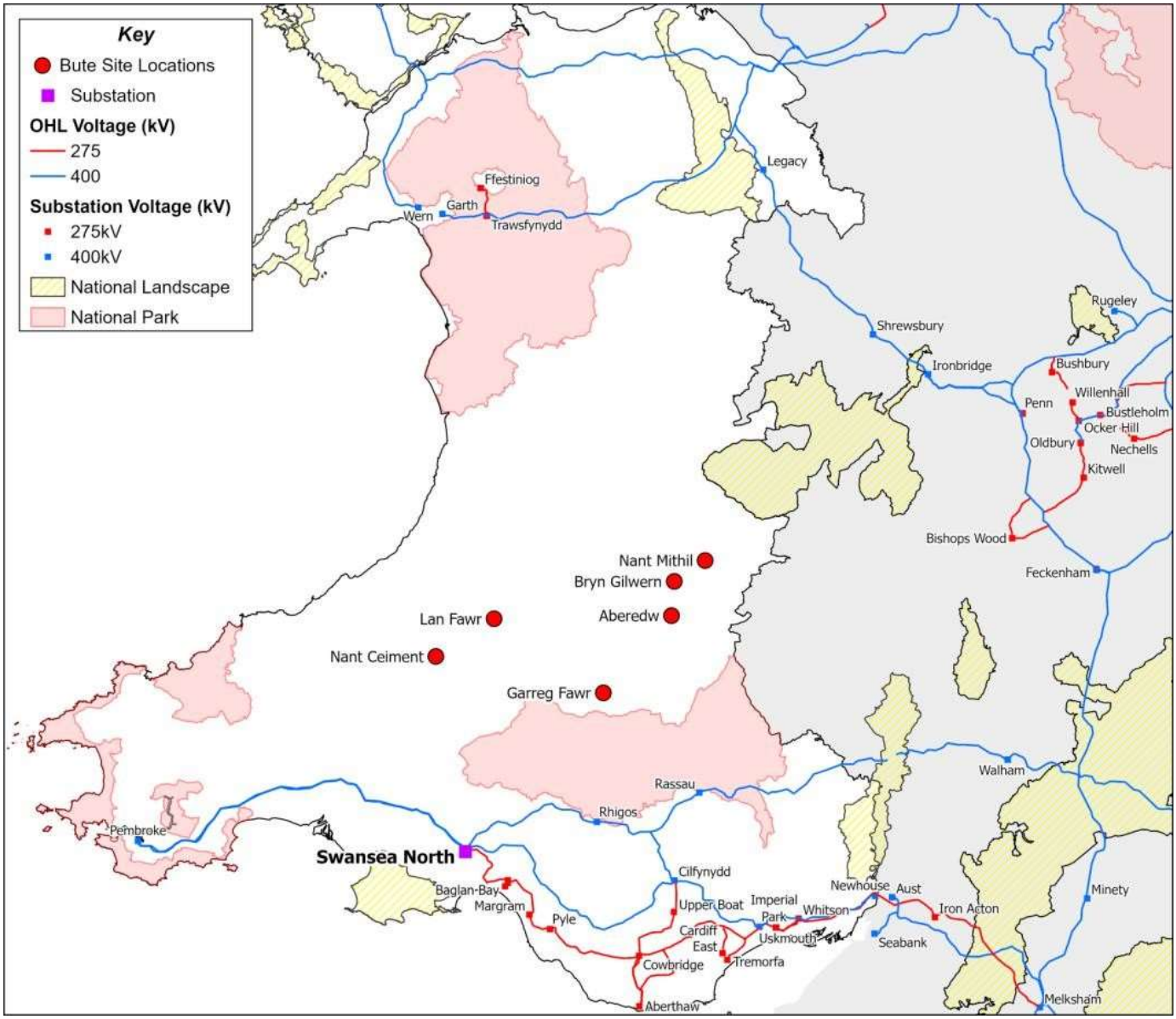

Figure 14 - Option 9 - Swansea North (Existing Substation)

171. Swansea North 400kV substation is located north of the city of Swansea. There are four existing 400kV circuits that connect Pembroke to Swansea North.

