Plas Power Solar and Energy Storage Project

4.3 Environmental Statement Volume 3: Appendices

Part 14 of 14

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Appendix 9.1
Climate Change Policy Review

PLAS POWER SOLAR AND ENERGY STORAGE PROJECT

Environmental Statement: Appendix 9.1 - Policy Review

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1 CLIMATE CHANGE POLICY REVIEW

National Planning Policy and Legislation

1.1 Planning Policy Wales (Welsh Government, 2024a) states that the overall commitment to tackle climate change is of paramount importance and introducing new sources of renewable and low carbon energy is essential for meeting this commitment. The report sets out the goal of generating at least 70% of its electricity consumption from renewable sources by 2030.

1.2 Paragraph 5.7.13 states that the Welsh government recognises an energy hierarchy to which all new developments are expected to adhere to, thereby mitigating the causes of climate change. The energy hierarchy ensures that new developments will reduce energy demand and increase energy efficiency, are suitably located and designed and assist in meeting energy with renewable and low carbon sources. The energy hierarchy will become increasingly important with increased electrification (through increased use of electric vehicles etc).

1.3 Section 5.9: Renewable and Low Carbon Energy sets out the duty of planning authorities to facilitate renewable and low carbon energy developments and recognise that the benefits of renewable energy are part of the overall commitment to tackle climate change. Paragraph 5.9.1 states *"local authorities should facilitate all forms of renewable and low carbon energy development … local authorities should seek to ensure their area's full potential for renewable and low carbon energy generation is maximised and renewable energy targets are achieved"*.

1.4 Developments of National Significance: A Procedural Guide (Welsh Planning Inspectorate, 2019) defines a Development of National Significance (DNS) as *"all energy generation projects of between 10MW and 350MW"*. In these proposed developments, a Local Impact Report is required. Local Impact Reports give an objective view of the impacts of the proposed development in the local authority area in question, which may include its impacts on climate change and climate change mitigation measures.

1.5 Future Wales: The National Plan 2040 (Welsh Government, 2021b) sets out the direction for development in Wales to 2040, including key national priorities such as achieving decarbonisation and climate-resilience. This plan addresses the climate emergency and shows strong support for the development of renewable and low carbon energy, stating that "*The Welsh Government will support regional and local energy planning to identify opportunities for all types of renewable projects"*. It also emphasises that the construction of renewable and low carbon energy projects should be resource efficient, sustainable and reflect the principles of a circular economy.

1.6 Future Wales policy 17 outlines the Welsh Government's support for developments that involve renewable energy generation. These are applicable for Developments of National Significance.

- "*The Welsh Government strongly supports the principle of developing renewable and low carbon energy from all technologies and at all scales;*
- *In determining planning applications for renewable and low carbon energy development, decision makers must give significant weight to the need to meet Wales's international commitments and target to generate 70% of consumed electricity by renewable means by 2030;*
- *Proposals should describe the net benefits the scheme will bring in terms of social, economic, environmental and cultural improvements to local communities; and*
- *New strategic grid infrastructure for the transmission and distribution of energy should be designed to minimise visual impact on nearby communities"*

1.7 Future Wales policy 18 outlines further criteria that are required in addition to those from policy 17 that are relevant for Developments of National Significance:

- *"The proposal includes consideration of the materials needed or generated by the development to ensure the sustainable use and management of resources;*
- *There are acceptable provisions relating to the decommissioning of the development at the end of its lifetime, including the removal of infrastructure and effective restoration; and*
- *The cumulative impacts of existing and consented renewable energy schemes should also be considered"*

1.8 Alongside these policies are three targets relating to the provisioning of renewable electricity generation:

- "*For 70% of electricity consumption to be generated from renewable energy by 2030;*
- *For one gigawatt of renewable energy capacity to be locally owned by 2030; and*
- *For new renewable energy projects to have at least an element of local ownership from 2020".*

1.9 The Well-being of Future Generations (Wales) Act 2015 outlines seven well-being goals for a future Wales, built around sustainable development principles. This ensures that, in assessing current proposed developments, the needs of the present are met without compromising the ability of future generations to meet their own need. The Act states that in considering proposed developments, public bodies must take into account all seven well-being goals, which include the ambition to reach a *"low carbon society which recognises the limits of the global environment and therefore uses resources efficiently and proportionately (including acting on climate change)"* (from 'a Prosperous Wales' goal).

1.10 The Climate Change Act 2008 as amended commits the UK government to reducing greenhouse gas emissions by 100% of 1990 levels by 2050 and created a framework for setting a series of interim national carbon budgets and plans for national adaptation to climate risks.

1.11 At present, the Third, Fourth, Fifth and Sixth Carbon Budgets, set through The Carbon Budget Orders 2009, 2011, 2016 and 2021, are 2.54 GtCO2e for 2018-2022, 1.95 GtCO2e for 2023-2027, 1.73 GtCO2e for 2028-2032 and 0.97 GtCO2e for 2033-2037 respectively. The Sixth Carbon Budget is the first Carbon Budget that is consistent with the UK's net zero target, requiring a 78 % reduction in GHG emissions by 2035 from 1990 levels.

1.12 The Climate Change Act also created the Committee on Climate Change (now Climate Change Committee) to give advice on carbon budgets and report on progress. The Committee through its Adaptation Sub-Committee also gives advice on climate change risks and adaptation. Its advice regarding carbon and climate policy relevant to the Project is summarised below.

1.13 The Environment (Wales) Act (2016) provides Welsh ministers with powers to put in place statutory emissions reduction targets, including an aspiration to achieve net zero GHG emissions by 2050.

1.14 The Climate Change (Carbon Budgets) (Wales) (Amendment) Regulations 2021 regulates two carbon budgetary periods; the period of 2021-2025 limits GHG emissions to an average of 37% lower than the 1990 baseline (this is updated from 33% as stated within the 2018 Regulations), and the period of 2026-2030 limits GHG emissions to an average of 58% lower than the baseline.

National energy and climate change policy

Clean Growth Strategy, 2017

1.15 The 2017 Clean Growth Strategy for the UK (BEIS, 2018) contains a key objective of 'Delivering Clean, Smart, Flexible Power' and details specific policies through which this can be achieved:

- Policy 33 of the report states the government's intention to phase out the use of unabated coal for electricity production by 2025;

- Policy 35 sets government's intentions to improve the route to market for renewable technologies;
- Policy 36 details plans to target a total carbon price in the power sector which will give businesses greater clarity on the total price they will pay for each tonne of emissions.
- Policy 37 sets the government's intentions to improve the route to market for energy storage systems, with £265 million investment in smart systems to reduce the cost of electricity storage, advance innovative demand response technologies, and develop new ways of balancing the grid.

1.16 The Strategy discusses a potential low-carbon pathway whereby annual emissions are as low as 16 $MtCO_2e$ by 2032. The report states this is only likely to be achieved if low-carbon power generation including renewables and nuclear has the capacity to provide at least 80% of generation demand. The report also states the penetration of low-carbon power to this extent will rely on smarter, flexible electricity networks through the use of energy storage and demand-side management.

Energy Efficiency in Wales: A strategy for 2016-2026

1.17 The Energy Efficiency in Wales Strategy (Welsh Government, 2016) outlines the opportunities for improved energy efficiency and renewable energy production. Of most relevance to renewable energy generation, is area of action 1.11 – *"Facilitating renewable and low carbon energy development through the planning system".* This sets out measures to improve local development plans to facilitate renewable energy developments.

Energy White Paper: Powering Our Net Zero Future, 2020

1.18 The Energy White Paper builds on the Ten Point Plan to set energy-related measures in a long-term strategic vision, working towards the net zero emissions target for 2050. It establishes a shift from fossil fuels to cleaner energy in terms of power, buildings and industry, whilst creating jobs and growing the economy. In addition to this, the best solutions should be determined for very low emissions and reliable supply, keeping cost low for consumers.

1.19 Focusing on electricity is key for the transition away from fossil fuels and decarbonising the economy by 2050. Some commitments from this white paper include:

- Accelerate the deployment of clean electricity generation through the 2020s
- Invest £1 billion in UK's energy innovation programme to develop the technologies of the future such as advanced nuclear and clean hydrogen
- Ensure that the transformation of the electricity system supports UK jobs and new business opportunities, at home and abroad.

1.20 The Net Zero Innovation Portfolio (DESNZ, 2023b) has been developed, and aims to *"accelerate the commercialisation of innovative low-carbon technologies, systems and processes in power, buildings and industry to set the UK on the path to net zero and create world-leading industries and new jobs."* It looks to focus on ten priority areas, including energy storage and flexibility to decarbonise the energy system.

1.21 Key commitments relating to the energy system include:

- *"Publish a new Smart Systems Plan in spring 2021, jointly with Ofgem, and define electricity storage in law, legislating when Parliamentary time allows;*
- *Through the Net Zero Innovation Portfolio, we will launch a major competition to accelerate the commercialisation of first-of-a-kind longer duration energy storage, as part of our £100 million investment in storage and flexibility innovation, with delivery from spring 2021; and*

- *We will legislate, when Parliamentary time allows, to enable competitive tendering in the building, ownership and operation of the onshore electricity network."*

National Infrastructure Strategy, 2020

1.22 The National Infrastructure Strategy focuses on the investment and delivery of infrastructure, which is fundamental to delivering net zero emissions by 2050. The strategy sets out the UK Government's plans to deliver on this target, decarbonising the economy and adapting to climate change:

- Work towards meeting the net zero emissions target by 2050 – Decarbonise the UK's power, heat and transport networks, and take steps to adapt to climate change impacts. This will require increased investments in network infrastructure, storage and increased renewable and low carbon generation capacity.
- Reducing emissions across whole sectors of the economy must be done in a sustainable way that minimises cost.

The Sixth Carbon Budget: The UK's Path to Net Zero, 2020

1.23 It has been advised that *"the UK sets its Sixth Carbon Budget to require a reduction in UK emissions of 78% by 2035 relative to 1990. This will be a world-leading commitment, placing the UK decisively on the path to Net Zero by 2050 at the latest, with a trajectory that is consistent with the Paris Agreement."*

1.24 Meeting the recommended budget will require major investment, with the upscaling of low carbon markets and supply chains. These investments should also have climate resilience in mind to account for the impacts of future climate change. Key objectives should be:

- reducing demand and improving efficiency: require changes that will reduce carbon-intensive activities and the improvement of efficiency in the use of energy and resources;
- take-up of low carbon solutions: phase out fossil fuel generation by 2035;
- expansion of low carbon energy supplies: increasing renewables to 80% of generation by 2050; and
- electricity generation: will require a significant expansion of low carbon generation; This includes low cost renewables, with more flexible demand and storage.

1.25 Increasing the renewables penetration in the UK electricity mix to 80% by 2050 will largely be met with intermittent, non-dispatchable generation types. The CCC suggest that on average, 3 GW per year of solar generation will need to be installed to reach renewable supply targets.

1.26 The budget report also breaks the economy down into sectors and provides emissions projections for each, these show the necessary decarbonisation trends that must be attained to reach net zero. The pathway for the manufacturing and construction sector shows it must reduce emissions by 70% by 2035, and 90% by 2040 from 2018 levels. It is recommended that this will be achieved by fuel switching, carbon capture and storage, and improvements to resource and energy efficiency.

Policies for the Sixth Carbon Budget and Net Zero, 2020

1.27 This policy report accompanies the CCC's advice on the Sixth Carbon Budget, and sets out the broad policy changes that could deliver the budget and the UK's net zero target.

1.28 The report identifies carbon leakage as an issue of importance to the UK's climate targets, and as such is relevant to consider within the policy context of the Project. Carbon leakage may occur if, for cost reasons related to climate policies, production is transferred to another country resulting in increased emissions in that country.

1.29 *"The design of policies to reduce UK manufacturing emissions must ensure that it does not drive manufacturing emissions overseas"*. While this would reduce reported UK emissions, it would not reduce global emissions and would be damaging to the UK economy.

Net Zero Wales, Carbon Budget 2 (2021-2025), 2021

1.30 Net Zero Wales (NZW) (Welsh Government 2021c) follows the last Plan: Prosperity for All, a Low Carbon Wales (2019) which covered the first carbon budget. It builds on Wales's decarbonisation strategy and sets out the policies and proposals to meet Wales Carbon Budget 2 (2021-2025) and set Wales on a longer-term pathway to net zero. NZW recognises the need to 'outperform' the second carbon budget of 37% average reduction in emissions, as the third carbon budget (2026-2030) requires an average reduction of 58%, reflecting the scale of change that must be made now to ensure this budget is also met.

1.31 This strategy sets the ambition to increase renewable energy capacity by 1GW by 2025 in order to progress towards a decarbonised energy system. Of most relevance is Policy 22 – *"increasing renewable energy developments on land through our planning regime".* This policy reiterates that renewable and low carbon energy developments are of national significance and supports the Future Wales policies 17 and 18 regarding the positive policy framework towards renewable energy developments.

1.32 The Carbon Budget also sets out more general policies relating to sustainable development, including Policy 5 – *"A circular economy"* and several policies relating to reducing emissions from transport of construction materials, including shipping and zero emission HGVs in policies 33, 40 and 42, and reduction of embodied carbon within construction materials in policy 47. These policies have an overall aim of supporting decarbonisation of the construction and building sector.

The Path to Net Zero and Reducing Emissions in Wales, 2020

1.33 The Path to Net Zero and Reducing Emissions in Wales (CCC, 2020c) supports the Welsh government's target to reduce all GHG emissions to Net Zero by 2050. . A number of carbon budgets have been recommended, as follows: the Third Carbon Budget (2026-2030) should be set at an average 58% reduction compared to 1990 levels; the Second Carbon Budget (2021-2025) should be tightened to a 37% reduction compared to 1990 levels. Both budgets have been recognised within the Climate Change (Carbon Budgets) (Wales) (Amendment) Regulations 2021.

1.34 Four key actions have been identified by the CCC to enable Wales to meet its net zero ambition, which are also found in the Sixth Carbon Budget. These include the recommendation to expand low carbon energy supplies in order to drive grid decarbonisation, especially low-carbon electricity, as electricity demand is anticipated to double by 2050.

Industrial Decarbonisation: Net Zero Carbon Policies to Mitigate Carbon Leakage and Competitiveness Impacts, 2020

1.35 This research paper (Sturge, 2020) was commissioned by the CCC to address concerns regarding the impact of carbon policies on carbon leakage. The paper focuses on recommendations to enable deep decarbonisation of UK industry in line with net zero pathways, whilst also mitigating carbon leakage and competitiveness impacts.

1.36 The suggested policies have not yet been incorporated by the UK Government, however they do highlight that carbon leakage is an issue that must be considered, and work is currently being undertaken to address it.

Environmental Audit Committee: Carbon Border Tax Measures, 2021

1.37 The Environmental Audit Committee (EAC) has announced an inquiry into carbon border adjustment mechanisms in order to address carbon leakage and reduce the carbon footprint of imported goods. In turn, this may prompt other manufacturing countries to decarbonise.

1.38 This carbon border adjustment mechanism, should it be implemented, will play a role in enabling the UK to meet its environmental objectives whilst considering wider impacts, risks and opportunities.

Update on Carbon Leakage Mitigation, 2022

1.39 This written statement from the Financial Secretary to the Treasury (UK Parliament, 2022) outlines the measures that the UK Government is intending to implement to address carbon leakage. A consultation on developing the UK emissions trading scheme was launched, which sought to address how a net zero carbon cap and trade market may be established.

1.40 No policies have yet been implemented, but a consultation ran from March to June 2023 into a range of carbon leakage mitigation options, including measures such as product standards and a carbon border adjustment mechanism. Feedback is currently being analysed.

Net Zero Strategy: Build Back Greener, 2021

1.41 This strategy (BEIS, 2021a) sets out the UK's long-term plans to meet net zero emissions by 2050 and gives the vision for a decarbonised economy in 2050.

1.42 The policies detailed in the strategy will be phased in over the next decade or beyond in order to continue decarbonisation towards net zero. They also aim to keep the UK on track to meet upcoming carbon budgets.

1.43 This strategy brings forward the ambition for a fully decarbonised power system by 15 years, building on the targets set out in the Energy White Paper and the 10 Point Plan for a Green Industrial Revolution. The ambition is to fully decarbonise the UK's power system by 2035, with electricity sourced predominantly from wind and solar generation, supported by nuclear power in addition to an increase in energy storage capacity, gas with CCS, and hydrogen to increase the flexibility of supply.

1.44 Further, the strategy outlines aims to support the decarbonisation of the construction and building sector. Reporting on embodied carbon in buildings and infrastructure is sought to be improved, alongside reductions in embodied carbon by way of material substitution, where appropriate, and resource efficiency.

1.45 The strategy recognises the importance of addressing the risks of carbon leakage, so policy interventions within the UK do not lead to increased emissions elsewhere. Options will continue to be explored to mitigate carbon leakage, with key efforts to address it through global action on industrial decarbonisation and climate regulation, with continued monitoring of related global policy developments.

Transitioning to a net zero energy system: Smart Systems and Flexibility Plan 2021

1.46 Published in 2021 by the Department of Business, Energy and Industrial Strategy (BEIS) and Ofgem, the Smart Systems and Flexibility Plan outlines how energy can be delivered in line with the transition to net zero and the sixth Carbon Budget. This involves increasing flexibility in energy systems according to availability of energy, owing to fluctuations in renewable energy production, as current flexibility on the grid primarily comes from fossil fuel generation.

1.47 Significant flexibility is anticipated to be required: around 30 GW of total low carbon flexible capacity is to be achieved by 2030, and 60 GW by 2050, up from the current levels of 10 GW. This flexibility would be achieved in several ways, including provisioning of smart technologies, changes to energy storage and rewarding energy flexibility.

1.48 The Plan predicts that approximately 13 GW of low-carbon energy storage will be needed by 2030, in part through increased battery storage. To further encourage development of energy storage infrastructure, there is a commitment to "*defining electricity storage as a distinct subset of generation in primary legislation".*

UN Climate Change Conference of Parties (COP27), 2022

1.49 The CoP are (typically) annual climate summits, attended by world leaders globally, where the effects of measures introduced to limit climate change are discussed.

