GREEN GEN CYMRU

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Green GEN Phase 2 Grid Connection Strategy

August 2023

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Executive Summary

Green GEN Cymru has prepared this document which sets out an appraisal of grid connection options to determine the most appropriate solution to connect Bute Energy's proposed Mid Wales Energy Parks to the National Electricity Transmission System (NETS). The scope of this Grid Connection Strategy includes the general location for a proposed substation to connect to the National Electricity Transmission System (NETS), as well as the potential connection route from the Energy Parks.

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.

This document explains the assessment and decision-making process which has led to the selection of the preferred option for the connection of the Mid Wales Energy Parks to the NETS. The preferred option will be taken forward for further development, including the identification of potential corridor and route options to connect the Mid Wales Energy Parks to the NETS. This document focuses on the connection infrastructure between the Bute Energy Mid Wales Energy Parks and a single connection point on the NETS, it does not examine the Energy Parks themselves. To do this, potential connection points in Wales and England have been considered.

Our initial review considered and assessed 10 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 process has concluded that the most appropriate solution would be to construct a new connection to a new substation within Shropshire.

The Mid Wales Energy Parks, located in Powys would be connected to a new substation via a 132kV route from a 132kV collector substation in Powys. It is currently anticipated that the entirety of this route would be an overhead line of steel lattice design. This solution is referred to as Option 4 within this report.

Our appraisal has considered potential environmental impacts that the connection of the Mid 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 at Lower Frankton in Shropshire 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 consideration.

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.
Area of Outstanding Natural Beauty (AONB)	An AONB is an area of countryside in Wales, England or Northern Ireland, that 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.
Collector substation	An electrical site where generated electricity from the Energy Parks is combined to enable the more efficient transfer of electricity to the existing 400kV network operated by National Grid.
Connection substation	An electrical site where voltage will be increased to enable connection to the existing 400kV network. This site will be operated by National Grid.
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 one 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.

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 Policy Statements (NPSs)	National Policy Statements provide the UK Government's objectives for the development of nationally significant infrastructure in a particular sector. The energy National Policy Statements set out the government's policy for the delivery of energy infrastructure and provide the legal framework for planning decisions.
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).
Planning Inspectorate	The Planning Inspectorate is the government agency responsible for operating the planning process for Nationally Significant Infrastructure Projects (NSIPs).
Scottish Power	In North Wales, Merseyside, Cheshire and North Shropshire the local lower voltage Distribution Network is owned and operated by Scottish Power Energy Networks
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.
Mid Wales Energy Parks	The five Energy Parks proposed to be located within Mid 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.
Tee-connection	Where a new circuit connects into an existing circuit, so that the combined electricity is able to be transferred along one 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.

Introduction

Who are Green Generation Energy Networks Cymru

1. Green Generation Energy Networks Cymru (Green GEN Cymru) is a business in the Bute Energy Group and our aim is to promote, consent and develop new grid infrastructure to distribute green energy.

2. There is vast potential for renewable energy in Wales – particularly from the wind that blows across our hills and mountains. 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.

3. 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 and England. This will help tackle both the energy crisis and the climate crisis as well provide local communities with funds via a Community Benefit Scheme.

4. 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.

5. Our approach aligns with the UK Government's commitment to climate change and 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.

6. On top of this we will invest millions of pounds directly into Welsh and English communities closest to our projects. Green GEN Cymru is proposing a Community Benefit Fund, that could be worth millions of pounds every year, that will be spent in the local area. The fund will come from the Bute Energy projects that connect to the network and will be based on the amount of generating capacity connected to the lines.

7. We are keen to work in partnership with the UK and Welsh Governments, 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 Group

8. 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 the Energy Parks and grid connections are located.

9. 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.

10. 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.

11. 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 relevant policy including the National Policy Statements and the Welsh national spatial strategy - Future Wales.

Purpose of this document

12. 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 Mid 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 Mid Wales Energy Parks to the NETS.

13. This document focuses on the connection infrastructure between the Bute Energy Mid Wales Energy Parks and a single connection point on the NETS, it does not examine the Energy Parks themselves. To do this, potential connection points in Wales and England have been considered.

Background and Needs Case

14. 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 sixth 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].

15. 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.

16. 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.

17. 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 eleventh edition of Planning Policy Wales (PPW11)[6]. 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 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*".

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[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
[5] The Climate Change (Interim Emissions Targets) (Wales) (Amendment) Regulations 2021
[6] Planning policy Wales | GOV.WALES

18. 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.

19. 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.

20. It has long been acknowledged by the Welsh Government, energy generators and network operators that a key challenge with respect to delivering Wales' 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*" 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.

21. 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.

22. Five of the proposed Energy Parks are located in Mid Wales (referred to as the Mid 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. Additional Energy Parks would be located in South Wales and these are not discussed within this document. The most appropriate solution for connecting these South Wales Energy Parks to the NETS is the subject of separate consideration and documented within Green GEN Cymru Phase One Grid Connection Strategy[7].

23. 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.

[7] https://greengentowyusk.com/documents/Grid%20Connection%20Strategy%20Report.pdf

24. 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). Once licenced by Ofgem, IDNOs are able to develop, operate and maintain electricity distribution networks. IDNOs connect their networks onwards into the local Distribution Network or Transmission Network.

25. Green GEN Cymru has applied for an IDNO Licence, and we are anticipating a determination on our application in late-2023. This will enable 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.

26. 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'.

27. If confirmed as a licence holder, Green GEN Cymru would be required to adhere to 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*."

28. With oversight of the development of both the connection infrastructure promoted by Green GEN Cymru as well as the Energy Parks, Bute 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 prospective IDNO Licence holder, Green GEN Cymru will be able to play a proactive role in the progression towards achieving Net Zero in Wales. Bute 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.

29. As the connection for the Mid Wales Energy Parks to the NETS could potentially be made wholly in Wales or partly in Wales and partly in England different consenting regimes could apply.

30. A connection partly in Wales and partly in England of an overhead electric line, that has a nominal voltage of 132kV or above, and is over 2 km in length would fall within the definition of a 'Nationally Significant Infrastructure Project' (NSIP) under Section 14(1)(b) of the Planning Act 2008[8]. All NSIPs in England and Wales require a Development Consent Order (DCO).

31. An application for a DCO would be submitted to the Planning Inspectorate. The application will be examined, and a recommendation made to the Secretary of State (SoS) at the Department for Energy Security & Net Zero who will make the decision on the application.

[8] https://www.legislation.gov.uk/ukpga/2008/29/contents

32. For a connection wholly 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) 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

National Policy Statements

34. Should the connection be brought forward partly in Wales and partly in England as an NSIP then the National Policy Statements will provide the policy framework for decision making.

35. The relevant NPSs are:

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

36. 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.

37. 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.

38. 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. The principles set out in this policy will be adhered to through the Environmental Impact Assessment (EIA) process.

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[9] The Developments of National Significance (Specified Criteria and Prescribed Secondary Consents) (Wales) Regulations 2016 (as amended)

[10] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47854/1938-overarching-nps-for-energy-en1.pdf

[11] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1147384/NPS_EN-5.pdf

39. 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.

40. Paragraph 2.8.2 of EN-5 states that "*The Government does not believe that development of overhead lines is generally incompatible in principle with the developers' statutory duty under section 9 of the Electricity Act to have regard to amenity and to mitigate impacts*." It indicates that there is potential for OHL infrastructure to give rise to adverse landscape and visual impacts, however "*for the most part these impacts can be mitigated*".

41. 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.

42. The draft 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.

Future Wales: The National Plan 2040 (February 2021)

43. 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".*

44. 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 policy and legislation, including:

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

45. 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.

46. 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".

47. Section 2 of Future Wales sets out how it has been informed by climate change issues, including projections showing an increased chance of milder, wetter 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 11, February 2021)

48. In February 2021 the Welsh Government published Planning Policy Wales Edition 11 (PPW)[12]. 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.

49. 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.

50. 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".

51. 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

[12] Planning Policy Wales (2021)

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."

52. 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.

53. 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[13]. This position has been considered within this report under the 'Considered Technologies' section.

[13] The Welsh Government has recently consulted on 'Targeted policy changes to Planning Policy Wales on Net benefit for Biodiversity and Ecosystems Resilience (incorporating changes to strengthen policy on Sites of Specials Scientific Interest, Trees and Woodlands and Green Infrastructure. Changes to policy will be considered in subsequent backchecks previous work and ongoing routeing and design.

https://www.gov.wales/targeted-policy-changes-planning-policy-wales-net-benefit-biodiversity-and-ecosystems-resilience

Project Overview

Proposed Energy Parks

54. Green GEN Cymru's focus has been to identify the most appropriate infrastructure to provide a connection to Bute Energy's proposed Mid Wales Energy Parks.

55. The Mid Wales Energy Parks have a total contracted generation capacity (known as Transmission Entry Capacity (TEC)) of 685 MW. The proposed locations of these Energy Parks are shown in Figure 1, with the individual capacities for each of the parks set out in Table 1.

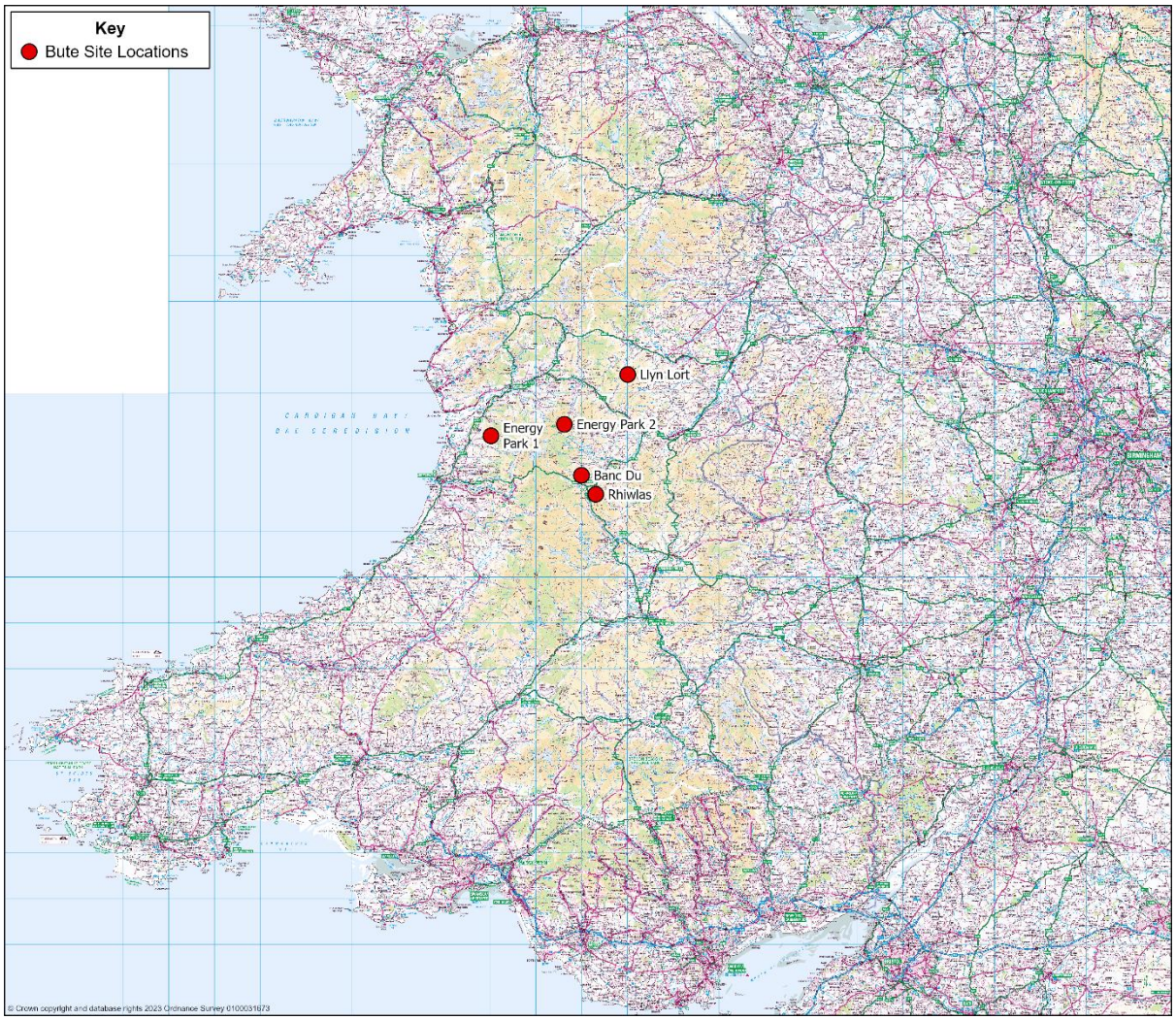


Figure 1 - *Location of Bute Energy's proposed Mid Wales Energy Parks*

Energy Park	TEC (MW)
Llyn Lort	158
Banc Du	46
Rhiwlas	106
Energy Park 1	250
Energy Park 2	125

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

Connecting the Energy Parks

56. New energy generation projects, such as the proposed Mid Wales Energy Parks, can connect to either the Transmission Network (the higher voltage network owned and operated by National Grid Electricity Transmission, NGET, in England and Wales) or the local lower voltage Distribution Network. In North Wales, Merseyside, Cheshire and North Shropshire the local lower voltage Distribution Network is owned and operated by Scottish Power Energy Networks. In South Wales this is owned and operated by National Grid, 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.