Technical Requirements

172. A direct point to point connection from the Eastern Cluster of Energy Parks to the Swansea North substation would require a connection length of approximately 65 km. A direct connection from the Western Cluster would be approximately 55 km in length. The total combined anticipated connection length would be approximately 120 km. An extension to the existing Swansea North substation would be required for this connection option.

Environmental Considerations

173. A direct point to point connection route from the Eastern Cluster of Energy Parks would be likely to interact with the Bannau Brycheiniog National Park and should therefore be avoided wherever possible. In order to avoid direct impacts with this designation, it is anticipated that a routeing diversion of approximately 15 km would be required to facilitate this. Should a route diversion to this connection option be taken forward to avoid direct impacts on the National Park, there remains the potential for impacts on the setting of Bannau Brycheiniog.

174. There is a significant pinch point at Llandeilo, on the corner of the north west part of the National Park. Here the River Tywi, Dinefwr Estate SSSI, Cernydd Carmel SSI and the two smaller country parks converge. This is combined with the built-up area of Llandeilo adjacent.

175. The immediate vicinity of the substation is congested with existing OHL infrastructure as well as notable road and rail infrastructure. Therefore, there is the potential that a new connection into the substation would likely have to employ special crossing techniques or undergrounding to avoid these pieces of key infrastructure.

176. It is also considered that there could be significant routeing challenges in any approach to the Swansea North substation due to the presence of built development in the area around the settlements of Ammanford, Tycroes, Capel Hendre, Cross Hands and Penygroes. A route in this location could lead to routeing pinch points, and the potential for undergrounding in some locations to facilitate crossings of sensitive infrastructure.

177. Any route from the Eastern and Western Clusters of Energy Parks would need to be carefully routed and considered to reduce potential impacts on a number of key designations, including (but not limited to):

- Bannau Brycheiniog National Park
- Dinefwr Estate SSSI
- Cernydd Carmel SSI and SAC
- Graig Fawr, Pontardulais SSSI
- Gelli Aur Country Park
- Llyn Llech Owain Country Park and SSSI
- Caeau Rhyd-Y-Gwiail SSSI
- Talley Lakes SSSI
- River Tywi SSSI and SAC
- River Wye SSSI and SAC
- River USK SSSI and SAC
- Elenydd SSSI and SPA
- Llandeilo, Rhulen and Llanbedr Hills SSSI
- Maelienydd SSSI
- Cwm Doethie - Mynydd Mallaen SSSI
- Elenydd Malaen – SPA

Cost Assumptions

178. Based on the anticipated point to point connection distance from the Eastern and Western Cluster of Energy Parks to the Swansea North substation, including the potential for OHL routeing around sensitive receptors and undergrounding or special crossings of existing infrastructure, the following high level cost assumption has been applied to this option.

Substation	Direct point-to-point distance[20]	Mitigations required	Indicative cost estimate
Swansea North	c. 120km	OHL routeing diversion (c. 15km), potential special crossings or undergrounding (c.5-10 km) and substation extension	c. £179 – 213m

[20] The point-to-point distance covers the total distance from the Western Cluster Energy Parks to the substation, as well as from the Eastern Cluster Energy Parks to the substation.

Option 10 - Pembroke (Existing Substation)