1.50 At the COP26 summit in November 2021, parties voted to adopt the draft COP26 report (United Nations Framework Convention on Climate Change (UNFCC), 2021), known as the Glasgow Climate Pact. This included commitments to phase down the use of coal and supports a common timeframe and methodology for national commitments on emissions reductions. Countries were tasked to return in 2022 with more ambitious 2030 emissions reductions targets.

1.51 However, the COP27 summit in November 2022 made very little progress on emissions reduction ambitions made at COP26. Global ambition could limit warming 2°C, but targets are not being sufficiently backed by action.

1.52 Instead, COP27 saw progress on agreements to establish a loss and damage fund to assist developing countries that are particularly vulnerable to the adverse effects of climate change to address impacts which cannot or have not been adapted to. Some progress was made with regards to adaptation to climate change, and nature-based solutions.

British Energy Security Strategy, 2022

1.53 Building on the ten point plan for a green industrial revolution and the net zero strategy, this policy paper (BEIS, 2022) references solar projects and energy flexibility in the following statements:

- *"With the sun providing enough daily energy to power the world 10,000 times over, solar power is a globally abundant resource. There is currently 14GW of solar capacity in the UK split between large scale projects to smaller scale rooftop solar. The cost of solar has fallen by around 85% over the past decade, and can be installed in just one day on a domestic roof. We expect a five-fold increase in deployment by 2035."*
- *"For ground-mounted solar, we will consult on amending planning rules to strengthen policy in favour of development on non-protected land, while ensuring communities continue to have a say and environmental protections remain in place."*
- *"We will also support solar that is co-located with other functions (for example, agriculture, onshore wind generation, or storage) to maximise the efficiency of land use. We have also included solar in the latest Contracts for Difference auction round and will include it in future rounds."*
- *"We will ensure a more flexible, efficient system for both generators and users (by) encouraging all forms of flexibility with sufficient large-scale, long-duration electricity storage to balance the overall system by developing appropriate policy to enable investment."*

Powering Up Britain: The Net Zero Growth Plan, 2023

1.54 Due to a successful legal challenge on the 2021 Net Zero Strategy (BEIS, 2021a), the UK Government published an updated strategy in March 2023, titled "the Net Zero Growth Plan"

(Department for Energy Security and Net Zero, 2023). This plan largely restated existing policy contained within previous policy papers above. The plan confirmed the UK's commitment to having a decarbonised power system by 2035, with the majority of power generated from renewable sources such as wind and solar. An increase to 50 GW of offshore wind capacity by 2030 and 70 GW of solar PV capacity by 2035 is targeted.

1.55 The Government also ensures a more flexible, efficient system for both generators and consumers by *''encouraging all forms of flexibility with sufficient large-scale, long-duration electricity storage to balance the overall system by developing appropriate policy to enable investment''*.

Net Zero Innovation Portfolio and the Advanced Nuclear Fund: Progress Report 2021-2022, 2023

1.56 The Net Zero Innovation Portfolio is a UK government fund delivered by the DESNZ, launched in 2021, and aims to *"accelerate the commercialisation of innovative low-carbon technologies, systems and processes in power, buildings and industry to set the UK on the path to net zero and create world-leading industries and new jobs."* It looks to focus on ten priority areas, including energy storage and flexibility to decarbonise the energy system.

1.57 Within the framework of the Net Zero Innovation Portfolio, two programmes have been developed: a £68 million Longer Duration Energy Storage programme which supports energy storage solutions, and a £65 million Flexibility Innovation programme which supports integrating systems for flexibility, and markets for flexibility. In 2022, the Net Zero Innovation Portfolio awarded £6.7 million to 24 projects in the first phase of the programme to develop detailed feasibility studies. In November 2022, the first allocation of Phase 2 funding was announced, awarding £32 million to five projects to demonstrate their technologies.

Future Energy Scenarios, 2023

1.58 The Future Energy Scenarios report is published by the National Grid Electricity System Operator (ESO) each year and outlines four different pathways for the future of energy to 2050. Each pathway considers how much energy we might need and where it could come from, to build a picture of how net zero can be accomplished.

1.59 Electricity storage capacity is required to increase in all scenarios to ensure that demand can be met reliably in peak times as an increasing proportion of the UK's electricity is generated from renewables which depend on weather conditions. According to the report, the UK will have 72 GW of energy storage installed by 2050 in a best-case scenario attainment of net zero which is just under 200 GWh of capacity. The best-case scenario also foresees the lowest levels of electricity curtailment across all scenarios by 2050, due to the highest level of flexibility.

1.60 The report details the following main roles for electrical energy storage in providing flexibility:

- managing seasonal differences in supply and demand (longer duration storage, i.e. four hours-plus);
- managing several days of oversupply or undersupply (longer duration storage);
- balancing daily variations in supply and demand (longer and shorter duration storage);
- reserve for unplanned outages/forecast error (shorter duration storage); and
- real-time operability (shorter duration storage).

1.61 Further to this, National Grid ESO expects battery storage to make up the largest portion of storage power capacity in all scenarios by 2050 to help with changing demand within the day and managing network constraints as the costs of batteries fall.

Local Energy and Climate Change Policy

Wrexham Local Development Plan (LDP), 2023

1.62 The Wrexham County Borough Council (WCBC) Local Development Plan (LDP) was adopted in December 2023. The LDP is a long-term land use and development strategy, focused on achieving sustainable development, guiding development, setting out policies and safeguarding areas of land requiring protection or enhancement.

1.63 The relevant policy within the LDP is as follows:

1.64 Policy RE2: Renewable Energy Schemes – *"Proposals to generate energy from renewable and low carbon sources will be supported. In assessing such proposals consideration will be given to the impacts of the development on the landscape, the number, scale, size, design and siting of renewable installations and associated infrastructure, alone, cumulatively and in combination."*

Summary

1.65 UK Carbon Budgets commit the UK to reducing GHG emissions by 100% of 1990 levels by 2050, with an interim target of a 78% reduction by 2035 in order to ensure UK emissions remain consistent with the goal to limit warming to 1.5°C. The Welsh Carbon Budgets (2021) limit emissions within 2026-2030 to an average of 58% below the baseline.

1.66 In order to achieve these emissions reductions, the deployment of clean electricity generation must be accelerated through the 2020s to decarbonise the energy system (HM Government, 2020). The Sixth Carbon Budget (2020) includes the key objective to phase out fossil fuel generation by 2035, and to increase renewable energy to 80% of generation by 2050. This is mirrored within Welsh policy where decarbonisation is a national priority, with goals to generate at least 70% of Welsh electricity consumption from renewable sources by 2030 (Welsh Government, 2021a and 2021c). It is anticipated that this decarbonisation will be met largely by solar and wind power, with 3GW per year of solar generation required to reach renewable supply targets (Committee on Climate Change, 2020a).

1.67 The effects of construction and supply chain emissions (including those taking place outside of the UK), and any associated mitigation, must be taken into consideration when considering the significance of emissions. The manufacturing sector within the UK must reduce emissions by 70% by 2035 from 2018 levels (Committee on Climate Change, 2020a). Further emissions from construction and manufacture, whilst not taking place within the UK (they may result from carbon leakage), and therefore not considered within the UK Carbon Budgets, are still of global importance and significance.

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Appendix 9.2
Climate Risk Assessment

MAKING COMPLEX EASY

A TETRA TECH COMPANY

PLAS POWER SOLAR AND ENERGY STORAGE PROJECT

Environmental Statement: Appendix 9.2 - Climate Risk

NP11567

V3

February 2024

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Prepared by:	**Prepared for:**
RPS	**Lightsource bp**

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Tables

1 CLIMATE CHANGE RISK

Overview

1.1 This appendix to Chapter 9: Climate Change summarises potential changes in climatic parameters at the Proposed Development location and considers whether there is potential for likely significant environmental effects.

1.2 Besides climate risks to the Project itself, there are potential inter-relationships between climate change and several other environmental topic areas reported in other chapters of the Environmental Statement (ES), most notably flood risk. The climate projections summarised in this appendix have been provided to all ES chapter authors in order that any changes in the future baseline or sensitive receptors due to climate change can be evaluated if relevant to the respective impact assessments.

Climate Change Projections

1.3 The Met Office Hadley Centre (MOHC) publishes both probabilistic climate change projections and downscaled global circulation model outputs for the UK at various spatial scales. This is called the UKCP18 dataset, first published in November 2018 and at v2.6.0 (MOHC, 2021) at the time of writing. The projections are based on representative concentration pathway (RCP) scenarios used by the Intergovernmental Panel on Climate Change, thereby giving a low-high range in potential global GHG reduction initiatives and resulting rate of climatic effects over a given time period.

1.4 The probabilistic projections published at 25 km grid cell scale are considered the most useful for this assessment, being designed to show a range of projection values that reflect uncertainty in modelled outcomes. The CP18 Overview Report (MOHC, 2018a) and supporting factsheets (MOHC, 2018b) for the wider regional and UK context have also been drawn from.

1.5 The Proposed Development is expected to have an initial 40 year design operating lifetime. Climate change projections for two periods in the mid- and late century have therefore been considered: average conditions during 2040-2069 and 2070-2099.

1.6 The Overview Report and factsheets indicate that in general, warmer, wetter winters and hotter, drier summers are predicted, though of course still with natural variations in that pattern from year to year. No clear trend in wind speeds or storminess is predicted, though the data currently published cannot make projections for local conditions and wind gusts.

1.7 Within the last two decades, annual average temperature and precipitation records have been consistently set in the UK relative to the preceding baseline period, although generally wetter rather than drier summers have been seen in this period. In the near future, roughly the next years to decade, these natural variations will likely continue to be the most visible year-to-year changes in climate but in subsequent decades, within the Proposed Development's operating lifetime, the anthropogenic climatic changes are expected to become more apparent.

1.8 Table 1.1 and Table 1.2 show potential climatic changes from the UKCP18 probabilistic dataset averaged over the 2040-2069 and 2070-2099 time periods relative to the 1961-1990 baseline for the 25 km grid square in which the site is located. The data presented here is for the emissions pathway RCP8.5, which is a high-emissions scenario assuming 'business as usual' growth globally with little additional mitigation. This is a conservative (worst-case) approach for the assessment.

1.9 In summary, the data within Table 1.1 shows increased intensity in seasonal precipitation trends: precipitation is predicted to increase during the wettest season and decrease during the driest season. Temperatures are anticipated to increase across the year, both during the coldest and hottest seasons and months. Additionally, cloud cover is anticipated to decrease which may result in increased anticipated annual yields. Furthermore, humidity is predicted to increase throughout the year, but more so in the winter months owing to milder, wetter winters in the future. Table 1.2 indicates that these trends will continue and amplify towards the end of the century.

Table 1.1: Climate Parameter Projections 2040–2069

Parameter†	Units	10th percentile	Median value	90th percentile
Precipitation – annual average	%	-6.64	-2.12	2.52
Precipitation – driest season	%	-42.19	-19.35	5.83
Precipitation – wettest season	%	-3.66	4.97	14.31
Precipitation – driest month	%	-46.08	-19.59	11.69
Precipitation – wettest month	%	-8.39	6.52	24.05
Temperature – annual average	ºC	1.01	2.00	3.11
Temperature – hottest season average	ºC	0.81	2.38	4.02
Temperature – coldest season average	ºC	0.62	1.98	3.43
Temperature – hottest month maximum	ºC	0.40	2.52	4.83
Temperature – hottest month average	ºC	0.81	2.64	4.64
Temperature – coldest month minimum	ºC	0.39	2.23	4.23
Temperature – coldest month average	ºC	0.64	1.95	3.34
Cloud cover change	%	-6.86	-3.35	1.74
Humidity – annual average	%	3.83	11.86	20.68
Humidity – winter	%	1.79	12.53	24.06
Humidity – summer	%	1.94	11.81	22.98

† daily mean, maximum or minimum, as applicable, averaged over time period specified
n.b. 10th and 90th percentile and median values for scenario RCP8.5.

Table 1.2: Climate Parameter Projections 2070–2099

Parameter†	Units	10th percentile	Median value	90th percentile
Precipitation – annual average	%	-6.52	-2.24	1.86
Precipitation – driest season	%	-60.02	-32.54	-2.68
Precipitation – wettest season	%	-1.27	8.61	20.10
Precipitation – driest month	%	-56.03	-31.67	2.96
Precipitation – wettest month	%	-7.97	11.80	33.33
Temperature – annual average	ºC	1.97	3.67	5.56
Temperature – hottest season average	ºC	1.96	4.67	7.52
Temperature – coldest season average	ºC	1.31	3.33	5.42
Temperature – hottest month maximum	ºC	1.68	5.25	9.10
Temperature – hottest month average	ºC	2.00	5.34	8.86
Temperature – coldest month minimum	ºC	0.85	3.76	7.07
Temperature – coldest month average	ºC	1.20	3.19	5.16
Cloud cover change	%	-11.85	-5.18	1.11
Humidity – annual average	%	10.95	22.14	34.80
Humidity – winter	%	7.07	23.55	41.52
Humidity – summer	%	7.24	21.14	37.07

† daily mean, maximum or minimum, as applicable, averaged over time period specified
n.b. 10th and 90th percentile and median values for scenario RCP8.5

1.10 No clear trend for change in wind speed during this time period is shown in the regional projections data. Probabilistic projections do not provide wind speed data.

Climate Risk and Resilience Scoping

1.11 Based on the information available for the Proposed Development, a high level risk assessment has been undertaken, considering the hazard, potential severity of effect on the development and its users, probability of that effect, and level of influence the development design can have on the risk. The severity of effect score considers the potential consequences of the hazard and the sensitivity of the receptor(s) affected. Each element of the risk assessment has been scored on a scale of one to three, representing low, medium or high; the scores are then summed to give a total risk score. Table 1.3 defines each of these terms.

1.12 Given the variability in the nature of the potential effects of climate change on the development, receptors have been identified on a risk-specific basis, whereby all receptors relate to the continued safe and effective operation of the Proposed Development. In line with IEMA (2020) guidance, the vulnerability and susceptibility have been considered in determining the severity of risk.

1.13 A risk score of five or more has been defined as a risk that could lead to a significant effect of or on the development, prior to mitigation, as this is the minimum score where at least two elements of the risk assessment score are above 'low'.

1.14 By considering the good practice design measures incorporated into the Proposed Development, professional judgement is used in determining whether the potentially significant effects would result in significant adverse of beneficial effects.

Table 1.3: Severity, Probability and Influence Factor Definitions

Factor	Score definitions
Severity: the magnitude and likely consequences of the impact should it occur.	**1 =** unlikely or low impact: for example, low-cost and easily repaired property damage; small changes in occupiers' behaviour.
	2 = moderate impacts with greater disruption and/or costs
	3 = severe impact, e.g. risk to individual life or public health, widespread property damage or disruption to business
Probability: reflects both the range of possibility of climatic parameter changes illustrated in CP18 projections and the probability that the possible changes would cause the impact being considered	**1 =** unlikely or low probability of impact; impact would occur only at the extremes of possible change illustrated in projections
	2 = moderate probability of impact, plausible in the central range of possible change illustrated in projections
	3 = high probability of impact, likely even with the smaller changes illustrated as possible in the projections
Influence: the degree to which design of the Proposed Development can affect the severity or probability of impacts	**1 =** no or minimal potential to influence, outside control of developer, e.g. reliance on national measures or individuals' attitudes/actions; or hypothetical measures would be impracticable
	2 = moderate potential to influence, e.g. a mixture of design and user behaviour or local and national factors; measures may have higher costs or practicability challenges
	3 = strong potential to influence through measures that are within the control of the developer and straightforward to implement

1.15 Table 1.4 shows the climate change risks to the Proposed Development that have been identified and the risk scores assigned, following the approach set out in paragraph 1.11 and Table 1.3.

Table 1.4: Risk Scores for the Proposed Development

Risk	Severity	Probability	Influence	Total score	Potentially significant?	Embedded mitigation
Flooding of site	Flood risk is assessed in Chapter 7: Hydrology and Flood Risk of the Environmental Statement.					
Structural damage to panel surfaces, mounting structures and BESS battery container crates from extreme weather events, i.e. high wind speed gusts or high intensity hail.	2	1	2	5	Yes	Panel surfaces and mounting structures are designed to withstand high wind speeds during storm events. Although there is potential for storm events with gales to increase in frequency, the climate projections do not indicate a likelihood of higher peak wind speeds or evidence of intense convective storm events with unusual hail requiring additional mitigation.
High winds causing significant damage to distribution and transmission lines and resulting in more than temporary loss of export capacity for the development.	2	1	1	4	No	Network operators have a statutory requirement to keep overhead power lines clear of vegetation for public safety reasons. Since 2006, operators have also been required to undertake a risk-based programme of resilience vegetation management. Within the Proposed Development site, intra-array connections would be made with buried cables which are not at risk.
Increased ambient temperatures leading to solar panel and inverter efficiency losses.	1	2	1	4	No	n/a
Extreme high temperatures and increased ambient temperatures leading to battery efficiency losses (either via reduced round trip efficiency losses due to overheating or via increased parasitic load due to increased cooling demand).	2	2	2	6	Yes	BESS will be designed to account for a range of temperatures and their housing will include ventilation.
Transmission and distribution line de-rating (from increased ambient temperatures) leading to development output capacity constraints.	1	1	1	3	No	n/a
Shrinking and swelling of clay soils due to excessive rainfall and drought leading to battery pack, switch and control unit and substation subsidence.	2	1	2	5	Yes	Relevant earthworks will be undertaken, upon which concrete bases will be installed on platforms to support the container crates. The switch and control units and inverter houses will be built to comply with Building Regulations for structural design.

1.16 The Climate Change Risk & Adaptation Response for UK Electricity Generation (Energy UK, 2015) concluded that risks to energy infrastructure from climate change remain relatively low. Climate change does not introduce any significant new risks which energy infrastructure developments do not already manage. It does, however, increase the likelihood and severity of such risks.

1.17 Short-term weather events may present more of a risk to the Proposed Development than long-term climate trends. Furthermore, the industry identifies engineering-related faults as more of a risk to losses in generation than changing weather patterns.

1.18 The most significant risk from climate change to the Proposed Development arises from flooding. This is assessed in Chapter 7: Hydrology and Flood Risk and appropriate flood management and resilience measures have been provided.