57. Bute Energy's site selection strategy for the Mid 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. The presumption in favour of large-scale renewable energy development in these areas would support the efficient and timely development of the Mid 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 the borders and 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 the amount of electricity to be generated at the Energy Parks would be at 132kV and there is currently a lack of these 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, it is understood that there is insufficient capacity on the existing DNO networks to accommodate the power generation proposed at the Energy Parks.

60. Four of the Mid Wales Energy Parks each exceed 100MW TEC, and the remaining Energy Park has a TEC of approximately 46MW. This, combined with the lack of 132kV infrastructure and capacity, means there is a requirement for the parks to connect to the Transmission Network.

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

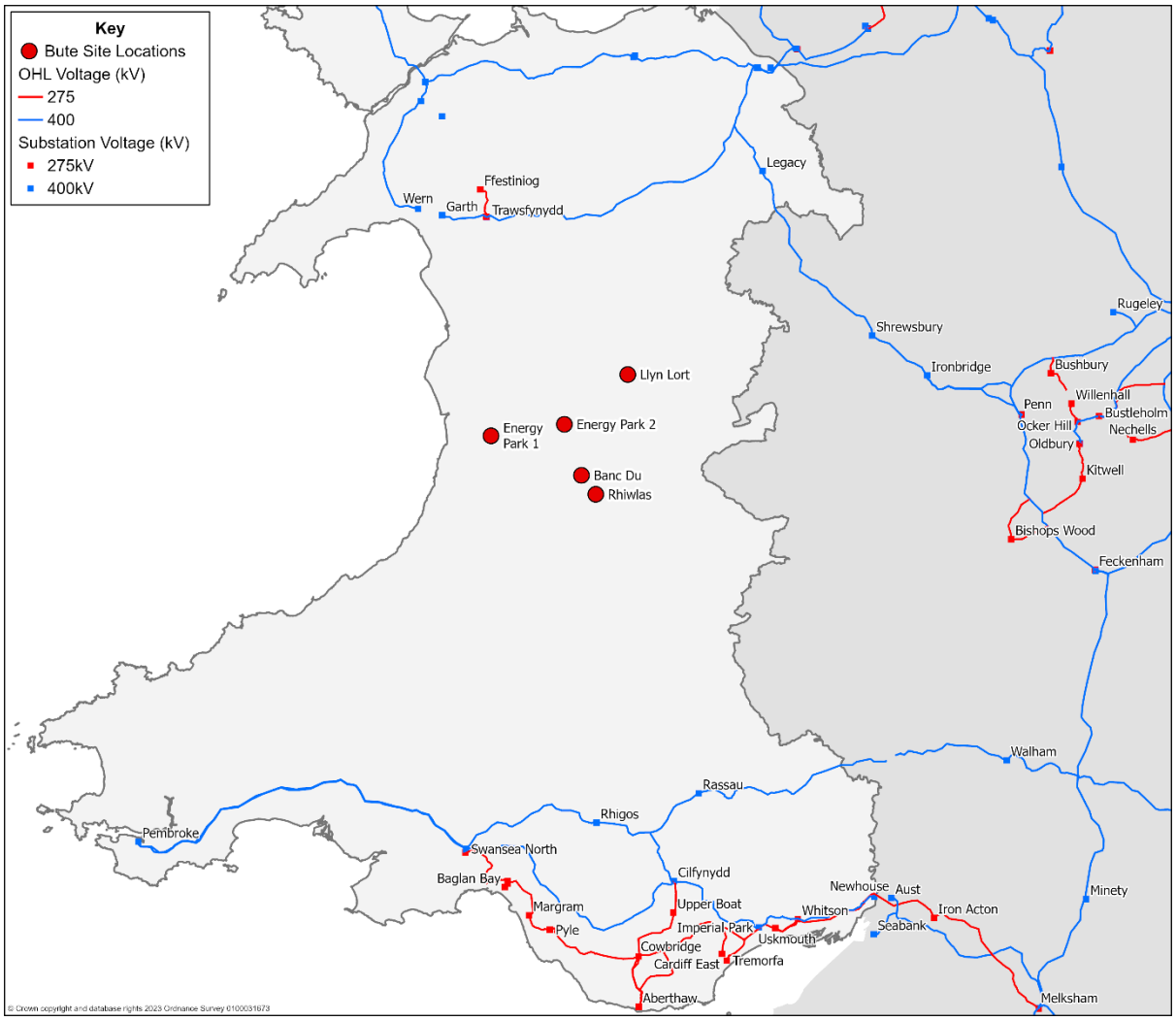


Figure 2 - Bute Energy's proposed Mid Wales Energy Parks and existing Transmission Network infrastructure

62. A proposal to create individual connections to the Distribution and / or Transmission Network from each of the Mid Wales Energy Parks would multiply environmental and community impacts. This combined with our 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 Mid Wales Energy Parks as whole (c. 685 MW) and the desirability of connecting those Energy Parks via shared circuits before connecting to the wider electricity network. At that level of power, a connection to the Transmission Network is necessary.

63. As such, the need for new electricity connections between the proposed Mid 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 the 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 Mid 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 Mid 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 connection would need to consist of two circuits, each likely to contain two conductors per phase.

Gas Insulated Lines

68. Gas Insulated Lines (GIL) 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 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 a 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 this potential cost of converter stations would be significantly higher than the entire cost of an Alternating Current (AC) solution (see below).

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 Mid 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.

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. Alternating current (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. Overhead Lines (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 Electricity Act duties, underground cable technology is generally only used in instances when an OHL could be 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 level of ground disturbance during construction and maintenance.

77. The estimated additional cost of placing a 132kV HV electrical connection underground could be approximately 6 - 10 times the cost of an over-head connection. It is however fully recognised that there are specific circumstances in which the use of UGCs could be appropriate.

78. Green GEN Cymru has considered a wholly underground solution for the connection, and deemed this unsuitable as the additional cost would severely impact the viability of the project, 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 minimise 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, for these reasons, the assumption at this stage is that AC OHL technology would be initially proposed for the proposed connection.

79. At this stage, Green GEN Cymru have assumed the undergrounding of a 132kV overhead line on steel lattice towers within designated landscapes such as a National Park or Area of Outstanding Natural Beauty and this has been taken into account in the consideration of the connection options below. Consideration of undergrounding will be determined on a specific project basis and will be considered in subsequent stages of project development.

Supporting structures

80. 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 3 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.

81. There are also double circuit structures that are capable of supporting 2 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 tower) and are able to support larger conductors and are therefore able to distribute more power than the equivalent single circuits. The standard height for a 132kV steel lattice L7 tower is 27m high and has spacing of between 200m -250m. 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). Larger standard steel lattice structures (such as an L8 design) are able to carry 132kV conductors, however these are much greater in height. L8 towers are normally used for 275kV and 400kV transmission connections.

82. Although lattice towers would be taller than using wood pole alternatives, wooden poles can only carry 3 wires meaning that 3 - 4 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 between 80m-100m but can increase up to 150m apart longitudinally. In contrast, L7 steel lattice towers are typically spaced between 200m-250m apart. This, alongside the lateral spacing requirements, could lead to greater impacts on the environment and greater restrictions on future land use.

83. 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 Mid Wales Energy Parks in the most appropriate manner, balancing our obligations to develop an economic, efficient and coordinated network.

84. Due to the combined generating capacity of the Energy Parks, the main OHL route 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 route. However, the use of wood poles for carrying conductors will be considered where appropriate.

85. 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 the 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.

86. From the smaller capacity Mid Wales Energy Parks, where the conductor capacity is expected to be lower, we expect to use a single 132kV circuit on either single or double wood pole structures to a collector substation, from where the main OHL route would commence.

Voltage level

87. We propose to distribute the electricity from the Mid 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 prospective IDNO Licence.

88. 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).

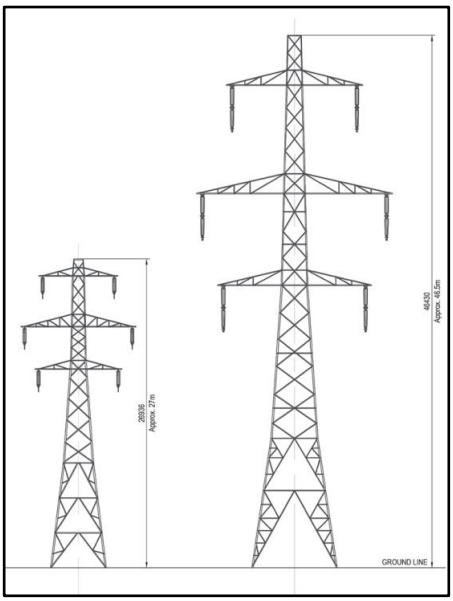


Figure 3 - L7 and L8 tower comparison[14]

89. 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.

90. 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 that would need to be taken into account.

91. As circuits operating at 132kV would be sufficient to enable the full capacity of the Mid 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 Mid 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.

92. This, coupled with the fact that the 400kV towers and conductors would likely exacerbate environmental effects 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.

[14] *Source: https://www.ssen-transmission.co.uk/media/2432/ssen-lairg-project-a4-12pp-web-hres.pdf*

The Grid Connection Options

Methodology

93. Our appraisal process identified and compared the feasible options to provide the connections from the Mid Wales Energy Parks, proposed by Bute Energy, 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.

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

95. This document explains the assessment and decision-making process which has led to the selection of the preferred option for the connection of the Mid 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.[15]

[15] Whilst not a differentiator in the assessment and decision making for the preferred option the broad options identified for the location of Collector Substation is considered later in this document.

Project Element	Description	Included in Scope?
Energy Parks	The individual Energy Park projects (see Table 1 and Figure 1). These assets would be developed, delivered, and owned by Bute Energy, independently of Green GEN Cymru.	**NO** The individual Energy Parks and their grid connections will be the subject of a separate planning and development process and hence optioneering around these elements is not reported in this document. However, key factors such as the intended locations and capacities of the Mid Wales Energy Parks have informed the appraisal of options undertaken.

96. 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 distinct geographical zones, a North Zone, an East Zone and a South Zone.

Assessment Framework

97. 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.

98. Under Section 9(2) of the Electricity Act 1989, Green GEN Cymru, as an IDNO, would be required to "*develop and maintain an 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."

99. 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, including the Eryri (formerly known as Snowdonia) and Bannau Brycheiniog (formerly known as the Brecon Beacons) National Parks and Areas of Outstanding National Beauty (AONBs) which have to be considered.

100. 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 AONBs);
    - Internationally designated ecological sites (SACs, SPAs and Ramsar sites);
    - Cultural heritage features that benefit from the highest level of protection (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 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.

  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 need for the potential of undergrounding or OHL diversions.

  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	£0.5m/km
132kV Double circuit underground cable	£3.4m/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.

101. Figure 4 shows the location of the Mid Wales Energy Parks and the NETS infrastructure in this area. Existing substations are represented by the named squares shown along the transmission circuit routes. In addition, Figure 4 shows the location of key sensitive areas including the Eryri and Bannau Brycheiniog National Parks and Areas of Outstanding Natural Beauty.