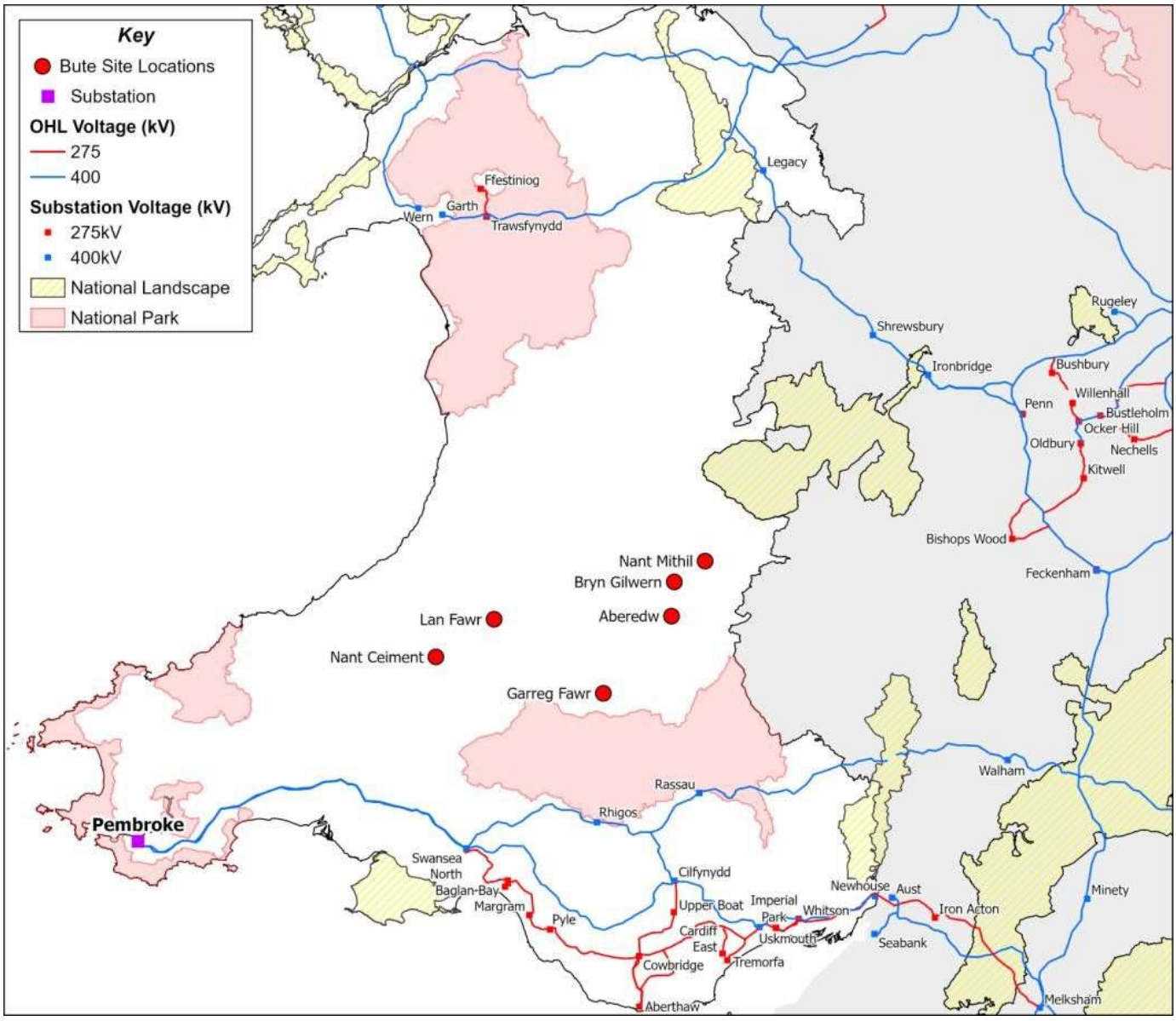

Figure 15 - Option 10 - Pembroke (Existing Substation)

179. Pembroke 400kV substation is located within the county of Pembrokeshire, Wales to the west of the town of Pembroke. There are 4 x 400kV circuits that connect Pembroke to Swansea North in the east.

Technical Requirements

180. A direct point to point connection from the Eastern Cluster of Energy Parks to the substation at Pembroke would require a connection length of approximately 120 km. A connection from the Western Cluster would be approximately 90 km. The total anticipated connection length for this option would be approximately 210 km.

181. There would therefore be a significant combined distance between the proposed South Wales Energy Parks and this substation. From a technical perspective, this could lead to higher electrical losses

compared to other options located closer to the Energy Parks. An extension to the existing Pembroke substation would be required for this connection option.

Environmental Considerations

182. A route to Pembroke substation could avoid Bannau Brycheiniog National Park or Pembrokeshire Coast National Park. However, in order to do so a potential routeing diversion of approximately 5 km would be required. This would lead to an overall connection distance of approximately 215 km.

183. Should a route diversion to this connection option be taken forward to avoid direct impacts on the National Parks, there remains the potential for impacts on the setting dependent on the proximity that the route would take. The route will have to travel southwards to avoid the Pembrokeshire Coast National Park whilst seeking to avoid passing through the Milford Haven Waterway SSSI and Pembrokeshire Marine SAC.