1.19 With the exception of flood risk, the impacts of climate change are unlikely to pose significant risk to the development over the course of its lifetime. Projections of future cloud cover change may result in beneficial impacts, with increased output from the solar farm over its lifetime as cloud cover decreases.

1.20 Network operators have a statutory requirement to keep overhead powerlines clear of vegetation that is a risk in storms and since 2006, operators have also been required to undertake a risk-based programme of resilience vegetation management.

1.21 Overall, it is considered that the potentially significant risks screened in Table 1.4 do not represent new or unexpected issues, and that best practice for the safe operation of electricity generation facilities would mitigate against the likelihood of significant adverse effects thereby reducing the effect to negligible.

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Appendix 9.3

Greenhouse Gas (GHG) Calculations

PLAS POWER SOLAR AND ENERGY STORAGE PROJECT

Environmental Statement: Appendix 9.3 - GHG Calculations

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1 GHG CALCULATIONS

1.1 This appendix includes further technical detail regarding the methodology and calculations outlined within Chapter 9: Climate Change. For ease of understanding, the headings used within this appendix follow those used within the main EIA chapter.

1.2 This appendix details the calculations undertaken to determine the likely emissions associated with the construction and operation of the Proposed Development, the following key project assumptions have been used to inform the GHG assessment:

- Solar PV array
  - 80 MW (57MWac)
  - Proposed first year of operation in 2026
- Battery Energy Storage System (BESS)
  - 50-57 MW
  - 2-6 hour discharge time
  - Proposed first year of operation in 2033 (at the latest).

1.3 At this stage in the design of the Proposed Development the storage capacity of the BESS elements is not yet fixed. As such, the assessment included within this Appendix incorporates the likely emissions associated with the range of options under consideration.

Baseline Environment

Future Baseline Conditions

Solar

1.4 The future baseline for electricity generation that would be displaced by the Proposed Development depends broadly on future energy and climate policy in the UK, and more specifically (with regard to day-to-day emissions) on the demand for operation of the Proposed Development compared to other generation sources available, influenced by commercial factors and National Grid's needs.

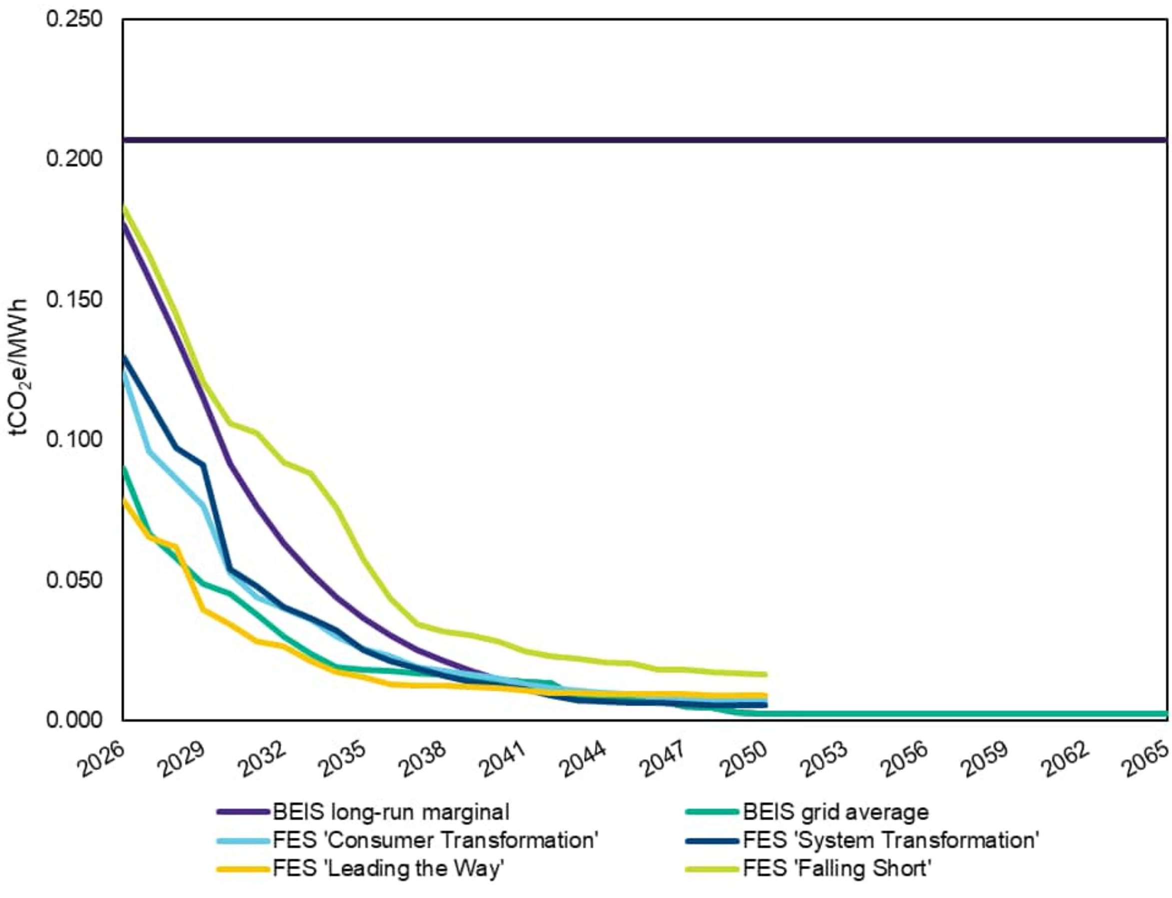
1.5 The carbon intensity of baseline electricity generation is projected to reduce over time and so too would the intensity of the marginal generation source displaced at a given time.

1.6 The UK government department for Business, Energy and Industrial Strategy (BEIS) (now department for Energy Security and Net Zero) publishes projections of the carbon intensity of long-run marginal electricity generation and supply that would be affected by small (on a national scale) sustained changes in generation or demand (DESNZ and BEIS, 2023). BEIS's projections over the Proposed Development's operating lifetime (2026 to 2065) are based on an interpolation from 2010's assumed marginal generator (a combined cycle gas turbine (CCGT) power station) to a modelled energy mix in 2030 consistent with energy and climate policy and predicted demand reduction scenarios by that point. A grid-average emissions factor is projected by BEIS for 2040 and the marginal factor is assumed to converge with it by that date, interpolated between 2030 and 2040; both factors are then interpolated from 2040 to a national goal for carbon intensity of electricity generation in 2050 and assumed to be constant after that point.

1.7 National Grid publishes 'Future Energy Scenario' (FES) projections (National Grid ESO, 2022[1]) of grid-average carbon intensity under several possible evolutions of the UK energy market, which have also been reviewed. The BEIS grid-average projection sits broadly in the middle of the National Grid range, and as stated above, the marginal factor is assumed by BEIS to converge with it (and hence with National Grid's scenarios) over time. Graph 1 illustrates both the BEIS and National Grid projected carbon intensity factors for displaced electricity generation over the anticipated Proposed Development lifetime. Graph 2 illustrates both the BEIS and National Grid projected carbon intensity factors for displaced electricity generation including adoption of carbon sequestration in the FES projections. This is achieved through sequestration of biogenic carbon dioxide (CO_2), via biomass facilities fitted with carbon capture utilisation and storage (CCUS). It has been assumed that the Proposed Development would not displace other forms of electricity generation with net negative GHG effects.

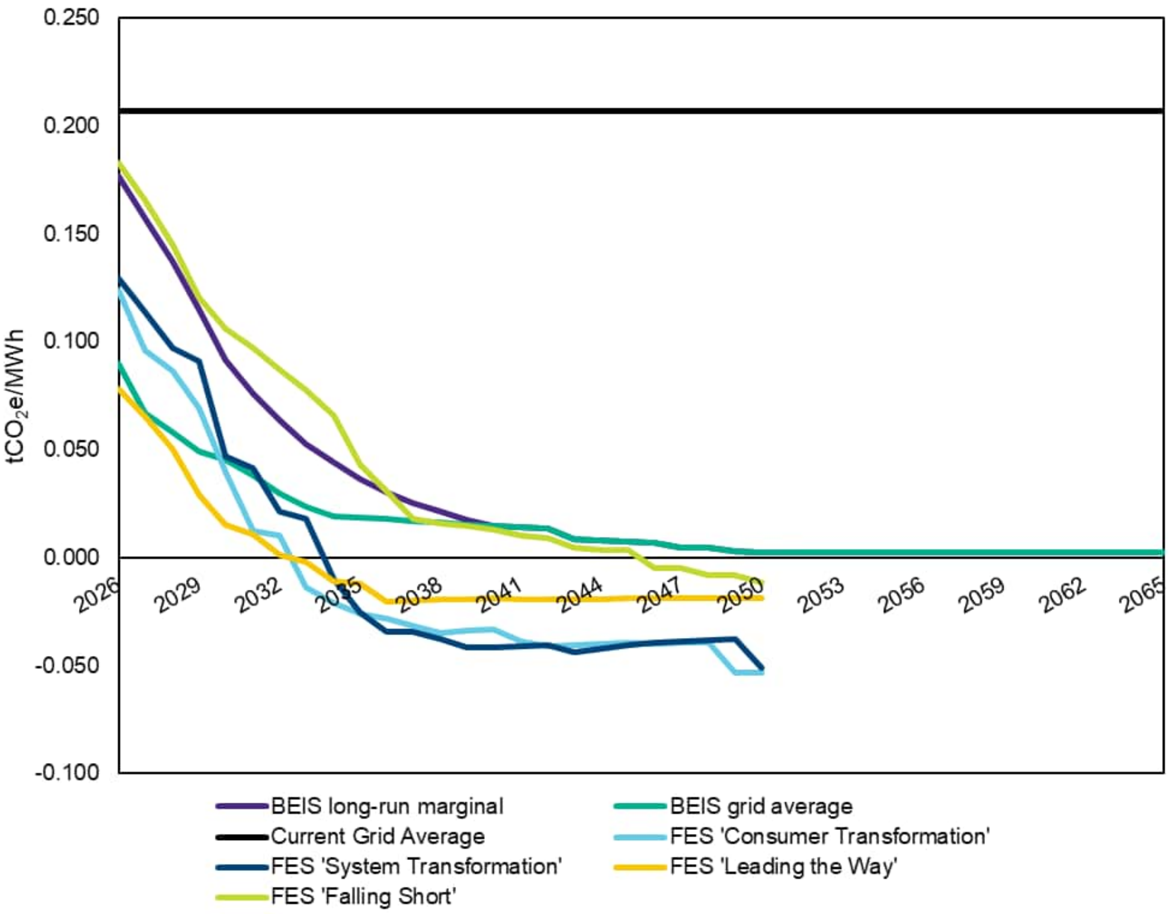
1.8 The FES projections reflect different routes to decarbonisation, with one, "falling short" not leading to near-full decarbonisation by 2050. The current grid average and BEIS projected values are projected to the end of the Proposed Development's lifetime, but FES projections are only published to 2050.

Graph 1: Predicted Grid Carbon Intensities under Different Scenarios



[1] National Grid ESO has published updated projections in 2023, however, no new carbon intensity factors appropriate for this assessment were provided in this update. As such, the 2022 factors have been reported within this Appendix.

Graph 2: Predicted Grid Carbon Intensities under Different Scenarios with CCUS



Battery Energy Storage Systems (BESS)

1.9 It is anticipated that in the absence of the Proposed Development, periods of low renewable energy supply and high demand will be met via gas-fired peaking plants. In order to provide a conservative assessment, and not overstate the potential benefits of the Proposed Development, potential trends in decarbonisation of the peaking power supply in the future baseline scenario have been considered.

1.10 The Climate Change Committee's (CCC) Sixth Carbon Budget (CCC, 2020) states that unabated gas generation (including peaking plants) should be phased out by 2035. The CCC recommends the implementation of policy to ensure that the carbon intensity of electricity generation tends to zero by 2035. In line with these recommendations, the UK's Net Zero Strategy (HM Government, 2021) and Net Zero Growth Plan (Department for Energy Security and Net Zero, 2023a) contain a commitment to "fully decarbonise our power system by 2035". Furthermore, the Environment Agency's latest advice regarding post-combustion carbon capture mandates at least a 95% capture rate (Environment Agency, 2022).

1.11 As such, it will be necessary for peaking plants to decarbonise (if not displaced by alternatives such as BESS). Projections specific to the carbon intensity of peaking power generation (rather than grid average) are not available.

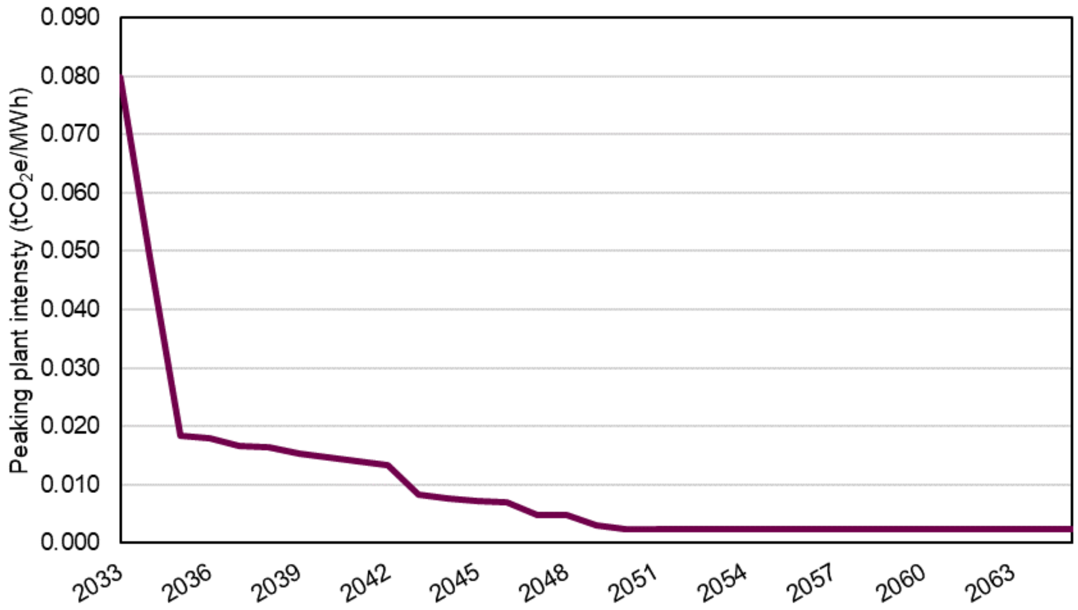
1.12 In order to determine the future baseline conditions, and subsequently the emissions that will be offset through the Proposed Development, a simple linear reduction in the carbon intensity of peaking plants from present-day values to converge with the BEIS projected factors (BEIS, 2022) by 2035 has been calculated. Table 1.1 displays the baseline carbon intensity of peaking plants for the duration of the Proposed Development's indicative operational phase. Since the calculations of peaking plant carbon intensity assumed their operational lifetime began in 2018, the expected peaking plant carbon intensity at the start of the operational life of the BESS (2033) will be 0.080 tCO_2e/MWh, reduced from 0.540 tCO_2e/MWh in 2018.

Table 1.1: Future Carbon Intensities of Peaking Plants

Year	Peaking Plant Carbon Intensity (tCO_2e/MWh)
2033	0.080
2034	0.049
2035	0.018
2036	0.018
2037	0.017
2038	0.016
2039	0.015
2040	0.015
2041	0.014
2042	0.013
2043	0.008
2044	0.008
2045	0.007
2046	0.007
2047	0.005
2048	0.005
2049	0.003
2050	0.002
2051	0.002
2052	0.002
2053	0.002
2054	0.002
2055	0.002
2056	0.002
2057	0.002
2058	0.002
2059	0.002
2060	0.002
2061	0.002
2062	0.002
2063	0.002
2064	0.002
2065	0.002

1.13 Graph 3 displays the baseline carbon intensity of peaking plants for the duration of the Proposed Development's indicative operational phase.

Graph 3: Linear Projected Future Carbon Intensities of Peaking Plants



Assessment of Construction Effects

Assessment of Effects on Climate Change

Magnitude of Impact

1.14 The installation of an 80 MW solar PV array, alongside 50 MW to 57 MW of BESS would result in both direct and indirect greenhouse gas (GHG) emissions at all stages of the Proposed Development's lifecycle. These emissions would occur as a result of the extraction of necessary raw materials, manufacturing of the panels and associated balance of system (BoS)[2], transportation of materials to the site, the onsite assembly/construction of the PV array, ongoing maintenance and end of life (EoL) treatment.

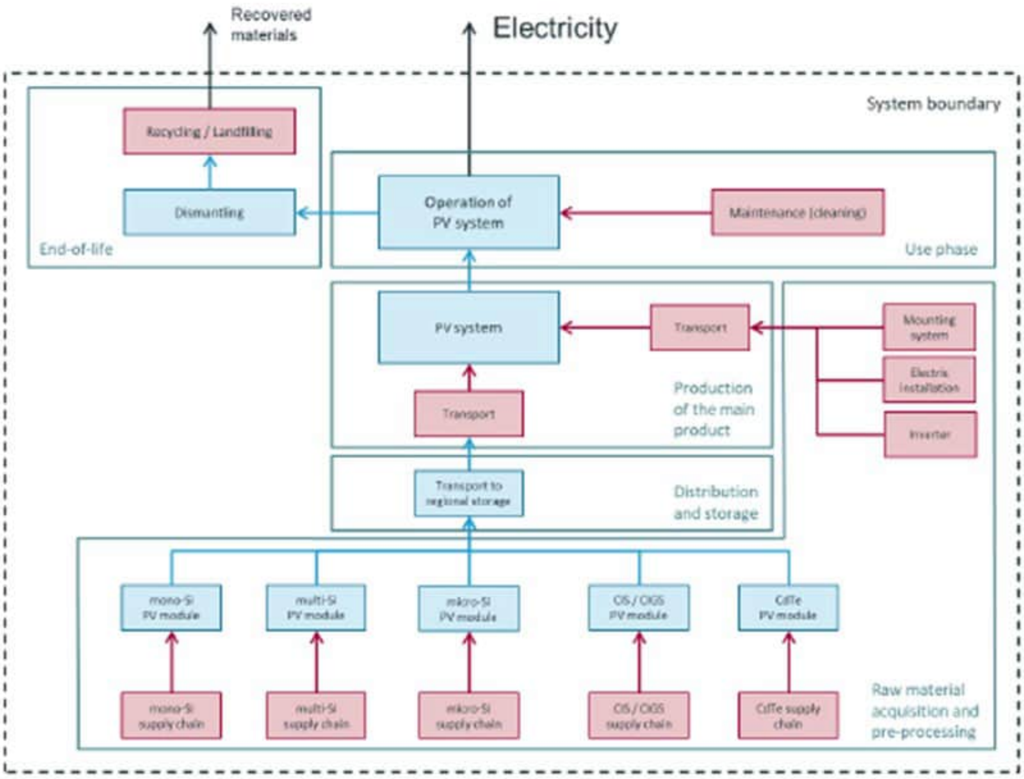
1.15 The following sections detail the methodology used to calculate the construction stage emissions associated with the Proposed Development. The development has been broken down into discrete categories, identified within the sections below, in order to distinguish between the methodologies used.