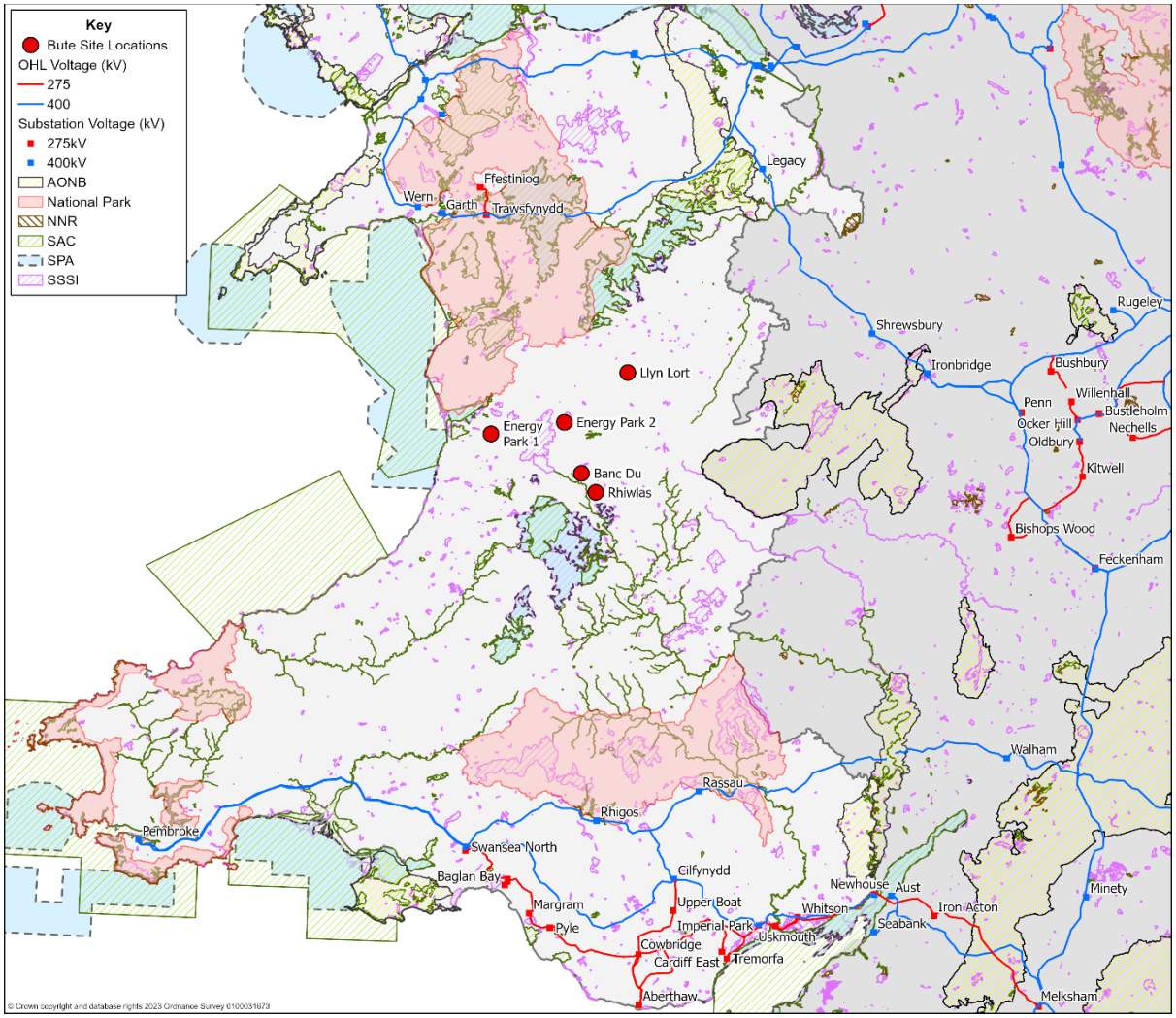


Figure 4 - Bute Energy's proposed Mid Wales Energy Parks, existing Transmission Network infrastructure and nationally designated areas.

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

- 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 Mid Wales Energy Parks are Trawsfynydd, Shrewsbury and Ironbridge. In addition to these existing substations consideration has also been given to a proposed new National Grid substation near Gwyddelwern which will connect the proposed Bute Energy Park at Moel Chwa.

- to the east – the 275kV circuit that connects to Bishops Wood 275kV substation.
- 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 Mid Wales Energy Parks are Rhigos and Rassau. In addition to these existing substations consideration has also been given to the proposed new National Grid substation near Carmarthen which will connect the proposed Bute Energy South Wales Energy Parks.

103. Following the identification of these areas, it was considered that there were 10 reasonable alternative options for a feasible connection from the Mid Wales Energy Parks, contained within the three geographic 'zones'. In each zone potential 'new substation' locations were identified based on either shortest route length and / or ability to avoid nationally designated sites. These were:

North Zone

1. Trawsfyndd – Existing substation.
2. Shrewsbury – New substation required.
3. Ironbridge – Existing substation required.
4. Lower Frankton – New substation required.
5. Chirk – New substation required.
6. Gwyddelwern – New substation proposed by National Grid.

East Zone

7. Bishops Wood – Existing substation.

South Zone

8. Carmarthen – New substation proposed by National Grid.
9. Rhigos – Existing substation.
10. Rassau – Existing substation.

104. Figure 5 illustrates the three feasible connection zones for the Mid Wales Energy Parks.

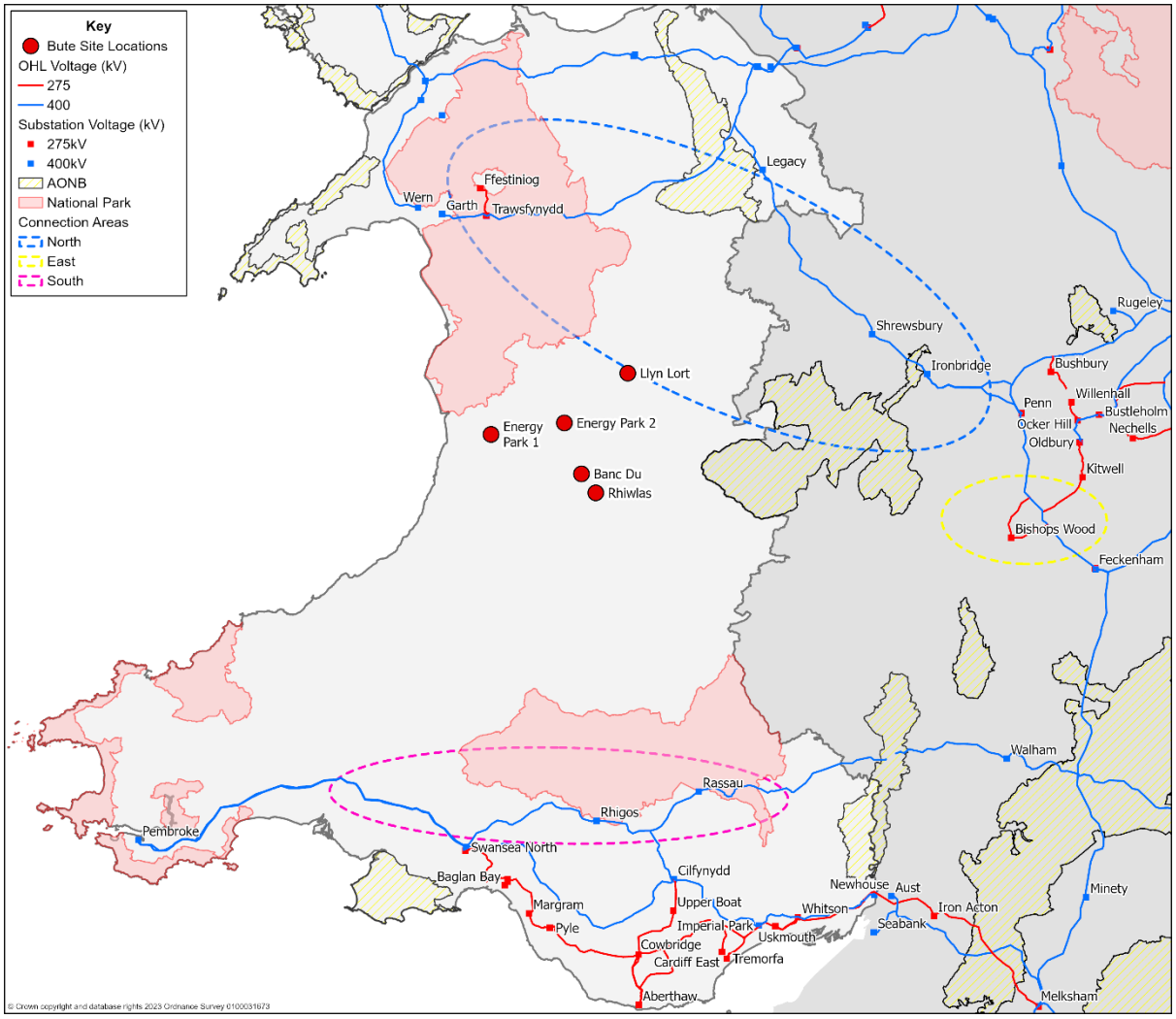


Figure 5 – The considered connection zones and nationally designated constraints

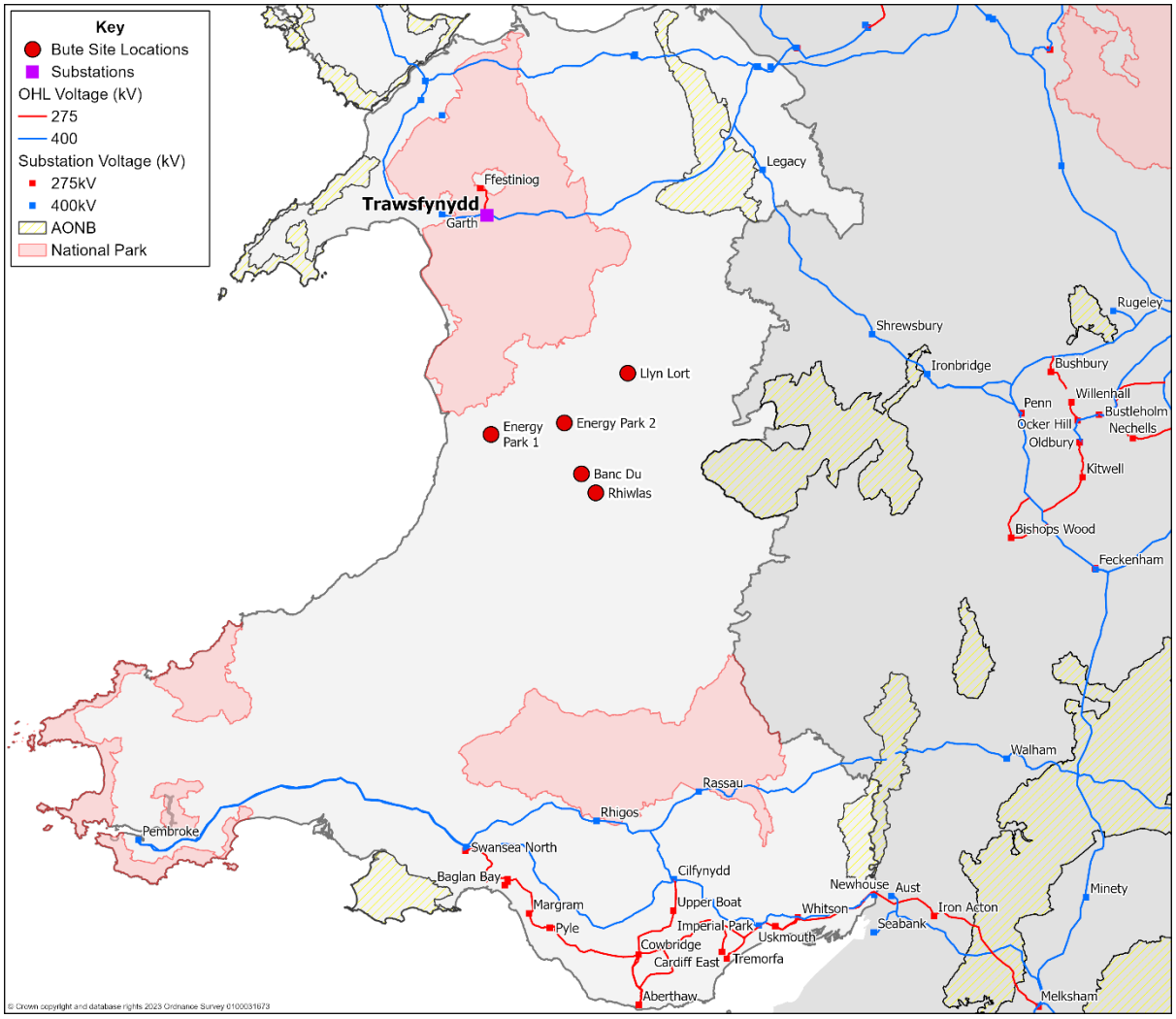
105. Employing the assessment criteria explained earlier within this document, we considered the implications of connecting the Energy Parks via single routes into each of the 10 connection options. We considered connecting into the existing NGET substations within each zone, and where appropriate, into potential new substations.

106. A summary of each of the 10 connection options considered, including the potential distance of the proposed connection in each case[16] and an outline of the key anticipated environmental or technical constraints at this stage is provided below.

[16] The 'point-to-point' measurements used within this section refers to the approximate distance from the central point of Mid Wales Energy Parks to the connection substation.

Options within the North Zone

Option 1 - Trawsfyndd (Existing substation)



107. 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 Eryri National Park.

Technical Requirements

108. A direct point to point connection from the Mid Wales Energy Parks to the Trawsfynydd substation would require approximately 53 km of OHL.