184. Seeking to avoid all three key designations will create a potential pinch point and with the route having to approach Pembroke substation from the south, it will have to avoid Gweunydd Somerton Meadows SSSI and limit its impacts on an area of Ancient Woodland.

185. Any route from the Eastern and Western Clusters of Energy Parks would also need to be carefully routed and considered to reduce potential impacts on a number of key designations, including (but not limited to):

- Pembrokeshire Coast National Park
- Milford Haven Waterway SSSI
- Wyndrush Pastures SSSI
- Pembrokeshire Marine SAC
- Gweunydd Somerton Meadows SSSI
- Bannau Brycheiniog National Park
- Cleddau Rivers SAC and SSSI
- River Teifi SSSI and SAC
- River Wye SSSI and SAC
- River USK SSSI and SAC
- Elenydd SSSI and SPA
- Llandeilo, Rhulen and Llanbedr Hills SSSI
- Maelienydd SSSI
- Cwm Doethie - Mynydd Mallaen SSSI
- Elenydd Malaen – SPA

Cost Assumptions

186. Based on the anticipated point to point connection distance from the Eastern and Western Cluster of Energy Parks to the Pembroke substation, including the potential for OHL routeing around sensitive designations, the following high level cost assumption has been applied to this option.

Substation	Direct point-to-point distance[21]	Mitigations required	Indicative cost estimate
Pembroke	c210 km	OHL routeing diversion (c.5km) and substation extension	c. £225m

[21] The point-to-point distance covers the total distance from the Western Cluster Energy Parks to the substation, as well as from the Eastern Cluster Energy Parks to the substation.

Option 11 - Carmarthen (New Substation)