Solar

1.16 The quantification of the emissions resulting from these activities requires a GHG Lifecycle Assessment (LCA). Figure 1 below displays the system boundaries considered in a typical GHG LCA for a PV development of this nature.

[2] BoS components are predominantly comprised of inverters, electrical cabling and frames/mounting structures.

Figure 1: System boundaries for a solar PV development (IEA, 2020)



1.17 Currently, 95% of total global PV production is accounted for by crystalline silicon (c-Si) panel technology (84% of which is accounted for by mono-crystalline (mono c-Si) and 16% by multi-crystalline (multi c-Si)) (ISE, 2023). Furthermore, the majority of options which are currently being considered for the chosen design are mono c-Si panels. Some thin-film cadmium telluride (CdTe) panels are also being considered. As such, only these two technology types have been considered in the assessment of GHG effects.

1.18 The key GHG emitting process involved in the manufacturing of c-Si panels and associated BoS components are:

- The extraction of quartz, from which metallurgical-grade silicon is extracted. This silicon is then further purified into solar-grade silicon, typically via the energy intensive Siemens reactor method.
- The forming of silicon ingots; an electricity-intensive process requiring 32 kWh per kg of mono-Si ingot (via the Czochralski process), or 7 kWh per kg of multi-Si ingot (IEA, 2020).
- The extraction of raw materials for and manufacturing of BoS components, e.g. silica for glass, copper ore for cables, iron and zinc ore extraction and refinement for mounting structures and bauxite extraction and refinement for module framing (c-Si modules require circa 2.1 kg of aluminium per m^2 of module) (IEA, 2015).

1.19 The emissions resulting from the processes described above, as well as the emissions occurring due to the transportation of materials to site and onsite emissions occurring during the assembly of the Proposed Development account for circa 70% of total lifecycle GHG emissions (not including the avoided emissions resulting from the displacement of more carbon intensive electricity generation) (NREL, 2012).

1.20 Solar PV LCAs are a complex process, given the large number of materials and processes involved in the production of PV modules and BoS components. Furthermore, the associated GHG emissions are dependent on the location (and associated energy mix) of where these processes are occurring.

A range of environmental product declarations (EPDs) containing detailed LCA information have been used to inform the calculations of embodied carbon associated with the solar PV modules. The EPDs used are specific to the modules the Applicant regularly procures, and as such can be assumed to apply to panels procured for the Proposed Development. Further detail is given below.

Emissions factors and data sources

1.21 The current literature surrounding PV system LCAs is characterised by a high degree of variability in its published GHG figures, and therefore a degree of uncertainty occurs in selecting any one of these figures as a means of analysing the embodied GHGs in constructing a solar array. As a means of dealing with this uncertainty, the primary sources of emissions factors used in assessing the construction-stage[3] GHG emissions of the Proposed Development were 15 solar module EPDs, specific to modules commonly procured by the Applicant. As identified in paragraph 1.17, the EPDs detail life cycle emissions associated with mono c-Si and thin-film CdTe panels. EPDs were grouped by panel type, with resultant emissions intensities associated with the product and construction (A1-A5), use (B1-B5) and end of life (C1-C4) stage emissions averaged accordingly. Table 1.2 summarises the resultant emissions intensities for each life cycle stage.

Table 1.2: Solar module LCA emissions intensities

Module type	Emissions intensity (tCO_2e/MWp)			
	Product and Construction Stage (A1-A5)	Use Stage (B1-B5)	End of Life Stage (C1-C4)	Total
Mono c-Si	517.27	0.31	26.44	654.57
Thin film CdTe	310.18	2.83	62.16	375.17

1.22 To provide a conservative assessment, the mono c-Si panels were selected for use within the calculation of construction-stage emissions as emissions associated with these panels are greater in comparison with those resulting from the thin film CdTe panels. As such, should the thin film panels be chosen at the product procurement stage, construction-stage emissions from the Proposed Development can be expected to be reduced.

1.23 Construction-stage emissions were calculated by scaling the proposed solar capacity (80 MWp) by the emissions intensities detailed in Table 1.2. Table 1.3 details the resultant emissions associated with the solar panels.

Table 1.3: Construction-stage emissions from solar PV modules.

Module type	Embodied carbon emissions (tCO_2e)			
	Product and Construction Stage (A1-A5)	Use Stage (B1-B5)	End of Life Stage (C1-C4)	Total
Mono c-Si	41,381	24	2,115	43,521
Thin film CdTe	25,175	226	4,972	30,374

[3] Construction-stage – in this sense – also refers to the emissions associated with maintenance and any EoL treatment-related emissions. It excluded the GHG implication of exporting low carbon power onto the grid.

Battery Energy Storage Systems

1.24 Owing to their charge capability, energy density, round-trip efficiency and falling costs, lithium-ion batteries (LIB) are the most commonly employed battery technology for stationary applications. At this stage, this is the technology type being considered in this assessment.

1.25 More specifically, as circa 60% of grid-scale batteries are currently nickel-manganese-cobalt (NMC) cathode material blends (IEA, 2020b), it is the carbon intensity of these materials – and the carbon intensity of the associated manufacturing processes – that have been considered in this assessment.

1.26 There are several carbon-intensive processes that take place in the manufacturing of a NMC LIB, that make up the majority of their associated embodied carbon emissions. These processes are as follows.

- The mining and refining of raw materials: the energy intensity varies greatly depending on the type of mine and type of ore being mined.
- Cathode production: cathodes are made via the production of NMC powder, an energy-intensive two-stage process involving co-precipitation and calcination. The co-precipitation step consumes 42.6 MJ of heat to produce 1 kg of NMC precursor, and the calcination step consumes 25.2 MJ of electricity to produce 1 kg of NMC powder (Dai et al, 2019).
- Anode production: anodes are composed of graphite and a polyvinylidene difluoride binder; to ensure the absence of any oxygen impurity in the graphite, it is baked at 1100° C in an inert or reducing atmosphere (Accardo et. al., 2021).
- Dry room: because moisture is detrimental to the electrochemical performance of LIBs, the cell assembly process needs to occur in a dry room with strictly controlled humidity levels. Dry room operation has been identified as a predominant driver of energy use for cell production (Dai et al, 2019).
- Production of non-cell materials: this involves the production of cell containers, separator, battery management system (BMS), cooling system, and final packaging.

1.27 The carbon intensity of the production of NMC LIBs used for the purposes of this assessment has been informed by Lithium-Ion Vehicle Battery Production: Status 2019 on Energy Use, CO_2 Emissions, Use of Metals, Products Environmental Footprint, and Recycling (Emilsson and Dahllöf, 2019), an IVL Swedish Environmental Research Institute study carried out in cooperation with the Swedish Energy Agency.

1.28 The study analysed the most up-to-date published data regarding the energy use associated with the production of LIBs. The study uses published heat and electricity consumption data for the various processes involved in LIB manufacturing to calculate the GHG intensity values which have been used in this assessment.

1.29 The study notes the potential uncertainty in estimating LIB production GHG emissions due to the variability of the penetration of renewables in the energy supply mix (both electricity and heat) at different geographical locations.

1.30 As such, a range of GHG intensities was stated. Assuming a 100% electricity powered cell manufacturing and battery pack assembly process (i.e. using electricity for heat and power), the electricity emissions factor ranged from a 100% renewables mix (0 $kgCO_2e/kWh$) to a fossil fuel-rich mix (1 $kgCO_2e/kWh$). Under this range of carbon intensities of battery pack production, the GWP of the manufacturing battery cells and packs is in the range of 2 – 47 $kgCO_2e/kWh$ battery capacity.

1.31 When accounting for further emissions of 59 $kgCO_2e/kWh$ battery capacity owing the sourcing of upstream materials (taken from Dai et al, 2019), a range of 61 – 106 $kgCO_2e/kWh$ battery capacity can be stated (with a mid-point of 83.5 $kgCO_2e/kWh$).

1.32 This range of GHG values accounts for the emissions associated with the upstream supply of raw materials, battery cell production and battery pack assembly.

1.33 The final storage capacity of the proposed BESS has not yet been determined, but it is known that the battery packs will have an output capacity that falls between 50 and 57 MW with a discharge time between 2 and 6 hours (both assuming one charge cycle per day). As such, both scenarios have been considered in the assessment, and construction and operation stage impacts of both scenarios have been calculated.

1.34 Table 1.4 displays the benchmark carbon intensities that have been used in assessing the magnitude of impact of the GHG emissions from the production of the 50 MW capacity BESS over a 2 hour discharge period. Similarly, Table 1.5 displays the benchmark carbon intensities that have been used in assessing the magnitude of impact of the GHG emissions from the production of the 57 MW capacity BESS, over a discharge time of 6 hours.

1.35 The lifetime of the battery packs is dependent on the average depth of discharge (DoD); while in reality this may vary depending on the state of the electricity market at any given moment, the current assumed average DoD for the Proposed Development is 80%. Based on published literature values, a DoD of 80% would result in an expected lifetime of 5,000 cycles (IEA, 2020c). Therefore, over the forecasted 33 year assessment period and assuming one full cycle per day, the battery packs would have to be replaced circa three times. This has been accounted for in the embodied carbon values in Table 1.4 and Table 1.5.To be conservative, present-day values have been used for the carbon intensity of battery pack production even for future replacements.

Table 1.4: Construction-stage GHG intensity and impact of BESS of 50 MW capacity over a 2 hour discharge time.

	Lower limit	Mid-point	Upper limit
Output capacity (MW)	50	50	50
Discharge Time (hrs)	2	2	2
Total storage capacity (MWh)	100	100	100
Number of battery pack replacements for Proposed Development assumed lifetime	3	3	3
Carbon intensity of battery pack manufacturing (tCO_2e/MWh battery capacity)	61	83.5	106
Battery packs embodied carbon (tCO_2e)	**14,695**	**20,115**	**25,535**

Table 1.5: Construction-stage GHG intensity and impact of BESS of 57 MW capacity over a 6 hour discharge time.

	Lower limit	Mid-point	Upper limit
Output capacity (MW)	57	57	57
Discharge Time (hrs)	6	6	6
Total storage capacity (MWh)	342	342	342
Number of battery pack replacements for Proposed Development assumed lifetime	3	3	3
Carbon intensity of battery pack manufacturing (tCO_2e/MWh battery capacity)	61	83.5	106
Battery packs embodied carbon (tCO_2e)	**50,257**	**68,794**	**87,331**

Substation (including busbars and BoS components)

1.36 There is limited design data and few published LCAs from which to calculate the embodied emissions associated with the substation, busbars and BoS components, alongside housing structures for the BESS. Data from an EPD for a 16 kVA – 1000 MVA transformer (ABB, 2003) has therefore been used to provide an approximation of the potential order of magnitude of emissions, as transformers are among the major substation plant components and have a relatively high materials and carbon intensity, including the copper or aluminium winding.

1.37 The LCA listed a manufacturing GWP of 2,190 kgCO_2e per MW. This was scaled by the Proposed Development's maximum output capacity of 80 MW to give an estimated embodied emission value of 175 tCO_2e. This value includes lifecycle stages A1-A3.

Assessment of Operational Effects

Assessment of Effects on Climate Change

Magnitude of Impact

1.38 The Proposed Development comprises both a PV array, generating renewable energy, and BESS which can store and then discharge power. Both are connected to the electricity grid. The BESS storage capacity could potentially be used to store part of the PV array generation, releasing that power at peak times when it is most needed, or could store power from the grid.

1.39 It is expected that, as a renewables development co-located with battery storage, the BESS element will aim to take advantage of both price/time shifting in order to accrue additional revenue from energy arbitrage and peak shaving, in order to avoid network curtailment or reinforcement costs. This would maximise both the environmental and economic benefit of the Proposed Development best matching the PV generation and storage/release of energy from the site to times of high and low electricity demand.

1.40 The business strategy for the BESS element of the Proposed Development therefore has implications for the quantification of the displaced emissions from both the PV array and the BESS itself. Two hypothetical scenarios (scenario 1 and scenario 2) have been developed to represent these options. It is likely that the Proposed Development's operations would in reality reflect a combination of both scenarios, and the avoided emissions are likely to therefore lie between those presented in either scenario.

1.41 As detailed in paragraph 1.33, the final storage capacity of the proposed BESS has not yet been determined, but it is known that it will have an output capacity that falls between 50 to 57 MW with a discharge time between 2 and 6 hours (both assuming one charge cycle per day). As such, two further options will be considered within each scenario:

a) BESS storage capacity of 100 MWh per day, or 1,204,500 MWh over the Proposed Development's lifetime; and

b) BESS storage capacity of 342 MWh per day, or 4,119,390 MWh over the Proposed Development's lifetime.

Scenario 1:

1.42 The BESS are charged directly from the PV array, and only draw power from the grid where their storage capacity exceeds that available to be provided by the PV array (only applicable under option b, where the BESS have a greater storage capacity).

1.43 Power provided by the PV array has no additional associated carbon intensity as the construction stage emissions have already been accounted for. However, it also reduces the direct grid export of the PV array: assuming one cycle of charging and discharge per day, the PV array export is reduced by 29,200 MWh when assessing the lower BESS storage capacity. When assessing the higher BESS storage capacity, 100% of the PV array export is directed to the BESS with 0% exported to the grid from the year when BESS become operational (2033).

1.44 Where the BESS storage capacity exceeds that able to be provided by the PV array, the remaining power would be provided from the grid at low demand/price times (i.e. when there is excess renewable generation that would otherwise be curtailed), which is represented by wind power under this scenario. An emissions intensity of 0.99 gCO2e/kWh (due to the operation and maintenance carbon cost of wind power generation) is applied to such energy supply and attributed to the Proposed Development.

Scenario 2:

1.45 The BESS operates independently of the PV array and is charged with grid power available at low demand/price times (i.e. when there is excess renewable generation that would otherwise be curtailed), which is represented by wind power under this scenario. Charging the BESS to full capacity results in the carbon used to generate that energy being attributed to the Proposed Development.

1.46 As such, the entirety of the PV's operational energy output is exported directly to the grid in this scenario.

Solar

1.47 The proposed 80 MW solar array would export energy to the grid that is zero-carbon at the point of generation[4], thereby displacing the marginal generating source that would be providing energy in the absence of the Proposed Development.

1.48 The marginal source displaced may in practice vary from moment to moment depending on the operation of the capacity market, i.e., led by commercial considerations and National Grid's needs at any given time. For the purpose of this assessment, the current grid average figure (totalling the intensity of electricity generated, and emissions associated with the upstream extraction, refining and transportation of fuels for electricity generation prior to combustion) of 0.252974 kgCO_2e/kWh (DESNZ & Defra, 2023) has been used as the baseline for this assessment, alongside the long run marginal figures (DESNZ and BEIS, 2023), and residual energy mix intensity of 0.365 kgCO_2e/kWh (AIB, 2022) to present a potential range of carbon emissions saved in association with the marginal generating source displacement as a result of the Proposed Development.

1.49 A range is provided, as the current grid average figure is a static figure that does not represent the likely scenario of an increasingly decarbonised grid over the Proposed Development's 40 year estimated operational lifespan. This represents no new renewable electricity abating fossil fuel generation in the grid. Whilst the long run marginal figures are dynamic and show year on year decarbonisation towards the UK's committed net zero 2050 pledge, it is only a future baseline projection and cannot be taken with certainty, hence, neither are perfect estimates.

1.50 The residual energy mix has also been used to inform the range of avoided emissions, given it represents the alternative marginal generator that may be displaced, i.e. the generator that would have been supplying the grid with electricity in the absence of the Proposed Development (i.e. generators powered by coal, oil and gas). Consistent with the current grid average figure, this residual mix emissions intensity factor is static, and does not represent the likely scenario of an increasingly decarbonised grid over the Proposed Development's 40 year estimated lifetime. As

[4] i.e not including the embodied carbon emissions associated with the construction of the array discussed in the construction effects section.

such, use of this factor assumes the Proposed Development will displace marginal generation sources over its lifetime, despite such generators becoming less likely to be constructed and operational due to national decarbonisation policy and legislation. This factor will provide an optimistic best case in avoided emissions.

1.51 It is likely that the true value of emissions displaced from the national grid as a result of the Proposed Development will fall somewhere within this range, however, due to uncertainties such as future development of climate policy and targets for renewables deployment actually being met, a more precise estimation could not be considered robust.

1.52 The annual energy output of the Proposed Development has been calculated assuming a load factor of 10.75%, as calculated from the Digest of UK Energy Statistics (DUKES) 6.3 data set, using the average UK load factors for solar PV generation from 2011/12 to 2022 (DESNZ, 2023). The annual load factor of solar PV facility refers to the total number of hours at which the facility is generating electricity at its rated capacity (i.e. 80 MW for the Proposed Development), over the total number of hours in a year. A PV facility's load factor is determined by irradiance conditions, performance ratio and orientation and tilt of the panels. The DUKES data will include both domestic and commercial systems, and is likely to be conservative for the performance of a utility-scale array that can be better optimised in its installation than domestic systems in particular.

1.53 The energy output calculation has also taken into consideration the degradation factor of the PV modules, assumed to be 0.7% per annum (IEA, 2021).

Scenario 1a:

1.54 Table 1.6 displays the annual power output and emissions avoidance of the PV array under scenario 1a (where BESS storage capacity totals 100 MWh). The output from the solar PV during the first seven years of operation, i.e. 2026-2033, is higher than in all subsequent years owing to the fact that the BESS are proposed to become operational from 2033, and as such will only draw energy from the solar PV from this time.