109. From a technical perspective, this connection length is one of the shortest and could lead to lower electrical losses compared to other options located further from the Mid Wales Energy Parks. This option is however only marginally longer than the shortest option (by 1km). From a technical perspective, there is little difference between this and the shorter options in terms of electrical losses.

110. An extension to the existing Trawsfynydd substation (itself within the National Park) would be required for this connection option.

Environmental Considerations

111. It is not possible to avoid the National Park by routeing. A prospective connection into the National Park would give rise to significant planning and environmental risks, given the great weight given to statutory purposes of National Park in planning policy and the desirability of avoiding, where possible, new infrastructure within National Parks.

112. Assuming a new connection into the National Park could be justified it is expected that approximately 32 km of cable out of the total 53 km would need to be undergrounded which could lead to potentially significant additional environmental impacts, technical routeing difficulties and costs associated with these connection circuits. This significant amount of underground cable could also have a detrimental effect on the environment within the Eryri National Park, including impacts on habitats and species associated with the laying of underground cables.

113. In addition to potential impacts on the Eryri National Park, that could not be avoided when routeing any connection could also interact with a number of additional key designations, including (but not limited to):

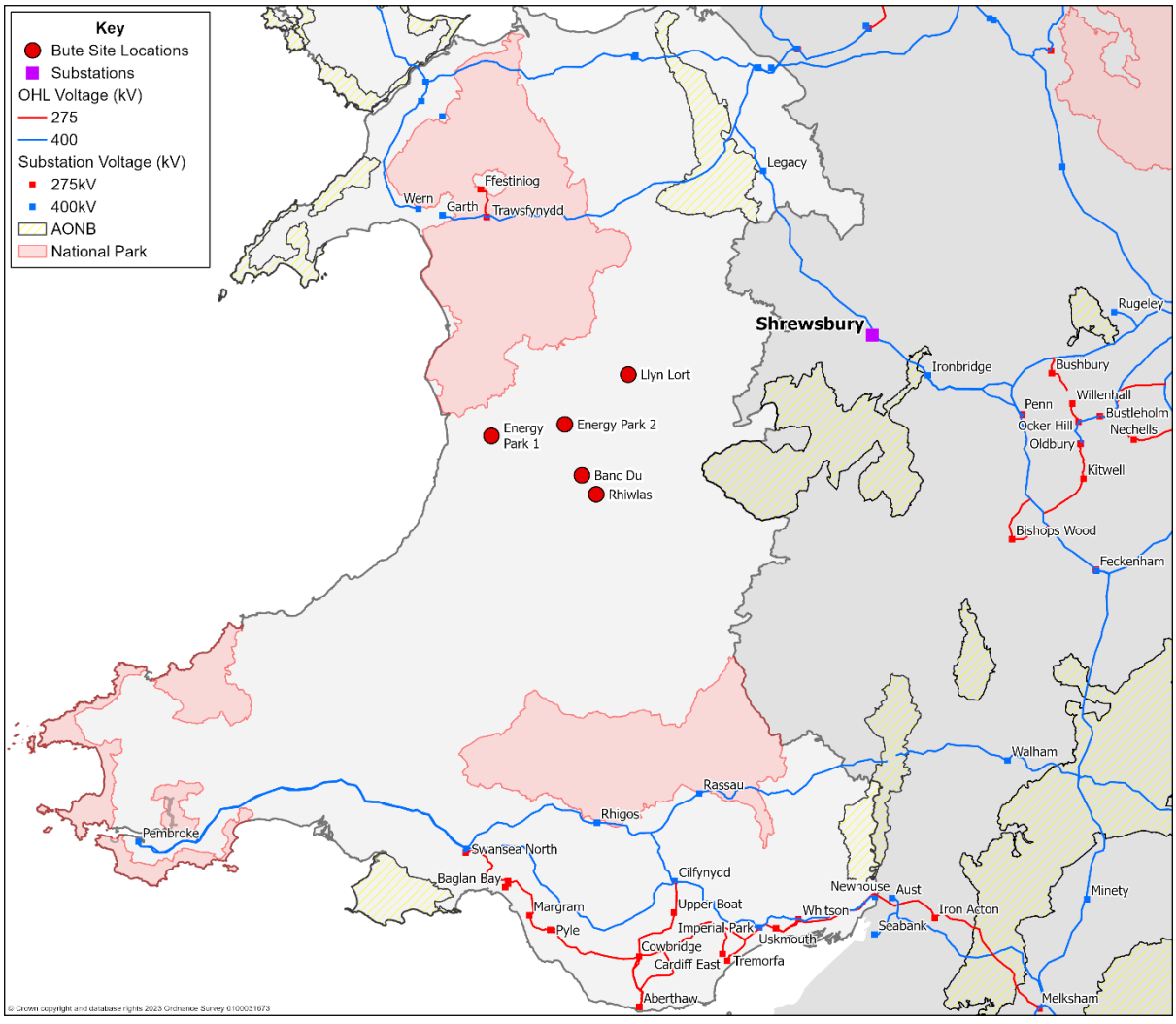
- Migneint-Arenig-Dduallt – Special Area of Conservation and Special Protection Area
- Berwyn and South Clwyd Mountains – Special Area of Conservation
- Berwyn – Special Protection Area and Special Area of Conservation
- Eryri / Snowdonia – Special Area of Conservation

Cost Assumptions

114. Based on the anticipated point to point connection distance from the Mid Wales Energy Parks to the Trawsfyndd 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.

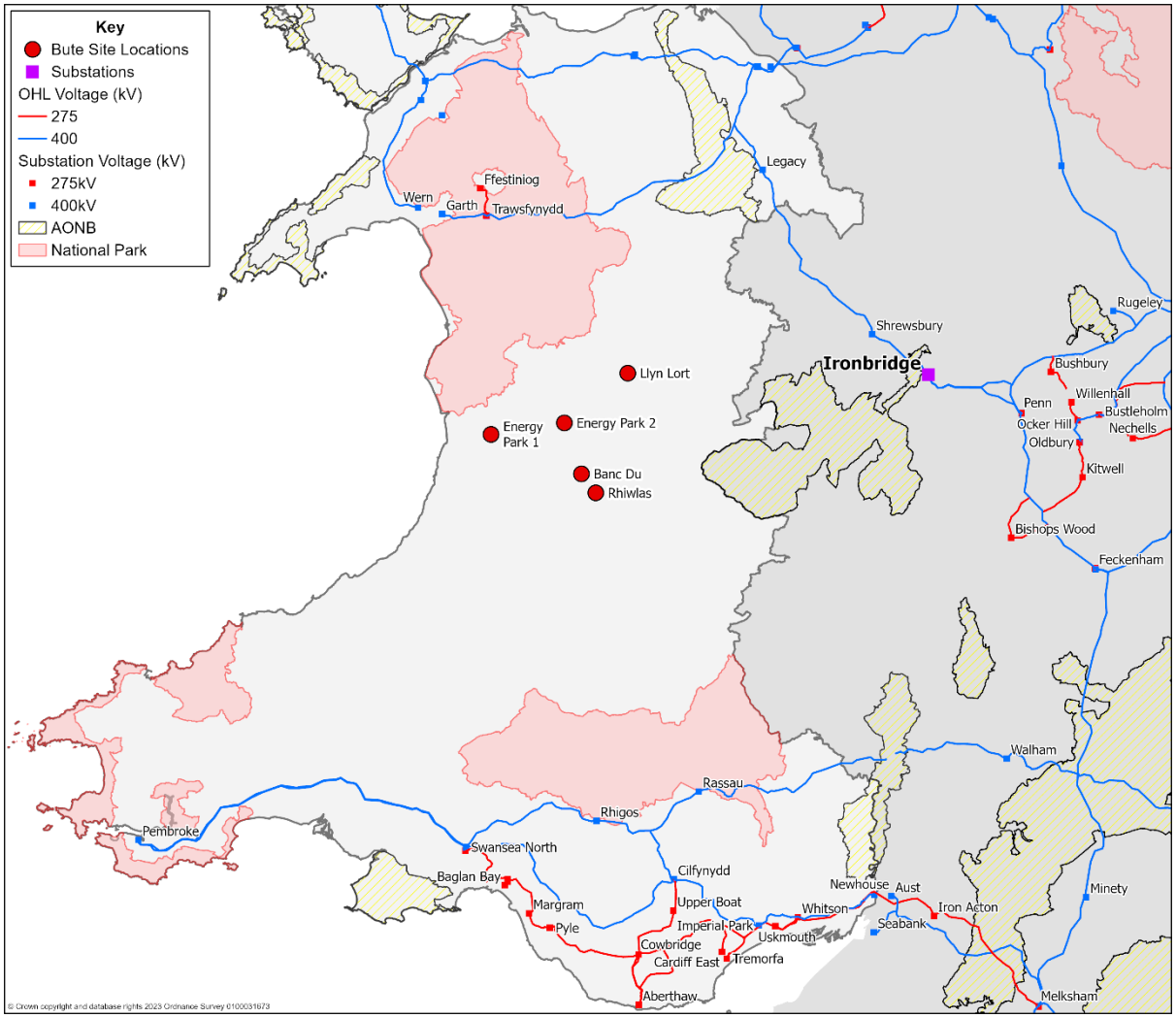
Substation	Direct point-to-point distance	Mitigations required	Indicative cost estimate
Trawsfynydd	c. 53 km	Undergrounding (c. 32 km) and substation extension	c. £129.3m

Option 2 - Shrewsbury (New substation)



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

Option 3 - Ironbridge (Existing substation)



116. 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. Although this is an existing substation due to its size and equipment a new substation would be required.

117. 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 AONB.

118. Although a connection route to Shrewsbury would not have to pass through the AONB it would be in proximity and could potentially impact on its setting. This interaction could lead to effects on the special qualities of the AONB.

119. A prospective connection to Ironbridge substation through the AONB would give rise to significant planning and environmental risks, given the great weight given to AONBs in planning policy and the regard given to the purpose of conserving and enhancing their natural beauty.

120. Assuming a new connection through the AONB could be justified it is expected that approximately 19 km of underground cable out of the total 67 km would need to be undergrounded which could lead to potentially significant additional environmental impacts, technical routeing difficulties and costs associated with these connection circuits. This significant amount of underground cable could also have a detrimental effect on the environment within the AONB, including impacts on habitats and species associated with the laying of underground cables.

121. A route avoiding the AONB (c. 79 km) would be the longest of any of the options in the North Zone.

122. In addition to the AONB, Ironbridge substation is located approximatley1.6 km from the Ironbridge Gorge World Heritage Site

Technical Requirements

123. A direct point to point connection from the Mid Wales Energy Parks to either the Shrewsbury or Ironbridge substations would be approximately 57 km and 67 km respectively.

124. From a technical perspective, this connection length to Shrewsbury is one of the shortest and could lead to lower electrical losses compared to other options located further from the Mid Wales Energy Parks. A new substation would be required at Shrewsbury.

125. When considering a direct point to point distance only, a connection to Ironbridge would be the longest option when compared to other options in the North Zone, and significantly longer if routed to avoid the AONB. This could lead to higher electrical losses compared to other options in the North Zone located closer to the Energy Parks.

Environmental Considerations

126. Any connection would need to minimise impacts on the Shropshire Hills AONB, located a short distance from the existing substations. In addition, potential effects on the Ironbridge Gorge World Heritage would have to be considered and minimised.

127. It is considered feasible that any connection from the Mid Wales of Energy Parks to the Shrewsbury substation could be routed without traversing the Shropshire Hills AONB itself. There would however be the potential for effects on the setting of the AONB due to topography. Routeing through the AONB would require undergrounding of the connection.

128. A connection to the Ironbridge substation would require undergrounding of that part of the connection within the AONB and there could still be the potential for effects on the setting of the AONB. In addition, the construction of an underground connection could present significant challenges due to topography.

129. It is considered that to avoid direct impacts on the AONB, a connection from the Mid Wales Energy Parks to Ironbridge would involve significant routeing diversions adding approximately 12 km to the length of the connection. Even considering potential routeing diversions to avoid direct impacts, the connection would still pass through the setting of the Shropshire Hills AONB to reach the existing substation.

130. Depending on the route of the connection there would also be the potential for indirect effects on the Ironbridge Gorge World Heritage Site.