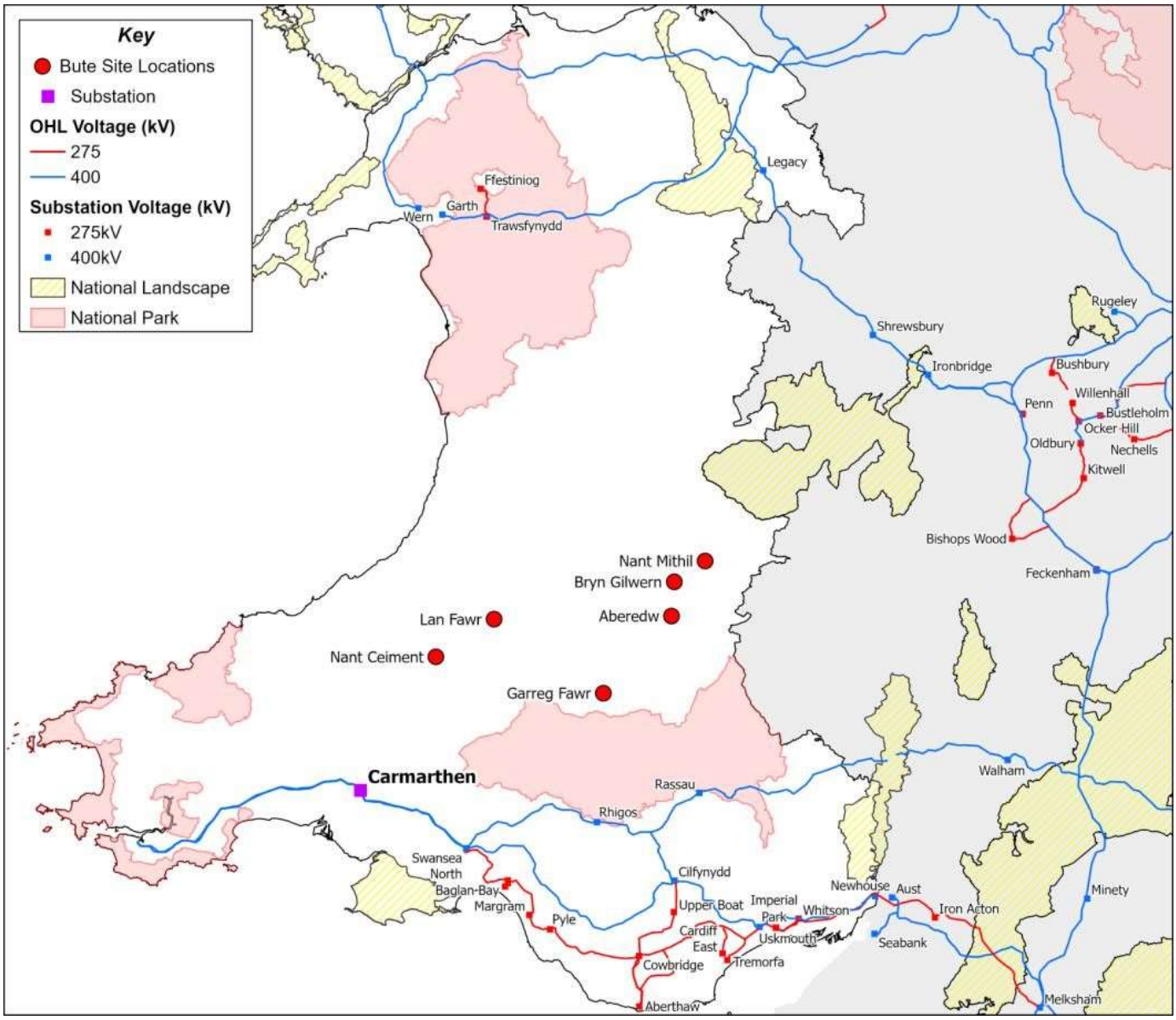

Figure 16 - Option 11 - Carmarthen (New Substation)

187. We have also considered the possibility of connecting into a prospective new Connection Substation located in Carmarthenshire close to the existing transmission circuits between Pembroke and Swansea North. This is referred to as the 'new Carmarthen substation' within this document as it would be located in the vicinity of Carmarthen, Wales.

Technical Requirements

188. A direct point to point connection from an assumed midpoint within the Eastern Cluster of Energy Parks to a new substation at Carmarthen would require a connection length of approximately 70 km. A connection from the Western Cluster would be approximately 45 km. The total anticipated connection length for this option would be approximately 115 km.

Environmental Considerations

189. A direct route to a new Carmarthen substation is considered feasible and will be able to avoid any National Parks or National Landscapes. The Eastern cluster of Energy Parks will veer close to Bannau Brycheiniog National Park but with correct routing, it will be able to avoid affecting the setting of the National Park. It is considered that in order to ensure this, a potential routeing diversion of approximately 5 km would be required. This would lead to an overall connection distance of approximately 120 km.

190. Both EP clusters will have to overcome small pockets of SSSI's and other environmental designations however due to the limited nature of them throughout the route and the large area where the route could pass through, there is considered to be a limited number of pinch points. The main environmental issue for the western cluster will be navigating through Ancient Woodland and limiting any impact.

191. Both routes will have to cross the River Tywi, and this will need to be done in a way which reduces the impact on the setting of the river. Overall, the relative short distance of the two combined grid routes and the fairly limited number of environmental designations throughout both routes provide a feasible option to service the South Wales EP's.

192. Any route from the Eastern and Western Clusters of Energy Parks would also need to be carefully routed and considered to reduce potential impacts on a number of key designations, including (but not limited to):

- Mynydd Ystyfflau-Carn SSSI
- River Tywi SSSI and SAC
- River Wye SSSI and SAC
- River USK SSSI and SAC
- Elenydd SSSI and SPA
- Llandeilo, Rhulen and Llanbedr Hills SSSI
- Maelienydd SSSI
- Cwm Doethie - Mynydd Mallaen SSSI
- Elenydd Malaen – SPA
- Caeau Mynydd Mawr SAC

193. Any proposal involving a new Connection Substation would involve a degree of additional land take, cost, and deliverability risk, together with potentially greater environmental impact, in comparison to a connection into an existing NGET substation.

Cost Assumptions

194. Based on the anticipated point to point connection distance from the Eastern and Western Cluster of Energy Parks to a new substation in the vicinity of Carmarthen, including the potential for OHL routeing around sensitive designations and development of a new substation, the following high level cost assumption has been applied to this option.