1.55 The decrease in power output directly to the grid compared with scenario 2 is a result of the solar energy being used to charge the batteries.

Table 1.6: Scenario 1a PV power output and emissions avoidance

Year of Operation	Year	Output to the grid (MWh)	Cumulative marginal projections avoided emissions (tCO_2e)	Cumulative current grid average avoided emissions (tCO_2e)	Cumulative residual energy mix avoided emissions (tCO_2e)
1	2026	75,368	-13,312	-19,066	-27,521
2	2027	74,840	-25,096	-37,999	-54,849
3	2028	74,316	-35,273	-56,799	-81,985
4	2029	73,796	-43,756	-75,467	-108,932
5	2030	73,280	-50,457	-94,005	-135,690
6	2031	72,767	-55,997	-112,413	-162,261
7	2032	72,257	-60,578	-130,693	-188,645
8	2033	42,551	-62,824	-141,457	-204,183
9	2034	42,254	-64,680	-152,146	-219,612
10	2035	41,958	-66,215	-162,760	-234,933
11	2036	41,664	-67,485	-173,300	-250,147
12	2037	41,372	-68,534	-183,767	-265,254
13	2038	41,083	-69,401	-194,159	-280,255

Year of Operation	Year	Output to the grid (MWh)	Cumulative marginal projections avoided emissions (tCO_2e)	Cumulative current grid average avoided emissions (tCO_2e)	Cumulative residual energy mix avoided emissions (tCO_2e)
14	2039	40,795	-70,119	-204,480	-295,151
15	2040	40,510	-70,712	-214,728	-309,944
16	2041	40,226	-71,273	-224,904	-324,632
17	2042	39,945	-71,802	-235,009	-339,218
18	2043	39,665	-72,133	-245,043	-353,702
19	2044	39,387	-72,438	-255,007	-368,084
20	2045	39,112	-72,720	-264,901	-382,366
21	2046	38,838	-72,993	-274,726	-396,547
22	2047	38,566	-73,181	-284,482	-410,630
23	2048	38,296	-73,362	-294,170	-424,613
24	2049	38,028	-73,476	-303,790	-438,499
25	2050	37,762	-73,563	-313,343	-452,288
26	2051	37,497	-73,648	-322,829	-465,980
27	2052	37,235	-73,733	-332,248	-479,576
28	2053	36,974	-73,818	-341,602	-493,078
29	2054	36,715	-73,902	-350,890	-506,484
30	2055	36,458	-73,985	-360,113	-519,797
31	2056	36,203	-74,067	-369,272	-533,017
32	2057	35,950	-74,150	-378,366	-546,144
33	2058	35,698	-74,231	-387,397	-559,179
34	2059	35,448	-74,312	-396,364	-572,123
35	2060	35,200	-74,392	-405,269	-584,976
36	2061	34,954	-74,472	-414,111	-597,740
37	2062	34,709	-74,551	-422,892	-610,414
38	2063	34,466	-74,630	-431,611	-622,999
39	2064	34,225	-74,708	-440,269	-635,496
40	2065	33,985	-74,786	-448,866	-647,906

Scenario 1b:

1.56 Under scenario 1b (where BESS storage capacity totals 342 MWh), 100% of the PV array's generated electricity will be diverted to the BESS. As such no electricity generated by the PV array will be directly exported to the grid once the BESS become operational in 2033, and no marginal generating sources are displaced, therefore avoided emissions attributed to the solar PV only cannot be claimed beyond 2033.

1.57 This scenario should be considered within the context of the wider Proposed Development. The benefits of the renewable energy generated by the solar PV and diverted directly to the BESS are accounted for when considering the avoided emissions resultant from the BESS in paragraph 1.74.

Table 1.7: Scenario 1b PV power output and emissions avoidance

Year of Operation	Year	Total Output (MWh)	Output to grid (MWh)	Cumulative marginal projections avoided emissions (tCO_2e)	Cumulative current grid average avoided emissions (tCO_2e)	Cumulative residual energy mix avoided emissions (tCO_2e)
1	2026	75,368	75,368	-13,312	-19,066	-27,521
2	2027	74,840	74,840	-25,096	-37,999	-54,849
3	2028	74,316	74,316	-35,273	-56,799	-81,985
4	2029	73,796	73,796	-43,756	-75,467	-108,932
5	2030	73,280	73,280	-50,457	-94,005	-135,690
6	2031	72,767	72,767	-55,997	-112,413	-162,261
7	2032	72,257	72,257	-60,578	-130,693	-188,645
8	2033	71,751	0	-60,578	-130,693	-188,645
9	2034	71,249	0	-60,578	-130,693	-188,645
10	2035	70,750	0	-60,578	-130,693	-188,645
11	2036	70,255	0	-60,578	-130,693	-188,645
12	2037	69,763	0	-60,578	-130,693	-188,645
13	2038	69,275	0	-60,578	-130,693	-188,645
14	2039	68,790	0	-60,578	-130,693	-188,645
15	2040	68,309	0	-60,578	-130,693	-188,645
16	2041	67,830	0	-60,578	-130,693	-188,645
17	2042	67,356	0	-60,578	-130,693	-188,645
18	2043	66,884	0	-60,578	-130,693	-188,645
19	2044	66,416	0	-60,578	-130,693	-188,645
20	2045	65,951	0	-60,578	-130,693	-188,645
21	2046	65,489	0	-60,578	-130,693	-188,645
22	2047	65,031	0	-60,578	-130,693	-188,645
23	2048	64,576	0	-60,578	-130,693	-188,645
24	2049	64,124	0	-60,578	-130,693	-188,645
25	2050	63,675	0	-60,578	-130,693	-188,645
26	2051	63,229	0	-60,578	-130,693	-188,645

Year of Operation	Year	Total Output (MWh)	Output to grid (MWh)	Cumulative marginal projections avoided emissions (tCO_2e)	Cumulative current grid average avoided emissions (tCO_2e)	Cumulative residual energy mix avoided emissions (tCO_2e)
27	2052	62,787	0	-60,578	-130,693	-188,645
28	2053	62,347	0	-60,578	-130,693	-188,645
29	2054	61,911	0	-60,578	-130,693	-188,645
30	2055	61,477	0	-60,578	-130,693	-188,645
31	2056	61,047	0	-60,578	-130,693	-188,645
32	2057	60,620	0	-60,578	-130,693	-188,645
33	2058	60,195	0	-60,578	-130,693	-188,645
34	2059	59,774	0	-60,578	-130,693	-188,645
35	2060	59,355	0	-60,578	-130,693	-188,645
36	2061	58,940	0	-60,578	-130,693	-188,645
37	2062	58,527	0	-60,578	-130,693	-188,645
38	2063	58,118	0	-60,578	-130,693	-188,645
39	2064	57,711	0	-60,578	-130,693	-188,645
40	2065	57,307	0	-60,578	-130,693	-188,645

Scenario 2:

1.58 As outlined in paragraph 1.45, 100% of the power generated by the solar PV is output directly to the grid, and the BESS does not draw any power from the PV array.

1.59 Table 1.8 displays the annual power output and emissions avoidance of the PV array under scenario 2.

Table 1.8: Scenario 2 PV power output and emissions avoidance

Year of Operation	Year	Output to grid (MWh)	Cumulative marginal projections avoided emissions (tCO_2e)	Cumulative current grid average avoided emissions (tCO_2e)	Cumulative residual energy mix avoided emissions (tCO_2e)
1	2026	75,368	-13,312	-19,066	-27,521
2	2027	74,840	-25,096	-37,999	-54,849
3	2028	74,316	-35,273	-56,799	-81,985
4	2029	73,796	-43,756	-75,467	-108,932
5	2030	73,280	-50,457	-94,005	-135,690
6	2031	72,767	-55,997	-112,413	-162,261
7	2032	72,257	-60,578	-130,693	-188,645
8	2033	71,751	-64,365	-148,844	-214,845
9	2034	71,249	-67,496	-166,868	-240,862
10	2035	70,750	-70,084	-184,766	-266,697
11	2036	70,255	-72,224	-202,539	-292,350
12	2037	69,763	-73,994	-220,187	-317,824
13	2038	69,275	-75,456	-237,712	-343,120
14	2039	68,790	-76,666	-255,114	-368,239
15	2040	68,309	-77,666	-272,395	-393,182
16	2041	67,830	-78,612	-289,554	-417,950
17	2042	67,356	-79,505	-306,593	-442,545
18	2043	66,884	-80,062	-323,513	-466,968
19	2044	66,416	-80,577	-340,315	-491,220
20	2045	65,951	-81,052	-356,999	-515,302
21	2046	65,489	-81,513	-373,566	-539,215
22	2047	65,031	-81,830	-390,017	-562,961
23	2048	64,576	-82,135	-406,353	-586,541
24	2049	64,124	-82,328	-422,575	-609,956
25	2050	63,675	-82,473	-438,683	-633,207
26	2051	63,229	-82,618	-454,678	-656,295
27	2052	62,787	-82,761	-470,561	-679,221
28	2053	62,347	-82,903	-486,334	-701,987
29	2054	61,911	-83,045	-501,995	-724,594
30	2055	61,477	-83,185	-517,548	-747,042
31	2056	61,047	-83,324	-532,991	-769,334
32	2057	60,620	-83,463	-548,326	-791,469
33	2058	60,195	-83,600	-563,554	-813,449
34	2059	59,774	-83,737	-578,675	-835,276
35	2060	59,355	-83,872	-593,691	-856,949

Year of Operation	Year	Output to grid (MWh)	Cumulative marginal projections avoided emissions (tCO_2e)	Cumulative current grid average avoided emissions (tCO_2e)	Cumulative residual energy mix avoided emissions (tCO_2e)
36	2061	58,940	-84,007	-608,601	-878,471
37	2062	58,527	-84,141	-623,407	-899,842
38	2063	58,118	-84,273	-638,109	-921,064
39	2064	57,711	-84,405	-652,709	-942,137
40	2065	57,307	-84,536	-667,206	-963,063

BESS

1.60 As the UK electricity grid decarbonises, and the penetration of non-dispatchable renewable energy resources (predominately wind and solar) increases, surpluses in demand may be increasingly met via carbon-intensive peaking plants in the absence of sufficient energy storage. In contrast, surpluses in supply are often met with the curtailment of zero carbon renewable energy: in 2020, over 6% of Britain's wind energy generation was curtailed (Staffell et. al., 2020).

1.61 Under all scenarios, it has been assumed that the battery cycles once a day (i.e. one full charge and one full discharge) and is used primarily to complement intermittent renewable generation, displacing peaking power generators at times of higher demand that is not fully met by renewables capacity. Hence discharging the battery results in the displacement of the quantity of GHG emissions resulting from the equivalent amount of energy being generated at a gas-fired peaking plant as discussed in the baseline section.

1.1.1 In 2023, wind power generated the largest share of British electricity for the first time in history, overtaking gas as the largest source of power (Staffell et al., 2023). Wind energy generation accounted for 32.4% of UK total electricity generation (including both renewables and non-renewables) in the first quarter of 2023; with onshore and offshore windfarms generating 9.6 TWh and 14.4 TWh respectively. Its dominance within the non-dispatchable renewable energy sector is likely to continue, with an additional 40 GW of offshore wind planned to be constructed by 2030 (HM Government, 2021), and 140 GW offshore wind recommended to be deployed by 2050 (CCC, 2020). As such, it is expected that this is the source of renewable energy that is most likely to be curtailed during periods of surplus demand. Therefore, for the purposes of this assessment the indirect GHG emissions associated with charging the battery are assumed to be equal to those of the lifecycle GHG emission of offshore wind.

1.62 The current literature surrounding LCAs for wind turbines is characterised by a high degree of variability in the published GHG figures and, therefore, a high degree of uncertainty occurs in selecting any one of these figures as a means of analysing the operational emissions resultant from wind generation. As a means of dealing with this uncertainty, the primary source of emissions factors was a study by the National Renewable Energy Laboratory (NREL, 2013) Life Cycle Assessment Harmonization Project, and Dolan and Heath (2012).

1.63 The NREL (2013) study was based on the output of the Dolan and Heath (2012) paper, and as such the Dolan and Heath paper has been referenced hereafter. This study (Dolan and Heath, 2012) conducted an exhaustive literature search, extracting normalized life cycle GHG emission estimates from published LCA literature. Data was screened to select only those references that met stringent quality and relevant criteria.

1.64 The median estimates of GHG emissions intensity figures were identified for both onshore and offshore wind across the whole life-cycle (Dolan and Heath, 2012). The NREL (2013) study further broke down and detailed the separation of intensity across each life cycle stage, attributing 9% of life-cycle emissions to operation and maintenance activities. This estimated percentage has been applied to the Dolan and Heath intensity (11 gCO_2e/kWh), to give an operational emissions intensity of 0.99 gCO_2e/kWh.

1.65 The magnitude of the GHG impact of displacing peaking plant generation depends on its carbon intensity. This has been discussed in the future baseline sections (paragraph 1.12).

1.66 The magnitude of impact of the Proposed Development is determined by the quantity of renewable energy use it enables by avoiding curtailment, the quantity of peaking plant generation it displaces, and the associated GHG impacts of both. The quantity of renewable energy enabled and peaking plant energy displaced is determined by the total annual energy input and output values for the Proposed Development (see Table 1.9). The associated GHG emissions are determined by the GHG intensity of the enabled and displaced sources of generation.

1.67 Table 1.9 displays the annual energy input and output values for the two battery options- A and B, and the parameters which they are determined by.

Table 1.9: Battery Energy Flows

Parameter	Option A	Option B	Unit	Source
Input parameters				
Rated Power	50	57	MW	See Table 1.4
Storage capacity	100	342	MWh	
Discharge time	2	6	Hours	
Round trip efficiency (RTE)[5]	0.85	0.85		Cole & Frazier, 2019
Depth of discharge	0.8	0.8		IEA, 2020
Battery cycles	365	635	days per annum	
Output parameters				
Annual energy input	29,200	99,864	MWh	
Annual energy output	24,820	84,884	MWh	

1.68 The magnitude of impact for the operational phase of the battery element of the Proposed Development is shown below in terms of avoided emissions, and assesses both scenarios 1 and 2, in addition to the two BESS capacity options (as listed in paragraph 1.41). In all scenarios, from 2035 the avoided GHG impacts of the Proposed Development are considered, to have become negligible. This is the point at which, under the simple linear reduction trend for peaking plant carbon intensity assumed, and the BEIS projection of grid average and marginal generation plant carbon intensity, there is anticipated to be little remaining difference between the carbon intensity of different generation sources.

1.69 The Proposed Development's supply and demand balancing function would still be crucial, but under these assumptions, significant ongoing carbon savings due to the balancing function after this time are less likely.

1.70 In effect, given the expected decarbonisation of grid electricity generation to meet national net zero targets, it is anticipated that energy storage facilities will become part of 'business as usual' in order

[5] The RTE of a battery refers to the ratio of energy required to charge a battery compared to the available energy during discharge. The source used in this assessment for determining RTE has considered a range of recent and relevant published RTE values and selected a mid-point value. The RTE includes losses associated with cooling systems and battery control equipment; as such, this assessment takes into account the implications of the operational energy use of onsite electrical equipment.

to enable the growth in renewable energy sources and maximise the amount of their energy available to the grid during times of peak demand.

1.71 Table 1.10 and Table 1.11 display the annual operational GHG implications for the battery storage element of the Proposed Development under scenario 1.

Scenario 1a:

1.72 Under scenario 1a (where BESS capacity is 100 MWh), the BESS are able to be charged by the solar PV only and do not require input from other sources. GHG impacts are calculated solely as a result of emissions avoided from the use of peaking plants.

1.73 Avoided emissions over the Proposed Development lifetime associated with BESS with a lower storage capacity totals 8,314 tCO_2e.

Table 1.10: Annual operational GHG impacts- scenario 1a

Year of operation	Year	Input (MWh)	Output (MWh)	Peaking Plant carbon intensity (tCO_2e/MWh)	GHG impacts (tCO_2e)	Cumulative GHG impacts (tCO_2e)
1	2033	29,200	24,820	0.080	-1,981	-1,981
2	2034	29,200	24,820	0.049	-1,219	-3,199
3	2035	29,200	24,820	0.018	-456	-3,656
4	2036	29,200	24,820	0.018	-445	-4,101
5	2037	29,200	24,820	0.017	-416	-4,516
6	2038	29,200	24,820	0.016	-406	-4,922
7	2039	29,200	24,820	0.015	-381	-5,303
8	2040	29,200	24,820	0.015	-363	-5,666
9	2041	29,200	24,820	0.014	-346	-6,013
10	2042	29,200	24,820	0.013	-329	-6,342
11	2043	29,200	24,820	0.008	-207	-6,549
12	2044	29,200	24,820	0.008	-192	-6,741
13	2045	29,200	24,820	0.007	-179	-6,920
14	2046	29,200	24,820	0.007	-175	-7,094
15	2047	29,200	24,820	0.005	-121	-7,215
16	2048	29,200	24,820	0.005	-117	-7,333
17	2049	29,200	24,820	0.003	-74	-7,407
18	2050	29,200	24,820	0.002	-57	-7,464
19	2051	29,200	24,820	0.002	-57	-7,521
20	2052	29,200	24,820	0.002	-57	-7,577
21	2053	29,200	24,820	0.002	-57	-7,634
22	2054	29,200	24,820	0.002	-57	-7,691
23	2055	29,200	24,820	0.002	-57	-7,747
24	2056	29,200	24,820	0.002	-57	-7,804
25	2057	29,200	24,820	0.002	-57	-7,861
26	2058	29,200	24,820	0.002	-57	-7,917
27	2059	29,200	24,820	0.002	-57	-7,974
28	2060	29,200	24,820	0.002	-57	-8,031
29	2061	29,200	24,820	0.002	-57	-8,087
30	2062	29,200	24,820	0.002	-57	-8,144
31	2063	29,200	24,820	0.002	-57	-8,201

32	2064	29,200	24,820	0.002	-57	-8,257
33	2065	29,200	24,820	0.002	-57	-8,314

Scenario 1b:

1.74 Under scenario 1b (where BESS capacity is 342 MWh), the solar PV does not have sufficient output to fully charge the BESS, as such remaining storage capacity that is not able to be met by on-site solar PV is assumed to be met by wind power supplied through the grid.