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

- Clarewen National Nature Reserve
- Elenydd Special Protection Area and Special Area of Conservation
- Cors Caron National Nature Reserve, Ramsar site and Special Area of Conservation
- The Stipperstones and the Hollies SAC (within the AONB)

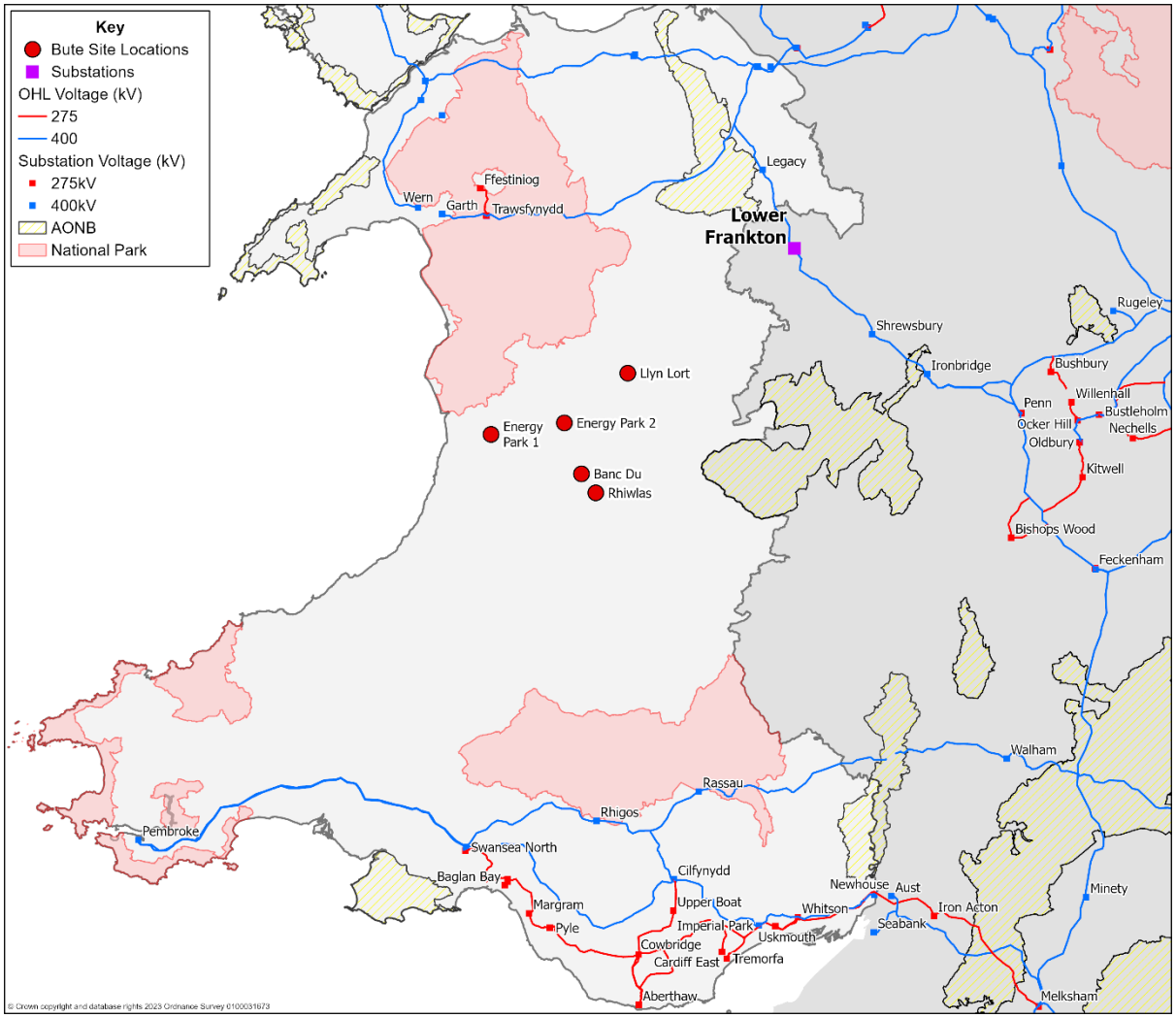
132. The proximity of the two existing substations to the town of Shrewsbury is also noted. This could lead to routeing challenges and the need for further OHL diversions to avoid heavily populated areas and existing infrastructure.

Cost Assumptions

133. Based on the anticipated point to point connection distance from the Mid Wales Energy Parks to the Shrewsbury or Ironbridge substations and the assumed mitigation required for routeing around the Shropshire Hills Area of Outstanding Natural Beauty, the following high level cost assumption has been applied to these options.

Substation	Direct point-to-point distance	Mitigations required	Indicative cost estimate
Shrewsbury	c. 57 km	OHL routeing and substation extension	c. £53.5 m
Ironbridge	c. 67 km	Undergrounding (c. 19 km) and substation extension	c. £98.6 m
Ironbridge	c. 79 km	OHL routeing (including diversion (c. 12 km) and substation extension	c. £49.5 m

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 along the existing 400kV overhead line in the vicinity of the village of Lower Frankton, England. Lower Frankton is approximately 8 km north-east of the town of Oswestry, and approximately 13 km east of the Welsh-English border. We have considered this new Lower Frankton substation it is proposed by National Grid. A substation in this area would be located nearby to the existing transmission circuits, and it is not located within, or immediately adjacent to, Eryri National Park or the Shropshire Hills AONB.

Technical Requirements

135. A direct point to point connection from the Mid Wales Energy Parks to a new substation at Lower Frankton would be approximately 52 km in length.

136. This is one of the shorter options to connect the proposed Mid Wales Energy Parks to the NETS and therefore would lead to the lower electrical losses compared to other options located further from the Energy Parks.

Environmental Considerations

137. Although the Shropshire Hills AONB is to the east the connection option, due to topography the connection could be routed to avoid either direct or indirect effects.

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

- Clarewen National Nature Reserve
- Elenydd SAC and SPA
- Cors Caron National Nature Reserve, Ramsar site and SAC
- Montgomery Canal SAC

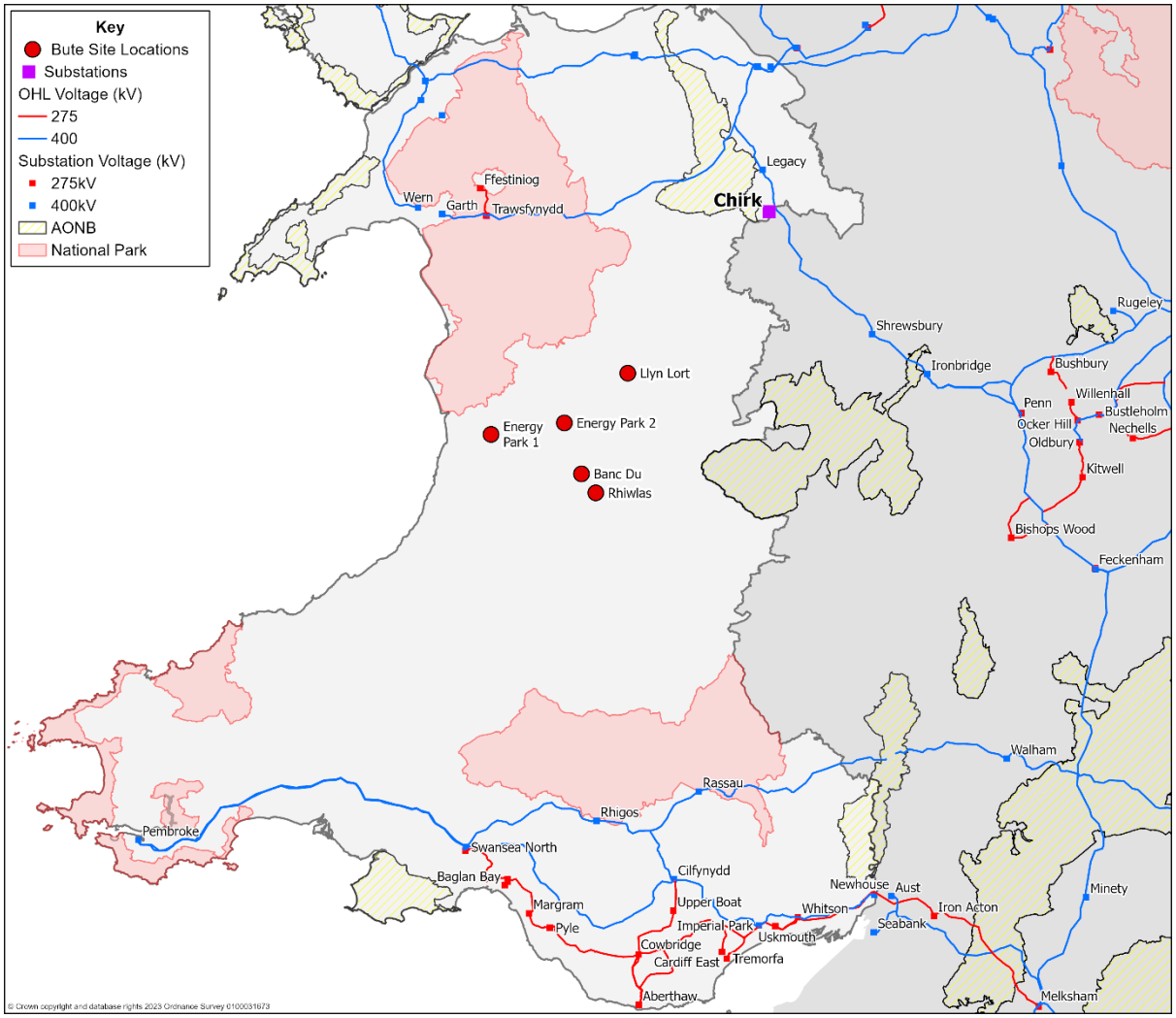
139. All options involving a new Connection Substation would involve a degree of environmental impact, additional cost and deliverability risk, when compared to connecting into an existing NGET substation.

Cost Assumptions

140. Based on the anticipated point to point connection distance from the Mid Wales 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	Mitigations required	Indicative cost estimate
Lower Frankton	c. 52 km	OHL routeing and new substation	c. £51.0m

Option 5 – Chirk (New substation)



141. This option considers the possibility of connecting into a prospective new connection substation located in the vicinity of Chirk in Powys. This is referred to as the new 'Chirk' substation within this document as it could be located close to the village of Chirk, along the existing 400kV overhead line. It is approximately 9 km west of the town of Oswestry. We have considered this new Chirk substation as it would be located nearby to the existing transmission circuits.

Technical Requirements

142. A direct point to point connection from the Mid Wales Energy Parks to a new substation at Chirk would be approximately 55 km in length.

143. This option is only marginally longer than the shortest option (by 3 km). From a technical perspective, there is little difference between this and the shorter options in terms of electrical losses.

Environmental Considerations

144. A direct route to a new Chirk substation from the Mid Wales Energy Parks could avoid passing through the Clwydian Range and Dee Valley AONB however it would be in very close proximity to the boundary and could impact on its setting and special qualities. This would give rise to significant planning and environmental risks, given the great weight given to AONBs in planning policy and the regard given to the purpose of conserving and enhancing their natural beauty.

145. Direct effects on the Pontcysyllte Aqueduct and Canal World Heritage Site and Scheduled Monument can potentially be avoided but the buffer zone which forms part of the setting (and the Outstanding Universal Value of the WHS) is unavoidable.

146. Due to the proximity to the AONB and the World Heritage Site it is likely that some undergrounding would be required. This could lead to potentially significant additional environmental impacts, technical routeing difficulties and costs associated with the connection circuits.