Substation	Direct point-to-point distance[22]	Mitigations required	Indicative cost estimate
Carmarthen	c. 115 km	OHL routeing diversion (c.5 km), new substation	c. £140m

[22] The point-to-point distance covers the total distance from the Western Cluster Energy Parks to the substation, as well as from the Eastern Cluster Energy Parks to the substation.

Summary and Preferred Option

Summary of options within the North Zone

195. All of the connection options within the North Zone would require more than 175 km of Connection Circuits (increasing further once OHL diversions are accounted for). There is therefore a significant distance between the proposed South Wales Energy Parks and all North Zone options in comparison with a number of the connection points in the southern zones. Whilst it is acknowledged that a northern route from the Eastern and Western Clusters of Energy Parks could provide the benefit of potentially linking in with other Energy Parks that Bute Energy has connection agreements for, the amount of energy generated from these parks would necessitate an additional connection and could not be accommodated on the proposed connections from the Eastern and Western Cluster of Energy Parks described in this document.

196. The longer anticipated routes to connection options in the North Zone would lead to additional cost, interaction with more land and environmental receptors, increased disruption, and higher electrical losses. It is therefore considered that options within the North Zone should be discounted from further consideration.

197. It is also noted that a number of the options within the North Zone could have significant interactions with designated areas, such as the Eryri National Park and the Shropshire Hills National Landscape. These interactions could lead to increased environmental impacts and the associated material planning and consenting risks, as well as additional costs associated with avoidance and the compensatory measures that would be required.

Summary of options within the South East Zone

198. The connection options within the South East Zone would offer a wide variety of point-to-point route lengths. The shortest direct point-to-point total length would be a connection from the South Wales Energy Parks to the Rhigos or Rassau substations, whilst the longest distance would be a connection to Walham substation.

199. As with the connection options considered in the North Zone, a new connection from the Energy Parks to Walham substation would be considerably longer in distance than other available options. Longer routes would lead to additional interaction with environmental receptors, cost, increased disruption, and higher electrical losses.

200. A connection to Walham would also need to pass through, or diverted around, three Nationally designated areas; the Bannau Brycheiniog National Park, the Malvern Hills National Landscape, and the Wye Valley National Landscape. These interactions could lead to increased environmental impacts and the associated material planning and consenting risks, as well as additional costs associated with mitigation measures that are likely to be required.

201. In view of these factors, a possible new connection between the South Wales Energy Parks and Walham should be discounted.

202. Whist a direct route would offer shorter and more direct connection routes than other possible solutions, connections to either Rhigos or Rassau substations were not considered to perform strongly given the availability of other routes with lesser impacts on National Parks. If these options were to be progressed, we would expect that a significant portion of the route would be undergrounded or a significant diversion around the National Park would be required that would pass by other reasonable alternatives.

203. In addition to the significant financial costs associated with undergrounding, such a long length of UGC would also lead to substantial disruption within the Bannau Brycheiniog National Park, impacting on local communities, visitors to the National Park, as well as the environment and its scenic beauty. For these reasons, routes to Rhigos or Rassau should be discounted.

204. The proposal for a new Abergavenny substation was considered as an alternative to avoid directly routeing the new connection through the Bannau Brycheiniog National Park. Whilst routeing around the National Park would give rise to fewer impacts than routing directly through it, a connection to a new Abergavenny substation could lead to notable interactions with the setting of the National Park. This would be expected to necessitate a significant route diversion, particularly when considering a connection from the Western Cluster of Energy Parks.

Summary of options in the South West Zone

205. Two of the three considered connection options within the South West Zone offer comparatively short direct point-to-point route lengths: these are Swansea North and Carmarthen. In contrast a new connection to the Pembroke Connection Substation would result in a significantly longer Connection Circuit route.

206. Longer routes would lead to interaction with more environmental receptors, additional cost, increased disruption, and higher electrical losses. The significant length of the route required to the Pembroke substation was therefore considered to perform poorly as compared to other shorter options This, in addition to the fact that any route would be likely to pass in the vicinity of an option to connect in the Carmarthen area, means that an option to Pembroke is not preferred.