1.75 As such, the operational emissions resultant from wind generation attributed to the energy necessary to be obtained from the grid, have been deducted from the avoided GHG emissions of the Proposed Development resultant from the avoidance of peaking plant use.

1.76 Avoided emissions over the Proposed Development lifetime associated with BESS with a higher storage capacity totals 27,271 tCO_2e.

Table 1.11: Annual operational GHG impacts- scenario 1b

Year of operation	Year	Input (MWh)	Energy obtained from solar PV (MWh)	Energy obtained from grid (MWh)	Output (MWh)	Peaking Plant carbon intensity (tCO2e/MWh)	GHG impacts (tCO_2e)	Cumulative GHG impacts (tCO_2e)
1	2033	99,864	71,751	28,113	84,884	0.080	-6,746	-6,746
2	2034	99,864	71,249	28,615	84,884	0.049	-4,139	-10,886
3	2035	99,864	70,750	29,114	84,884	0.018	-1,532	-12,418
4	2036	99,864	70,255	29,609	84,884	0.018	-1,492	-13,910
5	2037	99,864	69,763	30,101	84,884	0.017	-1,391	-15,301
6	2038	99,864	69,275	30,589	84,884	0.016	-1,357	-16,658
7	2039	99,864	68,790	31,074	84,884	0.015	-1,273	-17,932
8	2040	99,864	68,309	31,555	84,884	0.015	-1,211	-19,143
9	2041	99,864	67,830	32,034	84,884	0.014	-1,153	-20,296
10	2042	99,864	67,356	32,508	84,884	0.013	-1,092	-21,388
11	2043	99,864	66,884	32,980	84,884	0.008	-675	-22,063
12	2044	99,864	66,416	33,448	84,884	0.008	-625	-22,688
13	2045	99,864	65,951	33,913	84,884	0.007	-578	-23,266
14	2046	99,864	65,489	34,375	84,884	0.007	-564	-23,830
15	2047	99,864	65,031	34,833	84,884	0.005	-379	-24,208
16	2048	99,864	64,576	35,288	84,884	0.005	-367	-24,575
17	2049	99,864	64,124	35,740	84,884	0.003	-219	-24,794
18	2050	99,864	63,675	36,189	84,884	0.002	-158	-24,952
19	2051	99,864	63,229	36,635	84,884	0.002	-158	-25,110
20	2052	99,864	62,787	37,077	84,884	0.002	-157	-25,267
21	2053	99,864	62,347	37,517	84,884	0.002	-157	-25,424
22	2054	99,864	61,911	37,953	84,884	0.002	-156	-25,580
23	2055	99,864	61,477	38,387	84,884	0.002	-156	-25,736
24	2056	99,864	61,047	38,817	84,884	0.002	-155	-25,891
25	2057	99,864	60,620	39,244	84,884	0.002	-155	-26,046
26	2058	99,864	60,195	39,669	84,884	0.002	-155	-26,201
27	2059	99,864	59,774	40,090	84,884	0.002	-154	-26,355
28	2060	99,864	59,355	40,509	84,884	0.002	-154	-26,508

Year of operation	Year	Input (MWh)	Energy obtained from solar PV (MWh)	Energy obtained from grid (MWh)	Output (MWh)	Peaking Plant carbon intensity (tCO2e/MWh)	GHG impacts (tCO_2e)	Cumulative GHG impacts (tCO_2e)
29	2061	99,864	58,940	40,924	84,884	0.002	-153	-26,662
30	2062	99,864	58,527	41,337	84,884	0.002	-153	-26,815
31	2063	99,864	58,118	41,746	84,884	0.002	-153	-26,967
32	2064	99,864	57,711	42,153	84,884	0.002	-152	-27,119
33	2065	99,864	57,307	42,557	84,884	0.002	-152	-27,271

Scenario 2a:

1.77 Under scenario 2 the BESS are charged entirely from the grid, which is represented by wind power. Avoided emissions over the Proposed Development lifetime associated with BESS with a lower storage capacity totals 7,360 tCO_2e.

Table 1.12: Annual operational GHG impacts- scenario 2a

Year of operation	Year	Input (MWh)	Output (MWh)	BEIS grid average	Peaking Plant carbon intensity (tCO_2e/MWh)	GHG impacts (tCO_2e)	Cumulative GHG impacts (tCO_2e)
1	2033	29,200	24,820	0.024	0.080	-1,952	-1,952
2	2034	29,200	24,820	0.019	0.049	-1,190	-3,142
3	2035	29,200	24,820	0.018	0.018	-428	-3,569
4	2036	29,200	24,820	0.018	0.018	-416	-3,985
5	2037	29,200	24,820	0.017	0.017	-387	-4,372
6	2038	29,200	24,820	0.016	0.016	-377	-4,748
7	2039	29,200	24,820	0.015	0.015	-352	-5,101
8	2040	29,200	24,820	0.015	0.015	-334	-5,435
9	2041	29,200	24,820	0.014	0.014	-317	-5,753
10	2042	29,200	24,820	0.013	0.013	-300	-6,053
11	2043	29,200	24,820	0.008	0.008	-178	-6,231
12	2044	29,200	24,820	0.008	0.008	-163	-6,394
13	2045	29,200	24,820	0.007	0.007	-150	-6,544
14	2046	29,200	24,820	0.007	0.007	-146	-6,690
15	2047	29,200	24,820	0.005	0.005	-92	-6,782
16	2048	29,200	24,820	0.005	0.005	-89	-6,870
17	2049	29,200	24,820	0.003	0.003	-46	-6,916
18	2050	29,200	24,820	0.002	0.002	-28	-6,944
19	2051	29,200	24,820	0.002	0.002	-28	-6,971
20	2052	29,200	24,820	0.002	0.002	-28	-6,999
21	2053	29,200	24,820	0.002	0.002	-28	-7,027
22	2054	29,200	24,820	0.002	0.002	-28	-7,055
23	2055	29,200	24,820	0.002	0.002	-28	-7,082
24	2056	29,200	24,820	0.002	0.002	-28	-7,110
25	2057	29,200	24,820	0.002	0.002	-28	-7,138
26	2058	29,200	24,820	0.002	0.002	-28	-7,166
27	2059	29,200	24,820	0.002	0.002	-28	-7,193

Year of operation	Year	Input (MWh)	Output (MWh)	BEIS grid average	Peaking Plant carbon intensity (tCO_2e/MWh)	GHG impacts (tCO_2e)	Cumulative GHG impacts (tCO_2e)
28	2060	29,200	24,820	0.002	0.002	-28	-7,221
29	2061	29,200	24,820	0.002	0.002	-28	-7,249
30	2062	29,200	24,820	0.002	0.002	-28	-7,277
31	2063	29,200	24,820	0.002	0.002	-28	-7,305
32	2064	29,200	24,820	0.002	0.002	-28	-7,332
33	2065	29,200	24,820	0.002	0.002	-28	-7,360

Scenario 2b:

1.78 Under scenario 2 the BESS are charged entirely from the grid, which is represented by wind power. Avoided emissions over the Proposed Development lifetime associated with BESS with a higher storage capacity totals 25,171 tCO_2e.

Table 1.13: Annual operational GHG impacts- scenario 2b

Year of operation	Year	Input (MWh)	Output (MWh)	BEIS grid average	Peaking Plant carbon intensity (tCO2e/MWh)	GHG impacts (tCO_2e)	Cumulative GHG impacts (tCO_2e)
1	2033	99,864	84,884	0.024	0.080	-6,675	-6,675
2	2034	99,864	84,884	0.019	0.049	-4,069	-10,744
3	2035	99,864	84,884	0.018	0.018	-1,462	-12,206
4	2036	99,864	84,884	0.018	0.018	-1,423	-13,629
5	2037	99,864	84,884	0.017	0.017	-1,322	-14,951
6	2038	99,864	84,884	0.016	0.016	-1,288	-16,239
7	2039	99,864	84,884	0.015	0.015	-1,205	-17,445
8	2040	99,864	84,884	0.015	0.015	-1,144	-18,588
9	2041	99,864	84,884	0.014	0.014	-1,086	-19,674
10	2042	99,864	84,884	0.013	0.013	-1,026	-20,700
11	2043	99,864	84,884	0.008	0.008	-609	-21,308
12	2044	99,864	84,884	0.008	0.008	-559	-21,867
13	2045	99,864	84,884	0.007	0.007	-513	-22,380
14	2046	99,864	84,884	0.007	0.007	-499	-22,879
15	2047	99,864	84,884	0.005	0.005	-314	-23,193
16	2048	99,864	84,884	0.005	0.005	-303	-23,496
17	2049	99,864	84,884	0.003	0.003	-156	-23,652
18	2050	99,864	84,884	0.002	0.002	-95	-23,747
19	2051	99,864	84,884	0.002	0.002	-95	-23,842
20	2052	99,864	84,884	0.002	0.002	-95	-23,937
21	2053	99,864	84,884	0.002	0.002	-95	-24,032
22	2054	99,864	84,884	0.002	0.002	-95	-24,127
23	2055	99,864	84,884	0.002	0.002	-95	-24,222
24	2056	99,864	84,884	0.002	0.002	-95	-24,317
25	2057	99,864	84,884	0.002	0.002	-95	-24,412
26	2058	99,864	84,884	0.002	0.002	-95	-24,507

Year of operation	Year	Input (MWh)	Output (MWh)	BEIS grid average	Peaking Plant carbon intensity (tCO2e/MWh)	GHG impacts (tCO_2e)	Cumulative GHG impacts (tCO_2e)
27	2059	99,864	84,884	0.002	0.002	-95	-24,602
28	2060	99,864	84,884	0.002	0.002	-95	-24,697
29	2061	99,864	84,884	0.002	0.002	-95	-24,792
30	2062	99,864	84,884	0.002	0.002	-95	-24,886
31	2063	99,864	84,884	0.002	0.002	-95	-24,981
32	2064	99,864	84,884	0.002	0.002	-95	-25,076
33	2065	99,864	84,884	0.002	0.002	-95	-25,171

Operational Avoided Emissions Summary

1.79 Table 1.14 summarises the total anticipated avoided emissions resultant from the operational stage of the Proposed Development under each scenario, as detailed above. The values reported equal total emissions avoided from both the solar PV and BESS elements of the Proposed Development.

Table 1.14: Total avoided emissions during the operational phase of the Proposed Development

	Option A – lower BESS capacity	Option B – higher BESS capacity
Scenario 1		
Current grid average	-457,180	-157,964
Long run marginal	-83,100	-87,849
Residual energy mix	-656,220	-215,916
Scenario 2		
Current grid average	-674,566	-692,377
Long run marginal	-91,896	-109,707
Residual energy mix	-970,423	-988,234

Assessment of Whole Life Effects

Magnitude of Impact

1.80 Table 1.15 summarises the range of estimated net whole life emissions resultant from the Proposed Development. Negative values represent avoided GHG emissions, and positive values represent net GHG emission output.

1.81 Under option a (100 MWh BESS storage capacity), the Proposed Development can expect to achieve between -19,289 tCO_2e and -906,612 tCO_2e over its lifetime. A carbon payback can be achieved at 3 years at the earliest.

1.82 Under option b (342 MWh BESS storage capacity), the Proposed Development can expect to achieve between 24,641 tCO_2e and -875,744 tCO_2e over its lifetime. A carbon payback period can be achieved at 5 years at the earliest.

1.83 Accounting for all scenarios (including BESS capacity, and grid decarbonisation) the anticipated range of whole life emissions for the Proposed Development totals between 24,641 tCO_2e, and -906,612 tCO_2e. With a payback period achieved at 3 years at the earliest.

Table 1.15: Whole life effects summary

	Option A – lower BESS capacity	Option B – higher BESS capacity
Construction	63,811	112,490
Operation		
Best case[1]	-970,423	-988,234
Worst case[2]	-83,100	-87,849
Whole Life Effect		
Best case[1]	-906,612	-875,744
Worst case[2]	-19,289	24,641

[1]Options A and B achieve the greatest avoided emissions under scenario 2 using the residual energy mix.

[2]Options A and B achieve the fewest avoided emissions under scenario 1 using the long run marginal.

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Appendix 10.1
Outline Soils Resource Management Plan (oSRMP)

PLAS POWER SOLAR AND ENERGY STORAGE PROJECT

OUTLINE SOIL RESOURCES MANAGEMENT PLAN

February 2024

KERNON COUNTRYSIDE CONSULTANTS LIMITED

PLAS POWER SOLAR AND ENERGY STORAGE PROJECT

OUTLINE SOIL RESOURCES MANAGEMENT PLAN

February 2024

Authorised By APK 02/24

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CONTENTS

1 INTRODUCTION

1.1 This document provides an outline Soil Resources Management Plan (oSRMP) for the proposed Plas Power Solar and Energy Project (hereafter referred to as 'the Proposed Development').

1.2 The objective of the oSRMP is to identify the importance and sensitivity of the soil resource and to provide specific guidance to reduce the risk of significant adverse effect on the soil resource as a result of the Proposed Development.

1.3 The oSRMP has been produced following the comments of PEDW in their Scoping Direction Addendum and the comments of the Soil, Peatland and Agricultural Land Use Planning Unit of the Welsh Government, 20th July 2023 appended to the Addendum Scoping Direction of 17th October 2023. That response suggested that soils be scoped into the ES, and that a soil management scheme should be prepared covering, in particular:

- soil stripping programme;
- soil handing techniques and procedure;
- size, location, construction and management of soil storage dumps;
- proposed after use and restoration programme.

1.4 This is an outline SRMP. To date limited field survey has been completed, and start dates and design details are not yet finalised. A detailed SRMP will be provided, which will include details of:

- soil stripping programme (for the tracks and inverters, plus the BESS);
- the location of soil storage for subsequent restoration of the tracks etc.

1.5 The oSRMP is structured as follows:

(i) section 2 sets out the reasons for and the scope of the oSRMP;

(ii) section 3 describes the soil resources and characteristics;

(iii) section 4 sets out key principles;

(iv) sections 5 - 8 set out the soil management requirements for key aspects of the Proposed Development:

- section 5: construction compounds;
- section 6: access tracks and fixed equipment;
- section 7: solar arrays;
- section 8: on-site trenching;
- section 9: substation and BESS;

(v) sections 10, 11 and 12 set out operational and maintenance phase management and the principles required for decommissioning.

1.6 This oSRMP draws on professional experience with the installation of solar panels. It also draws on experience with the installation of underground services (especially pipelines), and with soil movement and restoration of agricultural land in connection with roads, quarries and golf courses. It draws from the detailed Agricultural Land Classification (ALC) survey by AMET Property (November 2022) of part of the site, and on other published data as referenced in this report.

Summary

1.7 Subject to planning consent and the discharge of conditions the installation process is expected to commence with initial enabling works in spring 2025. If weather permits this will include creating the access tracks. The bulk of the panel legs are expected to be installed within 12 to 18 months of commencement, and wherever practicable whilst soils are dry, between spring and autumn.

1.8 The operators recognise the need to carry out such work when soil conditions are suitable and are committed to that.

Note about Why Soils are Important

1.9 Soils are an important resource. The Environment Agency estimates that UK soils currently store about 10 billion tonnes of carbon, equal to about 80 years of greenhouse gas emissions[1]. Yet many biological processes and soil functions are thought to be under threat. 4 million hectares are at risk of compaction, including grassland areas. Therefore soils need to be managed so as not to damage or lose those important functions.

Advice and Guidance Drawn Upon

1.10 This document has drawn upon:

- Construction Code of Practice for the Sustainable Use of Soils on Construction Sites, Defra (2009);
- Working with Soils Guidance Note on Benefiting from Soil Management in Development and Construction, BSSS (2022);
- Building on Soil Sustainability: principles for soils in planning and construction, Lancaster University and partners (2022);
- Agricultural Good Practice for Solar Farms, BRE (2014);

[1] State of the Environment: Soils, Environmental Agency (2019)

- Good Practice Guide for Handling Soils in Mineral Workings, The Institute of Quarrying (2021).

1.11 This oSRMP draws on published data and soil survey of some areas. It is recognised that for the full SRMP additional survey of the subgrade 3 land will be necessary to map the areas of medium and heavy clay loam approximately.

2 SCOPE OF THE OSRMP

2.1 This oSRMP sets out:

- a description of the soil types and their resilience to being trafficked;
- an outline description of proposed access routes and details of how access will be managed to minimise impacts on soils;
- a description of works and how soil damage will be minimised and ameliorated;
- a methodology for monitoring soil condition, and criteria against which compliance will be assessed;
- and an outline of how soil will be protected at decommissioning.

2.2 the oSRMP covers, in general terms, the following requested by LQAS:

- soil stripping;
- soil handling techniques;
- size and management of soil storage bunds;
- proposed restoration programme and after use.

2.3 A detailed SRMP will be produced post consent to identify the final programme and locations of soil storage etc.

2.4 The installation of the solar panel framework, and the assembly of the panels, does not require the movement or disturbance of soils. Those works should not, therefore, result in localised disturbance or effects on soils or agricultural land quality. The oSRMP however particularly covers vehicle movements and related impacts, as those could result in compaction.

2.5 Trenching works to connect the panels to the infrastructure do have the potential to cause localised effects on soils. Localised damage will be minimised by good practice. This oSRMP sets out soil resilience, good practice and monitoring criteria. It considers the effect of trenching works.

2.6 In localised areas there is a need for access tracks or bases for infrastructure and equipment. In those localised areas soil will need to be stripped and moved, for stockpiling for subsequent restoration. This oSRMP sets out:

- a description of the soil types and their resilience to being stripped and handled;
- an outline map showing the areas proposed for being moved, soil thickness and type;
- a methodology for creating and managing stockpiles of soil;

- an outline methodology for testing soils prior to restoration, and a methodology for respreading and ameliorating compaction at restoration.

2.7 This oSRMP focuses on the construction phase and immediate aftercare, and on the decommissioning phase, especially to set principles to avoid creating compaction. There will be some long-term storage of soil for restoration uses at the decommissioning phase. Any soil removal at construction for future restoration (eg of the tracks) will be stored on site and labelled for subsequent return.