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

- River Dee SAC

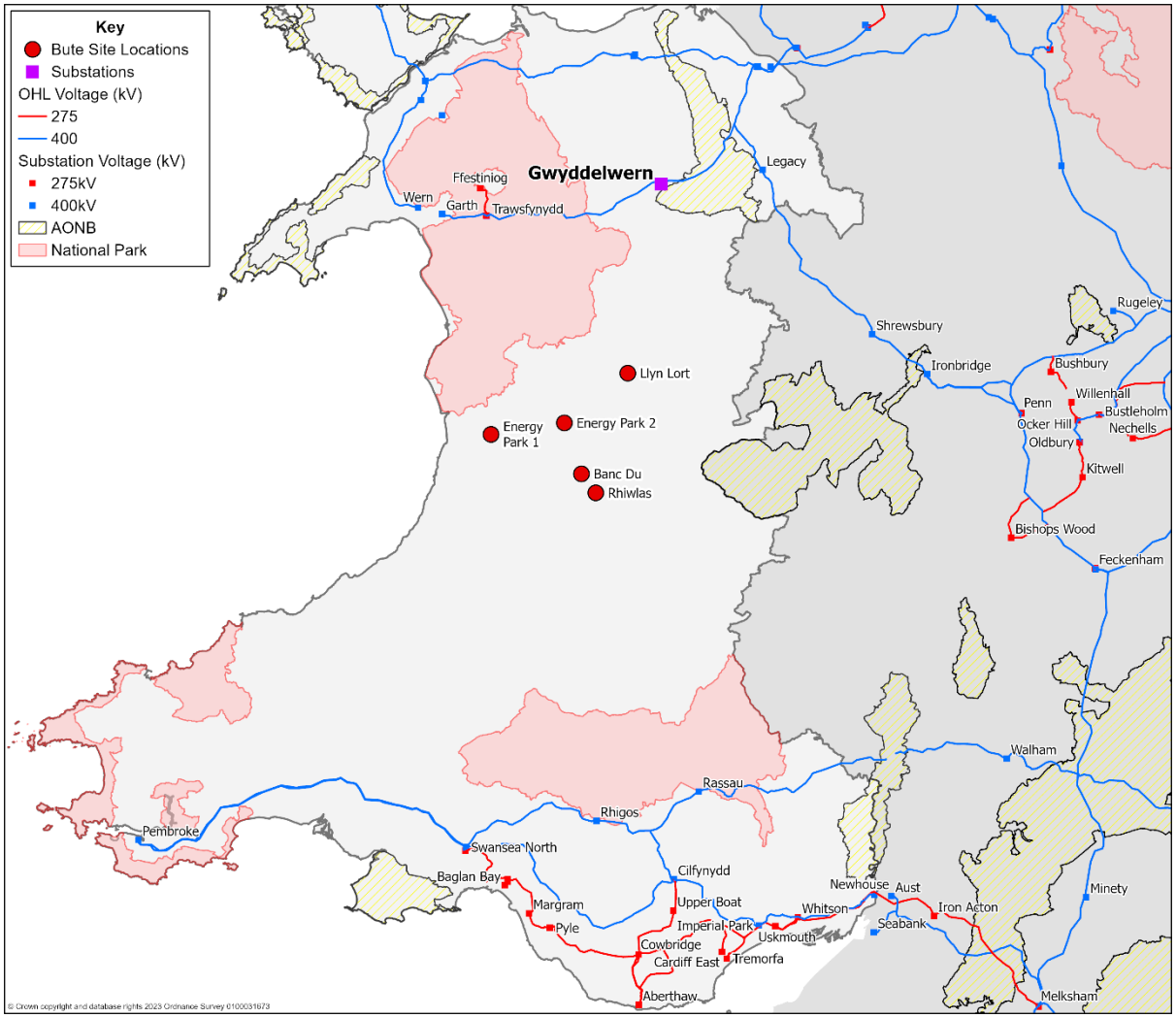
148. All options involving a new Connection Substation at Chirk would involve greater environmental impacts, additional cost and deliverability risk, when compared to connecting into an existing NGET substation.

Cost Assumptions

149. Based on the anticipated point to point connection distance from the Mid Wales of Energy Parks to a new potential substation at Chirk, 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	Mitigations required	Indicative cost estimate
Chirk	c. 55 km	OHL routeing and new substation	c. £52.5 m

Option 6 - Gwyddelwern (New substation)



150. This option considers the possibility of connecting into a prospective new connection substation located near Corwen at Gwyddelwern in Powys. This is referred to as the new 'Gwyddelwern' substation within this document. It is approximately 3 km east of the town of Corwen. We have considered this new Gwyddelwern substation as it is proposed by National Grid.

Technical Requirements

151. A direct point to point connection from the Mid Wales Energy Parks to the proposed new National Grid substation at Gwyddelwern would be approximately 52 km in length.

152. This is one of the shortest options to connect the proposed Mid Wales Energy Parks to the NETS and therefore would lead to the lower electrical losses compared to other options located further from the Energy Parks.

Environmental Considerations

153. A direct route to the new Gwyddelwern substation from the Mid Wales Energy Parks would need to pass through the Berwyn SPA, SSSI and National Nature Reserve and the Berwyn and South Clywd Mountains SAC and may need to pass close to or through the western boundary of the Clwydian Range and Dee Valley AONB.

154. A direct route to Gwyddelwern substation from the Mid Wales Energy Parks could avoid passing through the Clwydian Range and Dee Valley AONB however it would be in very close proximity to the boundary and could impact on its setting and special qualities. This would give rise to significant planning and environmental risks, given the great weight given to AONBs in planning policy and the regard given to the purpose of conserving and enhancing their natural beauty.

155. Due to the proximity to the AONB it is likely that some undergrounding would be required. This could lead to potentially significant additional environmental impacts, technical routeing difficulties and costs associated with the connection circuits.

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

- Bwerwyn and South Clwyd Mountains SAC and SPA
- Eryri National Park

157. Due to the location of the other environmental designations the SACs and SPAs could only be avoided by routeing through the Eryri National Park or the AONB. A prospective connection into the National Park would give rise to significant planning and environmental risks, given the great weight given to statutory purposes of National Park in planning policy and the desirability of avoiding, where possible, new infrastructure within National Parks. As noted above a connection through the AONB would also give rise to significant planning and environmental risks. Routeing to avoid the SACs and SPAs would add significant length to the connection with the associated environmental impacts, technical considerations and costs.

158. A connection through the SAC / SPA would be subject to assessment under the Conservation of Habitats and Species Regulations 2017.

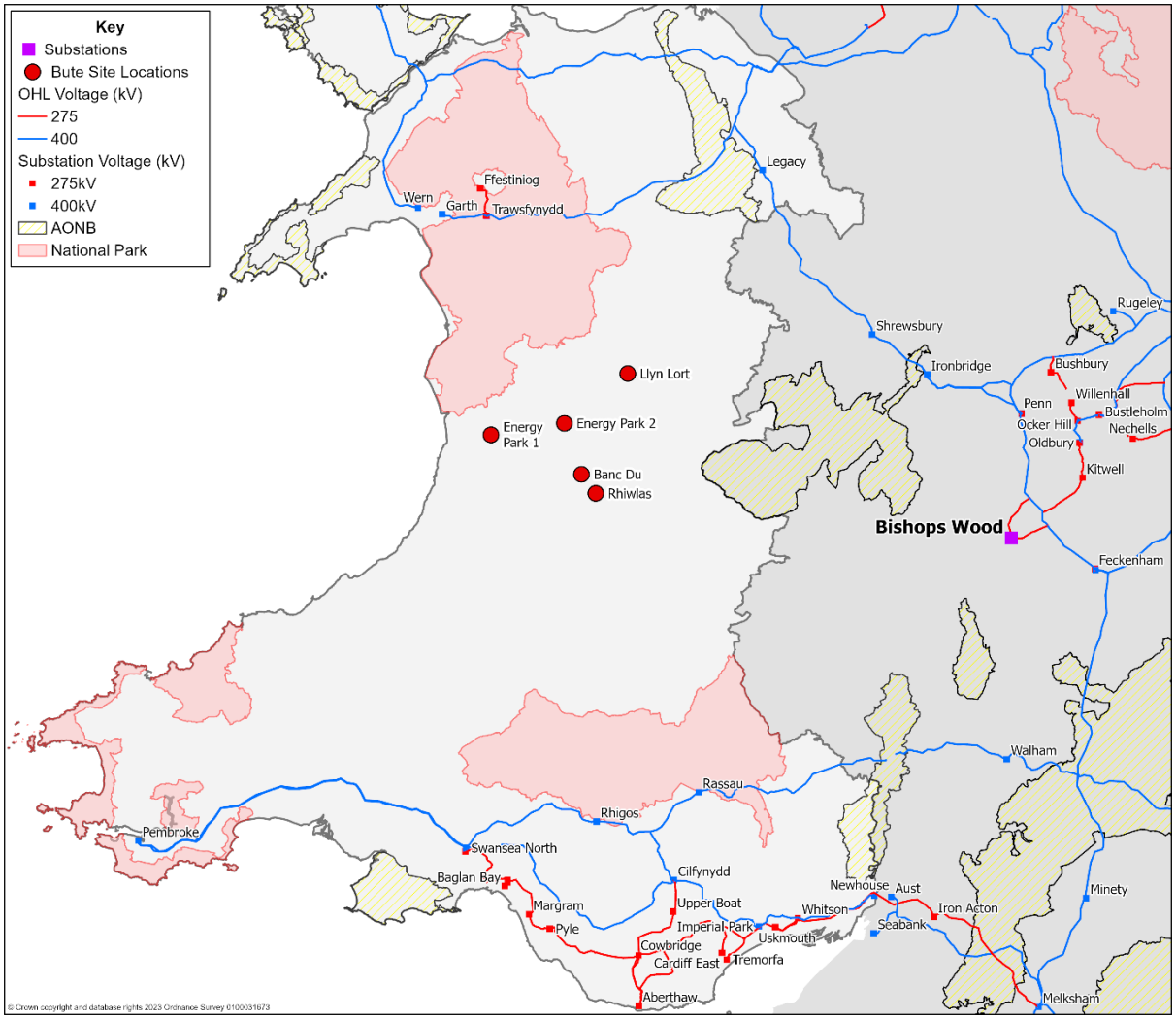
Cost Assumptions

159. Based on the anticipated point to point connection distance from the Mid Wales Energy Parks to a new potential substation at Gwyddelwern, including the potential for undergrounding, 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	Mitigations required	Indicative cost estimate
Gwyddelwern	c. 52 km	Undergrounding (c. 2 km) and substation extension	c. £41.8 m

Options within the East Zone

Option 7 – Bishops Wood (Existing substation)



160. This option considers the possibility of connecting into the existing 275kV substation at Bishops Wood located in Wychavon District in Worcestershire. It is approximately 4 km south of the town of Stourport on Severn and to the east of the Mid Wales Energy Parks.

Technical Requirements

161. A direct point to point connection from the Mid Wales Energy Parks to the existing National Grid substation at Bishops Wood would be approximately 88 km in length.

162. This is one of the longer options, significantly longer if routed to avoid the AONB, to connect the proposed Mid Wales Energy Parks, to the NETS and therefore would lead to higher electrical losses compared to other options located closer to the Energy Parks.

Environmental Considerations

163. A direct route to the Bishops Wood substation from the Mid Wales Energy Parks would need to pass through the Shropshire Hills AONB. Due to the configuration of the boundary of the AONB it would be likely to fall within the AONB or its setting for a significant portion of its length. This would give rise to significant planning and environmental risks, given the great weight given to AONBs in planning policy and the regard given to the purpose of conserving and enhancing their natural beauty.

164. It is considered that to avoid direct impacts on the AONB, a connection from the Mid Wales Energy Parks to Bishops Wood would involve significant routeing diversions adding approximately 50 km to length of the connection. Even considering potential routeing diversions to avoid direct impacts, the connection would have to be sensitively routed to avoid impacting on the setting of the AONB.

165. There are no other environmental designations along or in the vicinity of this connection.

Cost Assumptions

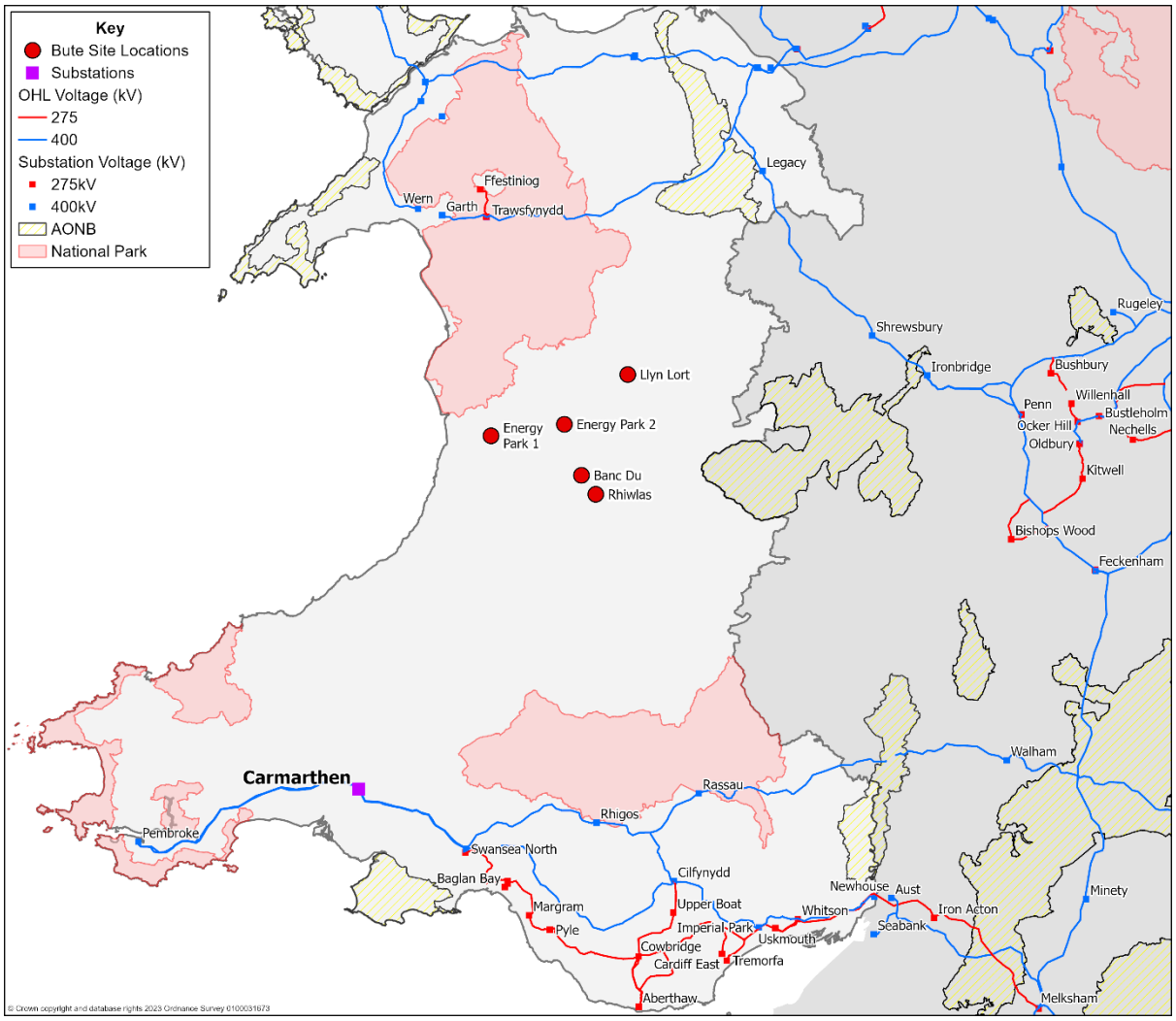
166. Based on the anticipated point to point connection distance from the Mid Wales of Energy Parks to the existing substation at Bishops Wood the following high level cost assumption has been applied to this option.