207. When compared to other options considered within the South East Zone, a new connection into the Swansea North substation would be capable of avoiding significant interactions with the Bannau Brycheiniog National Park. Some undergrounding and special crossings could be required within the vicinity of the existing substation at Swansea North due to the presence of other existing infrastructure. Any potential undergrounding or special crossings that would be needed at Swansea North would lead to a notable cost increase. It is also considered that a route to Swansea North could be challenging to progress due to the existing built environment in the area.

208. The connection to Pembroke substation is expected to be a similar cost range compared to the Swansea North option. However, the Swansea North substation would offer a far shorter point-to-point circuit route, which is unlikely to require significant route diversions or extensions when compared to other options that have been discounted. Short routes minimise disruption and electrical losses. The potential need for undergrounding and special crossings of existing infrastructure in the area would however lead to additional costs for this connection option.

209. As with the Swansea North option, the connection into a new Carmarthen substation is not considered likely to lead to significant interactions with the Bannau Brycheiniog National Park, however a new

substation would also be required. Notwithstanding, the proposal for a new Carmarthen substation would represent the lowest overall connection length required from the Eastern and Western Clusters of Energy Parks and would be the lowest cost option overall. This would therefore offer the most economical and efficient solution, whilst also having the lowest overall impact on communities and key designated areas out of the options that have been considered.

Summary of All Options

210. For ease of reference, the report has complied a table below showing all 11 options with a description and the total estimated cost of them all:

Table 4 - Summary of All Options

Option	Description	Total Distance	Indicative cost estimate
1 Trawsfynydd	Existing Substation with undergrounding needed (approximately 50km) and a substation extension	c. 170 km	c. £470m
2 Shrewsbury	Existing Substation with an OHL routeing diversion (c. 10km) and substation extension	c. 185 km	c. £195m
3 Ironbridge	Existing Substation with an OHL routeing diversion (c. 60km) and substation extension.	c. 250 km	c. £260m
4 Lower Frankton	New Substation with an OHL routeing diversion (c.5 km)	c. 185 km	c. £210m
5 Walham	Existing Substation with an OHL routeing diversions (c. 40 km) and substation extension	c. 245 km	c. £255m
6 Rhigos	Existing Substation with an OHL routeing diversion (c.95km) and substation extension	c. 200 km	c. £210m
7 Rassau	Existing Substation with an OHL routeing diversion (c.95km) and substation extension	c. 200 km	c. £210m
8 Abergavenny	New Substation with an OHL routeing diversion (c.45km)	c. 170 km	c. £195m
9 Swansea North	Existing Substation with an OHL routeing diversion (c. 15km), potential special crossings or undergrounding (c.5-10 km) and substation extension	c. 140/ 145km	c. £179 – 213m
10 Pembroke	Existing Substation with an OHL routeing diversion (c.5km) and substation extension	c. 215 km	c. £225m
11 Carmarthen	New Substation with an OHL routeing diversion (c.5 km)	c. 120 km	c. £145m

Preferred Option

211. After considering each of the factors associated with the options, such as environmental, technical requirements, length of circuits and viability of the project, we have concluded that, Option 11 (Carmarthen – New Substation) could facilitate connections from both the Eastern Cluster and Western Cluster of Energy Parks and is selected as the preferred grid connection option.

212. Following our appraisal of the options, this was considered to present the best performing option, having regard to environmental considerations and the need to deliver an economic and efficient solution to connect Bute Energy's South Wales Energy Parks to the Transmission Network. This option would ensure compliance with the licence obligations that Green GEN Cymru are subject to as a IDNO Licence holder. Option 11 will be taken forward for further consideration through further, more detailed routeing studies.

Current Project Status and Next Steps

213. Following the selection of Option 11 (Carmarthen – new substation), this will be taken forward for further consideration through the routeing stage of project development and subsequent public and stakeholder consultation.

214. Throughout the continued development of the projects, Green GEN Cymru will continue to back-check the analysis and assumptions within this report and will review items that could affect the analysis. This includes, technology developments, cost updates and changes based on consultation with key stakeholders such as local residents, the Welsh Government, statutory bodies and National Grid. We welcome comments in relation to the content, review and analysis included within this document. These will be taken into account as part of the ongoing development of the proposals.