3 SOIL RESOURCES AND CHARACTERISTICS

<u>The Site</u>

3.1 The site is outlined in red on the Google Earth image below. As can be seen, the site is mostly grassland with some arable land to the north and north west.

Insert 1: Google Earth Image

3.2 The site is generally level or gently sloping, and can be seen in the following photographs.

Insert 2: Site and Photograph Locations

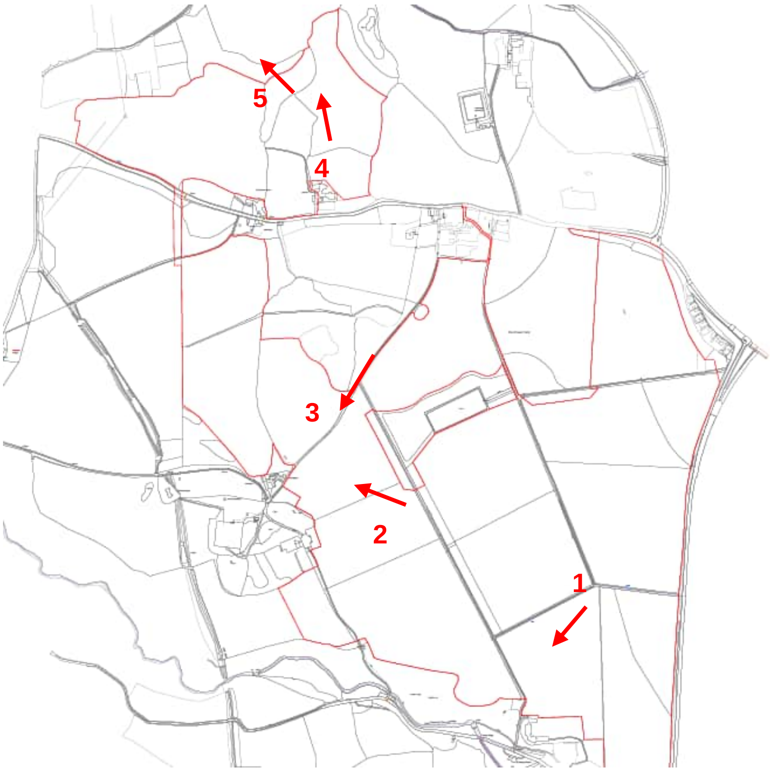


Photo 1: Looking South

Photo 2: Looking North-West

Photo 3:

Photo 4: Looking North

Photo 5: Unfarmed Area

3.3 The site is currently used for agricultural purposes, comprising of several agricultural fields, primarily used for pasture grazing, bounded by a mixture of mature woodland, trees, hedgerows and fencing. The northern fields are mostly in arable uses.

Site History

3.4 Much of the site formed part of an open cast mine in 1964 and subsequently a non-water fill in 1976. The site is currently used for agricultural purposes, comprising of agricultural fields, primarily used for pasture grazing, bounded by a mixture of mature woodland, trees, hedgerows and fencing. Parts of the northern parcel comprise arable land for the purpose of growing crops. The Proposed Development would support the continued use of the land for sheep grazing.

Geology and Topography

3.5 The geology of the site comprises a cover of Glacial Superficial deposits of either Glacial Till or Glaciofluvial sands and gravels overlying bedrock strata of the Pennine Lower and Middle Coal Measures. Cefn Rock sandstone is present in the northernmost part of the site. Whilst the site is located within a Mineral Resource Area, these deposits are recorded to extend significantly beyond the site boundary.

3.6 The topography of the site, based upon Ordnance Survey 1:10,000 mapping contours, generally falls from a high point of 180mAOD (metres above Ordnance Datum) within the north-western extent of the northern parcel of the site to approximately 102mAOD within the south-eastern extent of the southern land parcel.

Climate

3.7 The climate, assessed for ALC purposes for the ALC of parts of the site, has an average annual rainfall of about 930mm. This leads to a Field Capacity Days estimate of 208 days per year, again for ALC purposes.

Soils

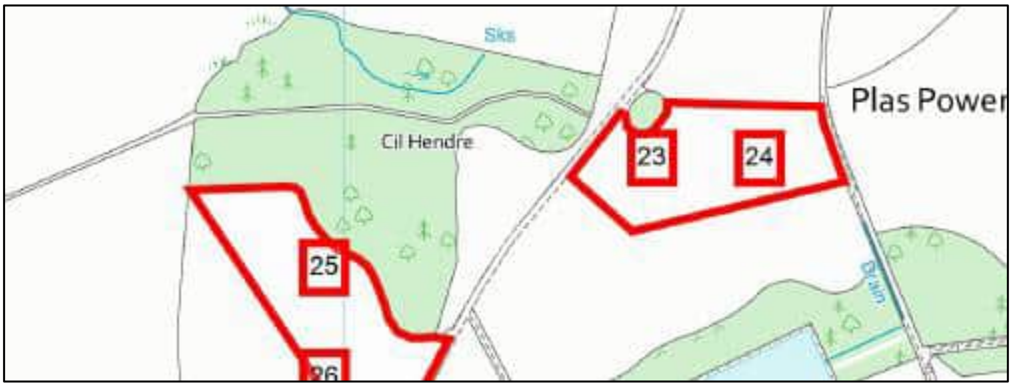
3.8 Much of the site is restored, so the historic soil has been disturbed.

3.9 In those areas that have been surveyed there was a high level of stoniness, as shown in the ALC report.

3.10 The soils identified medium clay loam, occasionally heavy clay loam, over a slowly permeable gleyed clay loam subsoil from between 25 and 50cm.

3.11 One area of very shallow soils was identified, at locations 23 and 24 below.

Insert 3: Locations 23 & 24



4 KEY PRINCIPLES

Terminology

4.1 In this oSRMP the following terminology is used:

- soil trafficking, which means vehicular passage over soils, but not physical disturbance;
- soil handling, which describes where soil is physically moved, such as by a mechanical digger.

Overview

4.2 For much of the installation process there is no requirement to handle (ie move or disturb) soils. Soils will need to be moved and disturbed to create temporary working compounds, and to create the tracks and small fixed infrastructure bases. Soils will need to be handled to enable cables to be laid, but those soils will be reinserted shortly after they are lifted out (ie this is a swift process). More significant works will be required to create the BESS.

4.3 For those limited areas where soil needs to be disturbed to create tracks and bases, the soil will be stored in suitably-managed bunds on the site. The soil needs to be looked after because it will be needed at the decommissioning phase to restore the land under the tracks and bases back to agricultural use, unless otherwise agreed with the landowner.

4.4 It is unlikely that subsoil will need to be removed to create the shallow tracks and bases, but if subsoil does need to be moved and stored, it will be stored separately to the topsoil, and clearly marked.

4.5 For the majority of the Proposed Development soils do not need to be disturbed. The effects on agricultural land quality and soil structure are therefore limited to the effects of vehicle passage (ie trafficking). This is agricultural land, so it is already subject to regular vehicle passage. Therefore the key consideration is to ensure that soils are passed over by vehicles (trafficked) when the soils are in a suitable condition, and that if any localised damage or compaction occurs (which is common with normal farming operations too), it is ameliorated suitably.

4.6 The key principles for successfully avoiding damage to soils are:

- timing;
- retaining soil profiles;
- avoiding compaction;
- ameliorating compaction; and
- retaining and storing soils for subsequent reuse.

Timing

4.7 The most important management decision/action to avoid adverse effects on soils is the timing of works. If the construction work takes place when soil conditions are sufficiently dry, then damage from vehicle trafficking and trenching will be minimal.

4.8 The installation process is unlikely to be restricted between April and October in a normal year. The weather in recent years has been very variable and work outside this period will be possible so long as soil conditions are suitable. The top soils are clayey and imperfectly drained, and so are susceptible to damage when wet. Accordingly the panels and trenches should mostly, so far as practicable, be installed before the soils become saturated. Final commissioning works are unlikely to create much need to traffic over the land, and could operate outside this window.

4.9 In some years, such as 2022-2023, extensive winter working opportunities existed because of long periods without rainfall. For winter working in the period November to March extra care is required, particularly for any activity that involves handling soils, a soil scientist shall be called out to inspect the land and provide advice prior to works commencing.

4.10 The soils are relatively resilient in summer to vehicle passage.

4.11 Any damage from vehicle trafficking in winter, which will be avoided so far as practicable, can generally be made good by mechanical husbandry once the soils start to dry in the spring.

4.12 In winter and early spring there is an increased risk of creating localised damage to soil structure from vehicle passage. There are obviously a great number of variables, such as recent rainfall pattern, whether the ground is frozen or has standing water, inevitable variations in soil condition across single fields, and the size and type of machinery driving onto the land. However, landwork in this period is most likely to result in the need for restorative works post installation and, so far as practicable, will be avoided.

4.13 As a general rule any activity that requires soil to be dug up and moved, such as cabling works, should be reduced so far as practicable during that period. Soils handled when wet tend to lose some of their structure, and this results in them taking longer to recover after movement, and potentially needing restorative works (eg ripping with tines) to speed recovery of damaged soil structure.

4.14 In localised instances where it is not practicable to avoid undertaking construction activities when soils are wet and topsoil damage occurs then soils can be recovered by normal agricultural management, using normal agricultural cultivation equipment (subsoiler, harrows, power harrows etc) once soils have dried adequately for this to take place. There may be localised wet areas in otherwise dry fields, for example, which are difficult to avoid.

Determining if Soils are Suitable

4.15 Soils should be friable when moved.

4.16 Basically with clayey soils of this type, if you can roll soil into a ball or a sausage easily and the soil holds that shape, it is too wet to travel over or move soils. This is illustrated in the photograph below. It is followed by a photograph indicating the type of physical impression the tractor movement can make in unsuitable conditions. Further guidance is given in Sheet A of the Good Practice Guide to Handling Soils in Mineral Workings, Institute of Quarrying (2021).

Inserts 4 and 5: Indication of When Soils are Too Wet

Retaining Soil Profiles

4.17 The successful installation of cabling requires a trench to be dug into the ground. Topsoils vary only slightly across the site and the coverage is generally 25-30cm.

4.18 As set out in the BRE Agricultural Good Practice Guidance for Solar Farms at page 3:

"**When excavating cable trenches, storing and replacing topsoil and subsoil separately and in the right order is important to avoid long-term unsightly impacts on soil and vegetation structure. Good practice at this stage will yield longer-term benefits in terms of productivity and optimal grazing conditions**".

4.19 In those areas where the soil is dug up (trenching and for compounds and access roads), the soils should be returned in as close to the same order, and in similar profiles, as it was removed.

Avoiding Compaction

4.20 This oSRMP sets out when soils should generally be suitable for being trafficked. There may be periods within this window, however, when periodic prolonged rainfall events result in soils becoming liable to damage from being trafficked or worked. In these (likely rare) situations, work should only continue with care, to minimise structural effects on the soils, until soils have dried, usually within 48 hours of heavy rain stopping.

Ameliorating Compaction

4.21 If localised compaction occurs during construction, it should be ameliorated. This can normally be achieved with standard agricultural cultivation equipment, such as subsoilers (if required), power harrows and rolls.

4.22 The amount of restorative work will vary depending upon the localised impact. Consequently where the surface has become muddy, for example in the photograph below, this can be recovered once the soil has dried, with a tine harrow and, as needed, a roller or crumbler bar. So far as possible this sort of damage should be avoided.

Inserts 6 and 7: Inter-row Ground Restoration: THIS IS AN EXAMPLE OF POOR PRACTICE FROM A DIFFERENT SITE

4.23 With the target construction programme from April to October this type of more extensive soil damage is unlikely to occur. In the November to March period particular care will be require to avoid causing this kind of disturbance to the soils. They can, as noted below, be restored but there is a time and cost implication.

4.24 If there is any localised problem, the type of machinery involved in restoration is shown below. This shows farming and horticultural versions.

Inserts 8 and 9: Type of Machinery Involved

4.25 If there are any areas where there has been localised damage to the soils due to vehicle passage, for example, a low wet area within a field which despite best efforts could not be avoided, this should be made good and reseeded at the end of the installation stage. This is not uncommon: most farmers will have times when they have to travel around the farm in a tractor in conditions where the tyres make deep impacts. This can happen during harvest time, for example, especially of late crops or in very wet harvest seasons. Whilst this is avoided so far as practicable, it occurs and the effects are made good when conditions are suitable.

4.26 The ground surface should be generally levelled prior to any seeding or reseeding.

4.27 Examples of areas that have been cultivated following the installation of panels, are shown below. These are the main vehicle trafficking routes. As can be seen, the area under and mostly between the panels, is not damaged.

Inserts 10 and 11: Localised Repairs (solar farm in Sussex)

Retaining Soils

4.28 At decommissioning stages the areas that will form the bases for the fixed infrastructure, can be returned to agricultural use. For this to be successful, the soils must have been retained on site, properly recorded or labelled so that they can be returned to the approximate position from where they came and stored properly for the lifetime of the scheme in an appropriately sized and managed bund.

4.29 No soil removed to construct the tracks will be removed from the site. It will all be stored on site for use at the decommissioning phase.

4.30 The storage bunds will be managed to prevent the growth of woody vegetation.

5 CONSTRUCTION COMPOUNDS

Construction Methodology

5.1 A temporary construction compound will need to be created at the start of construction and reinstated at the end.

5.2 Construction compounds are built by stripping topsoil and storing that in a bund on the edge of the site. A matting is then laid down, and stone imported and levelled, as shown below.

Insert 12: Newly-laid Construction Compound (Elsham-Lincoln Pipeline)

5.3 The matting prevents the stone from mixing with the subsoil, as shown below.

Insert 13: Matting

5.4 Topsoil is stored in a bund, as shown below. Guidance on this can be found in Box B1 of Sheet 2 of the Good Practice Guide for Handling Soils in Mineral Workings (Institute of Quarrying, 2021), *Insert 14: Topsoil Storage Bund (example from Lincolnshire)*

Movement of Soils

5.5 The soils need to be sufficiently dry to handle. If you can roll soil into a ball or a sausage easily and the soil holds that shape, it is too wet to travel over or move soils. This is illustrated in the photograph below.

Insert 15: Indication of When Soils are Too Wet

5.6 The topsoils will be stripped to a depth of 30cm, and placed in bunds on the edge of the compound, as shown above.

5.7 Short term storage of soil is shown above. If the soil is likely to be stored for in excess of six months then, depending upon timing, it should be seeded with grass. This binds the soil together and minimises erosion.

5.8 Therefore if the construction compound is not to be removed before the wet weather in the autumn, the bunds should be seeded with grass, as per the example below.

Insert 16: Grass-seeded Bund (photographed in Devon)

Removal

5.9 The removal of the construction compound should be timed for dry weather. That may be the following spring.

5.10 At the end of the construction process, the aggregate will be removed. This can be seen in progress below.

Insert 17: Start of Restoration of Construction Compound (example from Staffordshire)

5.11 The base area should be loosened when soils are dry and the topsoil then spread over the site to the original depth. This should be lightly cultivated.

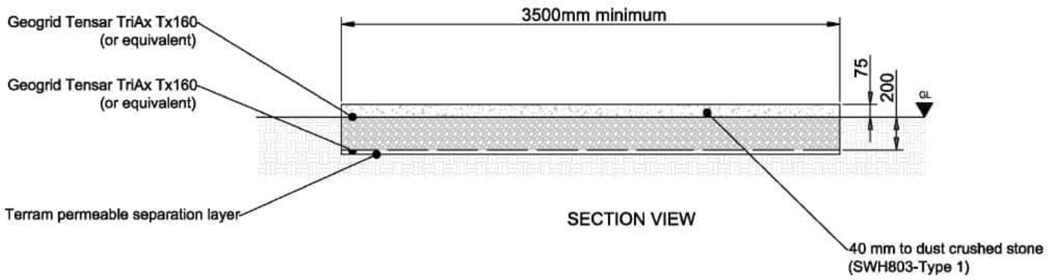
5.12 Panels can then be installed over the construction compound, or the area returned to agricultural use.

6 ACCESS TRACKS AND FIXED EQUIPMENT

Construction Methodology

6.1 The access tracks are created by stripping off some or all of the topsoil (to a depth of 200mm) and then adding an aggregate-based surface. Usually, the aggregate will be placed onto a permeable membrane, which allows water penetration but which prevents the aggregate from mixing with the topsoils or upper subsoils. A typical cross-section is shown below.

Insert 18: Access Track Cross Section



6.2 The small areas of fixed equipment normally stand on a gravel base area, as shown below. As these areas will be restored in the future, the construction is carried out as follows:

(i) topsoil to c 10-15cm is removed. This will be stored in a bund no more than 3m high at an agreed location, for use in future restoration;

(ii) a permeable terram layer is then laid;

(iii) the base of stone is then added, and forming put around before concrete is poured to create the pad, or stone is added to create the pad;

(iv) the equipment is then placed on top;

(v) further security fencing is added once the cabling and connections are complete.

6.3 A typical example of fixed equipment from an operating solar farm, is shown below.

Inserts 19: Typical Inverter Container (example from Monmouthshire)

Soil Management

6.4 Soil should be stripped when the soil is sufficiently dry and does not smear. This is a judgement that is easily made. If the soils can be rolled into a sausage shape in the hand which is not crumbly, or if rubbing a thumb across the surface causes a smudged smooth surface (a smear), the soil is generally too wet to strip or move without risk of structural damage. Topsoil depths are consistent across the site and a stripping depth of 30cm will be a suitable maximum depth for topsoil in most cases, although rarely will it need to be stripped to such a depth.

6.5 Soil stripping should be carried out in accordance with Defra "Construction Code of Practice for the Sustainable Use of Soils on Construction Sites" (Defra, 2009). The removed soil should be stored in bunds in accordance with the Construction Code of Practice.

6.6 The tracks involve the movement of soils. Therefore the soils are more susceptible to damage from mechanical moving. The topsoil will, however, be stored for the duration of the operational period. Accordingly if for operational reasons it is necessary to commence the construction of tracks and bases when soils are not in optimal condition, the soil to be stored should be stored initially in bunds of maximum 3 metres high.

6.7 This will allow the soils to dry. Shallow bunds can then be moved again once they are dry into larger bunds for long-term storage.