Substation	Direct point-to-point distance	Mitigations required	Indicative cost estimate
Bishops Wood	c. 88 km	Undergrounding (c 30 km) and substation extension	c. £141 m
Bishops Wood	c. 138 km	OHL routeing (including diversion (c. 50 km) and substation extension	c. £79 m

Options within in the South Zone

167. Whilst it is acknowledged that a route south from the Mid Wales Energy Parks could provide the benefit of potentially linking in with the South Wales Energy Parks in the Bute Energy portfolio, the combined amount of energy generated could not be accommodated on a single OHL route using L7 (or similar) towers. It would therefore necessitate an additional connection and could not be accommodated on the proposed grid connection described in the Green GEN Cymru Phase One Grid Connection Strategy Report and referred to as 'Towy Usk'.

Option 8 – Carmarthen (New substation)



168. This option considers the possibility of connecting into a prospective new connection substation located near Carmarthen in Carmarthenshire. This is referred to as the new 'Carmarthen' substation within this document. We have considered this new Carmarthen substation as it is proposed by National Grid as the point of connection for other Energy Parks in the Bute portfolio. The justification for the other Bute South Wales Energy Parks to connect into a new substation in Carmarthenshire can be found in the Green GEN Phase One Grid Connection Strategy.

Technical Requirements

169. A direct point to point connection from the Mid Wales Energy Parks to the new Carmarthen substation would require approximately 99 km of infrastructure. When considering a direct point to point distance only, this is one of the longest connections when compared to other options.

170. There would therefore be a significant distance between the proposed Mid 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.

171. An extension to the new Carmarthen substation would be required for this connection option.

Environmental Considerations

172. A connection to the new Carmarthen substation from the Mid Wales Energy Parks could be routed to avoid interacting directly with any National Parks or AONBs.

173. A direct route is likely however to pass in close proximity to Bute Energy's proposed South Wales Energy Parks. It is also likely that any route option could potentially follow a similar route to that proposed for the Green GEN Towy Usk project and other grid connections for the South Wales Energy Parks that may be proposed in future. It is considered that the potential for cumulative effects with other connections, promoted by Bute Energy and others, routeing to the Carmarthen substation is a key environmental consideration.

174. The connection would need to be routed sensitively to reduce potential impacts on a number of additional designations, including (but not limited to):

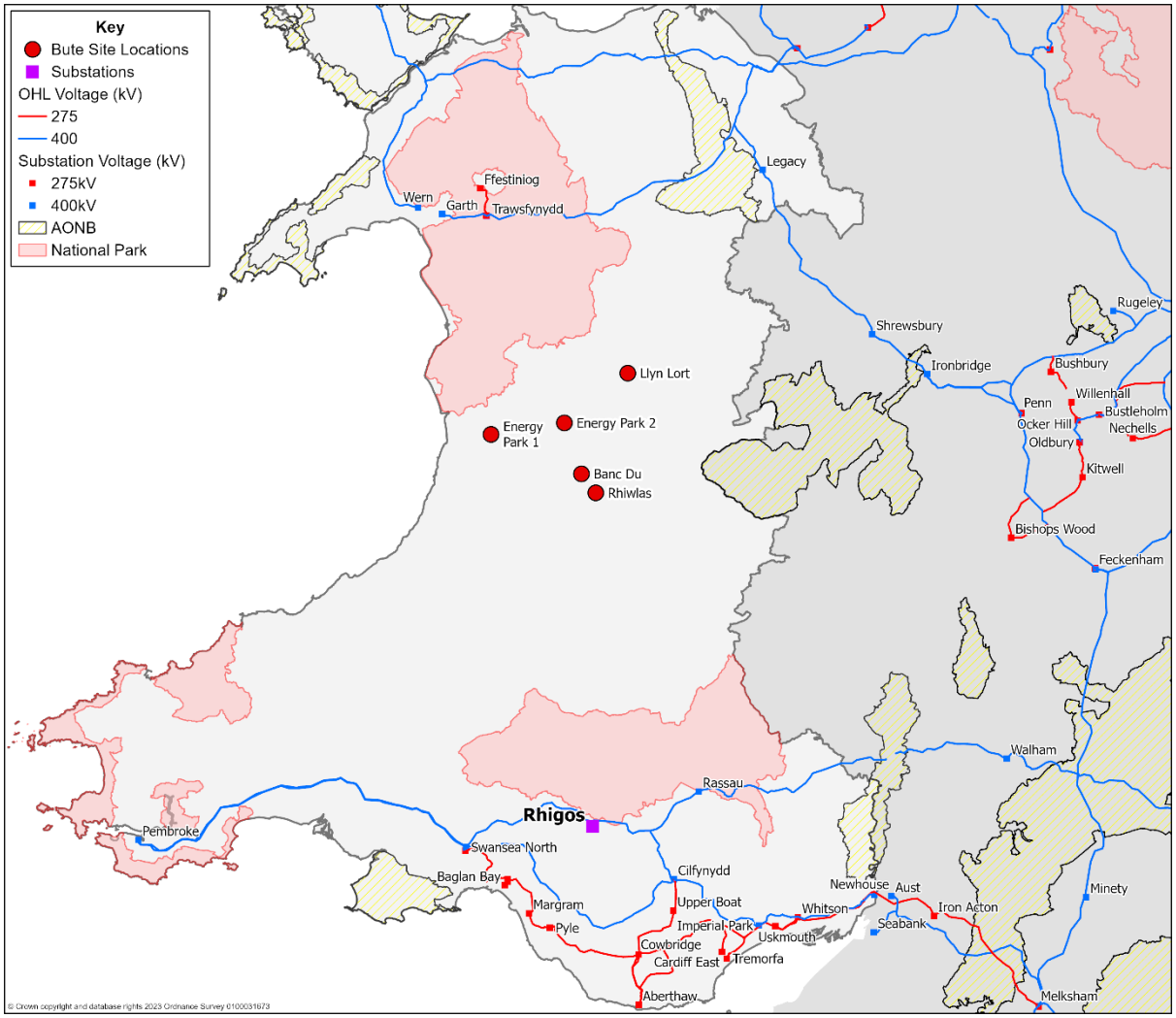
- River Wye SAC
- River Tywi SAC
- River Usk SAC
- Cwm Doethie - Mynydd Mallaen SAC
- Elenydd – Mallaen SPA
- Elan Valley Woodlands SPA

Cost Assumptions

175. Based on the anticipated point to point connection distance from the Mid Wales Energy Parks to the proposed Carmarthen substation, the following high level cost assumption has been applied to this option.

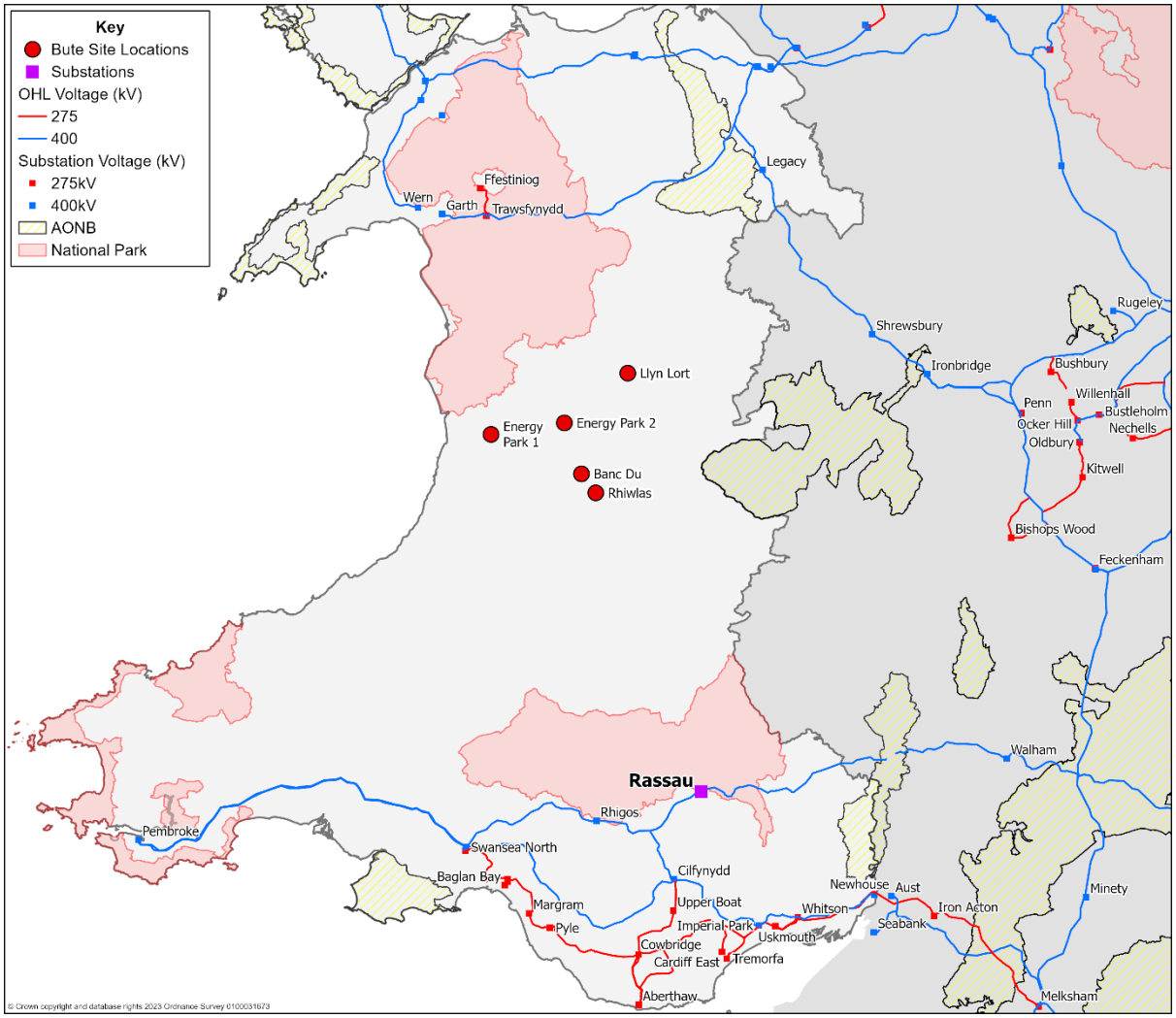
Substation	Direct point-to-point distance	Mitigations required	Indicative cost estimate
Carmarthen	c. 99 km	OHL routeing and substation extension	c. £59.5 m

Option 9 - Rhigos (Existing substation)



176. As the Rhigos and Rassau 400kV substations are geographically proximate, these connection options are discussed together below.

Option 10 - Rassau (Existing substation)



177. Both these substations are located adjacent to the southern edge of the Bannau Brycheiniog National Park and are within the Rhondda Cynon Taf County Borough and the Blaenau Gwent County Borough, respectively. There is a double 400kV circuit that connects Rhigos in the west to Walham Substation, via Rassau.

Technical Requirements

178. A direct point to point connection from the Mid Wales Energy Parks to the Rhigos or Rassau substations would require a route of approximately 89 km and 83 km in length respectively.

179. When considering a direct point to point distance only, these are longer connections when compared to other options considered and would be significantly longer if routed to avid the National Park. There would therefore be a significant distance between the proposed Mid Wales Energy Parks and these substations. From a technical perspective, this could lead to higher electrical losses compared to other options located closer to the Energy Parks.

180. An extension to the existing Rhigos or Rassau substations would be required for these connection options.

Environmental Considerations

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

182. 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.

183. Assuming a new connection into the National Park could be justified, it is expected that approximately 23 km or 17 km respectively of the proposed connections would need to be undergrounded, which could lead to potentially significant additional environmental impacts, technical routeing difficulties and costs associated with these connection circuits. This significant amount of underground cable 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 underground cables.

184. 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 34 km or 98 km respectively. Furthermore, should diversions of this length be proposed to avoid direct impacts, there remains the potential for the routes to have impacts on the setting of the National Park.

Cost Assumptions

185. Based on the anticipated point to point connection distance from the Mid Wales 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	Mitigations required	Indicative cost estimate
Rhigos	c. 89 km	Undergrounding (c. 23 km) and substation extension	£121.2 m
Rhigos	c. 123 km	OHL routeing diversion (c. 34 km) and substation extension	c. £71.5 m
Rassau	c. 83 km	Undergrounding (c 17 km) and substation extension	c. £115.8 m
Rassau	c. 181 km	OHL routeing diversion (c. 98 km) and substation extension	c. £100.5 m

Summary and Preferred Option

Summary of options within the North Zone

186. The options within the North Zone offer a variety of connections at mostly similar point-to-point route lengths. The shortest direct point-to-point total length would be a connection from the Mid Wales to Lower Frankton or Gwyddelwern, whilst the longest distance would be a connection to Ironbridge substation.

187. A new connection from the Energy Parks to Ironbridge 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.

188. A connection to Ironbridge substation would also need to pass through, or divert around, the Shropshire Hills AONB. 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.

189. In view of these factors, a possible new connection between the Mid Wales Energy Parks and Ironbridge should be discounted.

190. Whist a direct route to Trawsfyndd would offer a shorter and more direct connection route than other options, a connection would have to pass through the Eryri National Park as it is unavoidable. If this option was to be progressed, we would expect that a significant portion of the route would be undergrounded. In addition to the significant financial costs associated with undergrounding, this would also lead to substantial disruption within the Eryri National Park, impacting on local communities, visitors to the National Park, as well as the environment and its scenic beauty.

191. For these reasons and given the availability of other options with lesser impacts on the National Park, this option should be discounted.

192. Although a connection route to Shrewsbury would not have to pass through the Shropshire Hills AONB it would be in proximity and could potentially impact on its setting. This interaction could lead to effects on the special qualities of the AONB and the associated material planning and consenting risks, as well as additional costs associated with mitigation measures that are likely to be required. Routeing would however have to consider the effects on the proximity to Shrewsbury itself. As the existing substation is unlikely to be able to accommodate the required equipment a new substation would be required at additional cost. Given the availability of other options at similar cost this option has been discounted.

193. A connection to a new substation at Lower Frankton would be within or in proximity to any designated landscapes and therefore would not affect the settings. It is one of the shorter options and although not the least cost the potential for significant environmental effects is less than for other options.

194. A direct connection to a new Chirk substation could avoid passing through the Clwydian Range and Dee Valley AONB however it would be in very close proximity and could impact on its setting and special qualities. A direct connection would also have potential effects on the Pontcysyllte Aqueduct and Canal World Heritage Site and Scheduled Monument. These interactions and the associated material planning and consenting risks mean this option has been discounted.

195. A direct route to the new Gwyddelwern substation would interact with the Berwyn SPA, SSSI and National Nature Reserve and the Berwyn and South Clywd Mountains SAC and would pass close to the western boundary of the Clwydian Range and Dee Valley AONB. Although this option is the least cost the material planning and consenting risks associated with passing through the SACs mean that we have discounted this option.

Summary of options within the East Zone

196. A route to the existing Bishops Wood 275kV substation would be longer than options in the North Zone. In addition, a connection to Bishops Wood would need to pass through, or diverted around, the south of the Shropshire Hills AONB. These interactions could lead to increased environmental impacts and the associated material planning and consenting risks, as well as additional costs associated with the mitigation measures that are likely to be required.

197. In view of these factors, a possible new connection between the Mid Wales Energy Parks and Bishops Wood should be discounted.

Summary of options within the South Zone

198. All of the connection options within the South Zone would require more than 80 km of connection circuits. There is therefore a significant distance between the proposed Mid Wales Energy Parks and all South Zone options in comparison with a number of the connection points in the northern zone.

199. Two of the three options within the South Zone could have significant interactions with the Bannau Brycheiniog National Park. A direct connection would also have to pass through SPAs and SACs, which are unavoidable. These interactions would likely lead to increased environmental impacts and the associated material planning and consenting risks, as well as additional costs associated with avoidance and compensatory measures that would be required.

200. The longer anticipated routes to connection options in the South Zone would lead to additional cost, interaction with more land and environmental receptors, increased disruption and higher electrical losses.

201. Whilst it is acknowledged that a southern route from the Mid Wales Energy Parks could provide the benefit of potentially linking in with other Energy Parks in the Bute Energy portfolio, the combined amount of energy generated could not be accommodated on a single OHL route using L7 (or similar) towers. It would therefore necessitate an additional connection and could not be accommodated on the proposed connections from the South Wales Energy Parks described in the Green GEN Cymru One Grid Connection Strategy Report.

202. It is therefore considered that options within the South Zone should be discounted from further consideration.

Preferred Option

203. After considering each of the factors associated with the options, in particular noting the greater length of the circuits on the East and South Zones. (leading to greater electrical losses, higher costs and potentially increased environmental effects), and the environmental considerations for options in the North Zone, Option 4 (Lower Frankton – New substation) has been selected as the preferred grid connection option for the Mid Wales Energy Parks.

204. Although not the least cost option, following our appraisal of the options, this was considered, on balance, 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 Mid Wales Energy Parks to the Transmission Network. This option would ensure compliance with the licence obligations that Green GEN Cymru would be subject to as a prospective IDNO Licence holder. Option 4 will be taken forward for further consideration through further, more detailed routeing studies.

The Collector Substation

205. Although the Strategic Options have been considered from a central point in the Mid Wales Energy Parks Cluster, consideration has been given to the identification of an area for a collector substation.

206. A collector substation is required to 'collect' the generation from the Mid Wales Energy Parks and connect the combined generation to the strategic grid route to Lower Frankton. It would also provide opportunities for other generation to access the strategic grid route.

207. Two broad option areas were considered:

- Broad Option 1 - in the general vicinity of the Mid Wales Energy Parks (excluding the area for the proposed Bute Llyn Lort Energy Park) and
- Broad Option 2 - to the west of Newtown, Powys (in the vicinity of the junction of the A470 and the A489).

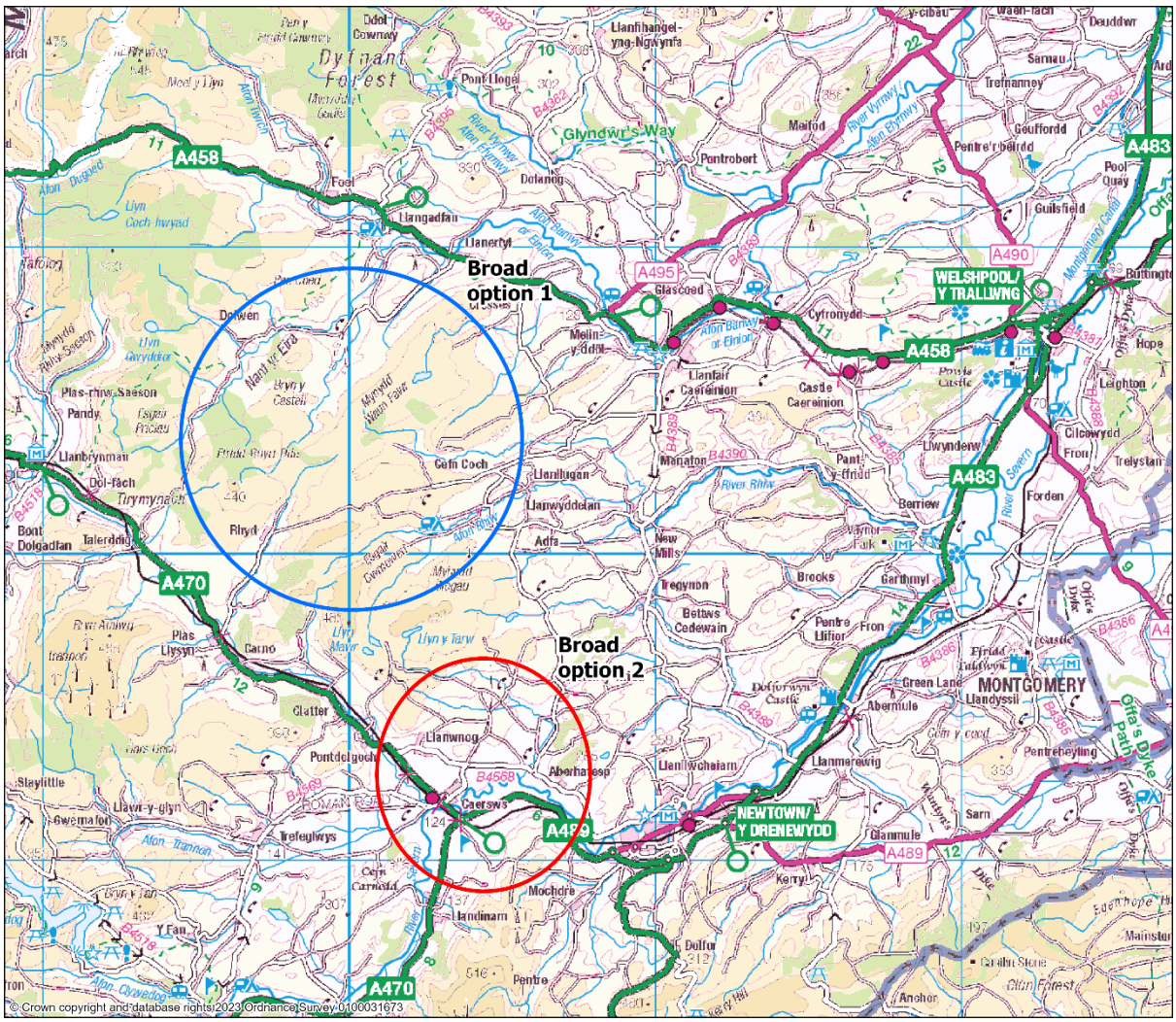


Figure 6 Broad Options Considered

208. It was considered that these general locations would offer opportunities for routeing a minimum of 5 connections on wood poles into the collector substation and routeing the strategic connection to Lower Frankton.

209. The consideration of the broad options is set out below:

Environmental Considerations

210. There are no SPAs, SACs or Ramsar sites which would potentially be affected, and the options are similar distances from the closest SSSIs.

211. Broad Option 2 is located in fewer LANDMAP aspect areas of 'high' overall evaluation, although it is within some aspect areas of 'outstanding' overall evaluation. There is however no overall preference in relation to LANDMAP. In terms of landscape character, the upland area (Broad Option 1) is relatively less sensitive though more exposed. The lowland location (Broad Option 2) is more sensitive due to smaller scale landscape, though more focused siting could benefit from more localised containment by vegetation. Broad Option1 is preferred as it is relatively less sensitive to this development and there are siting options which could benefit from containment by local topography and woodland screening. Broad Option 1 is also located in relatively more remote upland near fewer settlements.

212. For cultural heritage Broad Option 2 has a greater likelihood of effects related to setting change to Scheduled Monuments and Conservation Areas and is within a Registered Historic Landscape (the Caersws Basin). Broad Option 1 is therefore preferred.

213. More detailed investigation will be required to determine geology and peat conditions whichever option is selected.

Technical Considerations

214. Broad Option 1 is located further from the A road network and is likely to be accessed via the minor road network during construction and operation. There are proposed and consented wind farms in the vicinity of Broad Option 1 which may constrain routeing into a collector substation.

215. The capacity for routeing multiple wood pole OHLs into a collector substation and one steel lattice L7 tower route out of the substation has been considered. Routeing to Broad Option 2 would require potentially longer incoming connections on wood pole and would require additional OHL from the Llyn Lort Energy Park. Broad Option 1 offers shorter routeing opportunities from the Energy Parks and is therefore preferred.

Summary

216. The capacity for routeing the incoming OHLs, the need for an additional OHL and the potential greater effects for cultural heritage have led to, on balance a preference for Broad Option 1. Although in terms of construction, Broad Option 2 is preferred construction would result in only short-term effects. Broad Option 1 has therefore been taken forward for to more detailed siting of a collector substation location.

Current Project Status and Next Steps

217. Following the selection of Option 4 (Lower Frankton – new substation), and the are of Broad Option 1 for the collector substation these will be taken forward for further consideration through the routeing stage of project development and subsequent public and stakeholder consultation.

218. Throughout the continued development of the project, 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 UK and Welsh Governments, 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 project.