6.8 Once the soils are sufficiently dry, typically after two or three weeks, it will be possible to move the soils to long-term storage bunds.

6.9 As a general rule soil should not be moved during or within 24 hours of heavy rain.

Bund Management

6.10 Soil bunds should be no more than 3m in height to prevent anaerobic conditions in the base of the bund. The bund should be sown with a grass mix. This should be managed at least annually to prevent the growth of woody vegetation (eg brambles).

6.11 Examples of bunds are shown below.

Insert 20 and 21: Soil Bund Example (examples from Lincolnshire and Devon)

Reinstatement

6.12 Reinstatement of topsoil at the decommissioning phase should involve the following:

(i) removal of the stone from the track, and the membrane;

(ii) subsoiling in dry conditions along the route of the track and base areas to loosen the subsoil;

(iii) replacement of dry topsoil from the bunds, levelled and cultivated;

(iv) a second light compaction alleviation, eg with a tined cultivator, if needed;

(v) sowing with a crop or grass to get rooting into the profile as soon as practicable after replacement.

7 SOLAR ARRAYS

The Areas

7.1 The PV Arrays will be distributed across the Solar PV Site as shown on the application plans.

Construction Methodology

7.2 The process involves the following stages:

(i) marking-out and laying out of the framework. For this a vehicle needs to drive across the field possibly with a trailer, from which the legs are off-loaded by hand, or by use of a Bobcat such as that shown below delivering legs;

Insert 22: Bobcat Delivering Legs (example from Wiltshire)

(ii) pile driving in the legs. This involves a pile driver, knocking the legs down to a maximum 1.5m. The machinery is shown below;

Inserts 23 - 25: Pile Driving in the Legs

(iii) the frame is then constructed. The frame is brought onsite, bolted together, and the panels bolted on, as per the series of photographs below.

Inserts 26 - 28: Constructing the Frame. Note this is a very low panel

7.3 The installation should be carried out when the ground conditions are suitable (ie the soil is not so wet that vehicles cause tyre marks, such as shown below, deeper than about 10cm when travelling across the land). This will normally be between May and late September, which is a few weeks after soils should be dry and a few weeks before they would normally become wet. If conditions are suitable, this stage of the installation should create no soil structural damage or compaction, as shown below.

Inserts 29 and 30: Ground After Construction (example from Wiltshire)

Soil Management

7.4 As discussed earlier, the sausage test, should be used to determine suitability of the soils for working or access. In simple terms, if the soil is so wet that vehicles cause tyre marks, such as shown below, deeper than about 10cm when travelling across the land, conditions are not yet suitable. As construction is scheduled to start in spring, soils will normally be suitable.

Insert 31: Track Marks (example from Pembrokeshire)

7.5 In most years work access to the land is not restricted between April and October. Between those periods the ground conditions will normally be resilient to vehicle trafficking.

7.6 Between October and April the soils are more likely to be saturated and the propensity to being damaged, albeit in a way capable of rectification, is greatest. As a general rule, vehicular travel in these periods should be limited as much as practicable. It is recognised that rainfall is the factor that wets the soils, so a dry spring will offer different conditions to a wet spring, and this may mean that soil structural damage will inevitably result. This is outside the projected construction period.

7.7 This country sometimes experiences prolonged rainfall in the summer months that can saturate soils. If following a rainfall incident installation is causing rutting deeper than 10cm, activity should be minimised so far as practicable to allow soils to dry.

7.8 It is very unlikely that trafficking during construction when soils are relatively dry will result in compaction sufficient to require amelioration. However, if rutting has resulted the soil should be levelled by standard agricultural cultivation equipment such as tine harrows, once the conditions suit, and prior to seeding. This can be done with standard agricultural machinery, or with small horticultural-grade machinery such as is shown below.

Inserts 32 and 33: Horticultural Machinery

7.9 The objective is to get the surface to a level tilth for seeding/reseeding as necessary, as was shown earlier.

7.10 Grass growth will then recover or establish rapidly.

8 INSTALLATION OF ON-SITE TRENCHING

The Areas

8.1 This section refers to the cabling running within the consented area.

Construction Methodology

8.2 Cabling is done mostly with either a mini digger or a trenching machine. Trenches will typically be at depths of up to 1.0m where soil depth permits, although the CCTV trenching around the periphery could be shallower. An example trench, with the topsoil, placed on one side (0-30cm) and subsoil on the other (below 30cm), is shown below, and with the soil put back after cable installation.

Inserts 34 and 35: Cable Installation (example from Wiltshire)

8.3 It is important that topsoils are placed separately to the subsoils, and that they are then put back in reverse order, ie subsoils first.

8.4 The type of machinery used for trenching is shown below, taken from the BRE National Solar Centre “Agricultural Good Practice Guidance for Solar Farms” (2013).

Insert 36: Machinery Used (extract from BRE Good Practice Guidance)

Cable trenching, showing topsoil stripped and set to one side, with subsoil placed on the other side ready for reinstatement (photo courtesy of British Solar Renewables)

8.5 The trenches are typically narrow (mostly 40-70cm). If the topsoil was from grassland the grass will probably recover rapidly without the need to reseed. In bare soils the trench can be cultivated with the wider area for seeding to grass post installation.

Insert 37: Grass After 4 Weeks (natural recovery)

(The photos in this section were taken on heavy, clay soils with poorly draining subsoil, and the work was photographed in July and August 2015)

Soil Management

8.6 All trenching work will be carried out when the topsoil is dry and not plastic (ie it can be moulded into shapes in the hand).

8.7 The top 30cm will typically be dug off and placed on one side of the trench, for subsequent restoration. There is no need to strip the grass first.

8.8 The subsoils will then be dug out and placed on the other side of the trench, as per the example below.

Insert 38: Subsoils Dug out of the Trench

8.9 Once the cable has been laid, the subsoils will be placed back in the trench. Where there is a clear colour difference within the subsoils, so far as practicable the lower subsoil will be put back first and the upper subsoil above that, which is likely to happen anyway as the lower soil is at the top of the pile.

8.10 If dry and lumpy the subsoils will be pressed down by the bucket to speed settlement. If the soils are settling well no pressing-down is required.

8.11 The topsoil will then be returned onto the top of the trench. It is likely, and right, that the topsoil will sit a few centimetres higher than the surrounding level. This should be left to allow it to settle naturally as the soils become wetter.

8.12 If there is a surplus of topsoil this may be because the lower subsoils were dry and blocky and there are considerable gaps in the soil. These will naturally restore once the lower soils become wet again. If the trench backfilling will result in the soil being more than 5-10cm proud of surrounding levels, which is unlikely but possible, the topsoil should not be piled higher. It should be left to the side, and the digger would return once the trench has settled and add the rest of the topsoil onto the trench at that point.

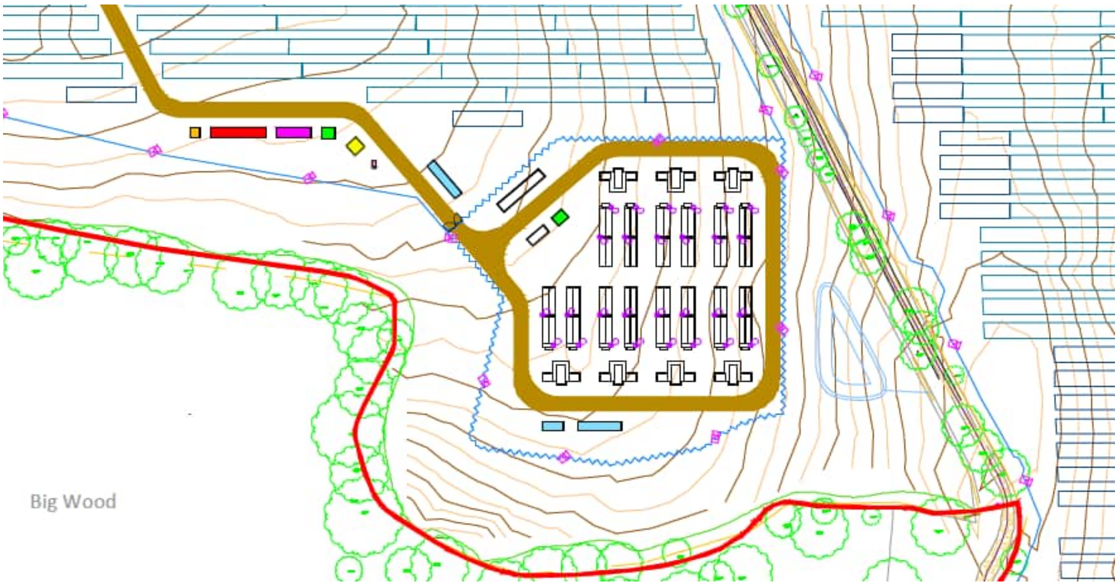
8.13 Any excess topsoil should not be piled higher than 5 – 10cm above ground level.

8.14 If considered appropriate, a suitable grass seed mix could be spread by hand over any parts of the trenches that would seem likely to benefit from extra grass.

9 SUBSTATION AND BATTERY COMPOUND

9.1 The battery compound is shown below.

Insert 39: BESS Proposal



9.2 This involves an area of about 0.7ha. This area may need to be levelled in part, and have a hard surface, which will be determined on site during construction.

9.3 Topsoil stripping will take place to create the area, and will be stored in a bund either beside the compound or against the edge of the field.

9.4 It will be necessary to level the site. This will involve movement of subsoils within the compound area (ie cut and fill), but no subsoils will need to be stored.

Insert 40: Example of Compound in Construction (example from Lincolnshire)

9.5 The volume of topsoil for storage will be of the order of 2,000 cubic metres, based on a compound size of 70m by 100m (7,000 sqm). At a strip depth of 30cm this would amount to 2,100 cubic metres.

9.6 Assuming a maximum bund height of 3m, and a level width of 3m at the top, with a slope of 45 degrees, the cross section will be 18 cubic metres per metre run. A bund length of the order of 120 metres in total would be required.

9.7 The bund should be managed, involving being cut at least once per year to prevent woody growth (eg brambles, elder) and to maintain grass growth, as this helps dissipate runoff and prevent erosion of the sides.

9.8 An example of long-term soil storage, this from a solar farm at Llanvapeley, Monmouth, is shown below.

Inserts 41 and 42: Long-Term Soil Storage (example from Monmouthshire)

9.9 The BESS area will be fenced.

9.10 An example of a large BESS, with the soil storage to the side (only partly visible in the photograph) is shown below.

Insert 43: Example of Part of a BESS and Bund (example from Herfordshire)

10 OPERATIONAL PHASE: LAND MANAGEMENT

Solar PV Arrays

10.1 The land around the Solar PV Arrays will be managed including by the grazing of sheep.

10.2 Panels grazed by sheep tend to be free of weeds, as shown below.

Insert 44: Sheep Grazing Under Panels (example from Bedforshire)

10.3 Any localised weed treatment can be carried out at the appropriate time of the year using a quad-mounted sprayer, or by hand using a strimmer or knapsack sprayer.

Ongoing Maintenance

10.4 There are many different cleaners on the market, some tractor based and some operated from smaller machines, such as below.

Insert 45: Cleaning of Solar Arrays

10.5 All the fields are wet in places, and therefore the cleaning should be timed so far as practicable to avoid the October to April period for the site. This is normal because the objective is to clean the panels before the peak summer generating period.

10.6 If vehicles, including farm vehicles, cause ruts in the soil these will naturally repair in time, especially as the land is grazed by sheep and their feet are excellent at levelling land. Alternatively a light harrow or rolling will restore the ruts, when the soil is still soft enough to roll but hard enough to not rut more.

Insert 46: Ruts Caused by Vehicles (example from Staffordshire)

10.7 If vehicles have caused rutting it is probably, as per the example above, only localised. In the photograph above this is a wet spot, and on the land either side of the ruts within the row there is no evidence of wheel indentation. If these areas are not levelled they will tend to sit with water in them.

10.8 Localised, small rutting should be repaired by either treading-in the edges with feet, by light rolling or harrowing, or adding a small amount of soil simply to fill-in the depression so that water does not collect there.

10.9 Deeper rutting will require either light harrowing in the drier period, or some soil adding, or both, before reseeding.

<u>Emergency Repairs</u>

10.10 For the duration of the operational phase there should be only localised and infrequent need to disturb soils, such as for repair of a cable. Any works involving trenching should be carried out, ideally, when the soils are dry but recognising that any works will be those of emergency repair, that may not be possible.

10.11 Accordingly if new cabling is needed and has to be installed in wet periods, soil will need to be disturbed, such as the example below.

Insert 47: Trench During Wet Period (example from Bedfordshire)

10.12 Any area disturbed should be harrowed or raked level once the soils have dried, and be reseeded. These areas will be small, and this can probably be done by hand.

11 OPERATIONAL PHASE: SOIL STORAGE

11.1 The critical part of successful long-term storage of soils is to place the soils into storage bunds when the soils are dry.

11.2 Ongoing maintenance should ensure that the bunds remain free from woody vegetation (eg brambles, elder) and that the soil bunds do not erode. For this reason the bunds should be seeded with a grassland mix, as the roots of the grasses will help bind the surface and prevent water channels forming.

11.3 At least once per year the bund should be managed, ideally by mowing or strimming.

11.4 An example of a bund that is seven years old, is shown below.

Insert 48: Soil Bund Example (example from Monmouthshire)

12 DECOMMISSIONING PRINCIPLES

12.1 Given the length of time before decommissioning it is likely that the ALC methodology will have been amended by then. Further, unless we are successful as a world, climate change may have altered the seasons and rainfall patterns. Therefore this guidance is prefaced with a requirement for a suitably qualified soil scientist to revisit the site prior to decommissioning, and to update the guidance and timing.

12.2 The objective is to remove panels and restore all fixed infrastructure areas to return the land to the same ALC grade and condition as it was when the construction phase commenced.

Removal of Panels

12.3 A qualified soil scientist should advise prior to decommissioning time. The effects of climate change in 40 years time may mean that these dates, applicable in 2024, are no longer applicable.

12.4 Once the panels have been unbolted and removed, the framework will then be a series of legs, as shown below.

Inserts 49 and 50: The Framework (examples from Wiltshire and Nottinghamshire)

12.5 These will be removed by low-ground pressure machines, in a reverse operation to the installation. These machines will provide a pneumatic tug-tug-tug vertically upwards. This will break the seal between soil and leg, and once that surface tension is released the leg will come out easily.

12.6 The legs will be loaded onto trailers and removed.

12.7 There will be no significant damage to the soils, and no significant compaction.

Removal of Cables

12.8 Cables buried less than 1 metre deep will be removed. This is likely to need a trench to be dug. This will be done is done mostly with either a mini digger or a trenching machine. Cabling will mostly be at depths of 0.8m where soil depth permits, although the CCTV trenching around the periphery could be shallower. An example trench, with the topsoil placed one side (0-20/25cm) and subsoil on the other (below 20-25cm), is shown below, and with the soil put back after cable installation.

Insert 51: Example Trench

Insert 52: Topsoil Replaced

12.9 The type of machinery used for trenching is shown below, taken from the BRE National Solar Centre "Agricultural Good Practice Guidance for Solar Farms" (2013).

Insert 53: Machinery Used for Trenching

Cable trenching, showing topsoil stripped and set to one side, with subsoil placed on the other side ready for reinstatement (photo courtesy of British Solar Renewables)

12.10 Once the trench has been backfilled it can be left for cultivation with the rest of the field post removal of panels.

Removal of Fixed Infrastructure

12.11 Switchgear, such as that shown below, will need to be removed.

Insert 54: Switchgear

12.12 Low ground pressure vehicles, and cranes, will be needed to lift the decommissioned units onto trailers, and removed from site. An example is shown below.

Insert 55: Example of Low Ground Vehicles

Case Steiger Quadtrac used to deliver inverters and other heavy equipment to site under soft ground conditions (photo courtesy of British Solar Renewables)

12.13 Any concrete bases will need to be broken up. This will most likely involve breaking with a pneumatic drill to crack the concrete, after which it can be dug up and loaded onto trailers and removed.

12.14 The ground beneath the base may then benefit from being subsoiled, to break any compaction. This can be done by standard tractor-mounted equipment, such as the following examples.

Inserts 56 and 57: Example of Tractor Mounted Equipment

Tracks

12.15 The tracks will be the last fixed infrastructure removed. The tracks will have been used for vehicle travel during the decommissioning stage. The tracks will also be used for removal of material from the tracks themselves, which will be removed from the furthest point first.

12.16 The stone will be removed and any matting removal. The base will then be loosened by subsoiler or deep tine cultivators, depending on specific advice given by the soil expert at the time following and analysis of soil compaction and condition.

Reinstatement of Soils

12.17 Topsoil from the storage bunds will then be returned and spread to the depth removed (typically 10-15cm). The area will then be cultivated, probably in combination with the whole of each field.

Fences and Gates

12.18 This will be removed in the summer months, after the panels have been removed. This will involve a tractor and trailer. The CCTV cabling is shallow buried and will probably pull out without the need for trenching, but if required tranches will be dug, as described above, and replaced in order once the cables have been removed.

Cultivation

12.19 The fields will be handed back to the farmers. Whether they are handed back as grassland or sprayed off and cultivated, will be determined in discussions with each landowner.

Appendix 10.2
ALC Survey Report

AGRICULTURAL LAND CLASSIFICATION
PLAS POWER SOLAR FARM

CLIENT: LIGHTSOURCE RENEWABLE UK DEVELOPMENT LTD
PROJECT: PLAS POWER SOLAR FARM
DATE: 7TH NOVEMBER 2022 – ISSUE 2
ISSUED BY: JAMES FULTON MRICS FAAV

Contents

1. EXECUTIVE SUMMARY

1.1 This report assesses the Agricultural Land Classification (ALC) grading of 25.1Ha, of agricultural land at Plas Power near Wrexham.

1.2 The limiting factor is found to be soil wetness on all of the land to the north and west, and droughtiness on the shallow soils over rock to the east, both of which are a combination of the soils found on site and the climatic regime.

1.3 The land is graded as follows:

Grade 3a:	1.6 Ha	6.4%
Grade 3b:	21.5 Ha	83.7%
Grade 4:	2.0 Ha	7.9%

2. INTRODUCTION

2.1 Amet Property Ltd have been instructed by Lightsource Renewable UK Development LTD to produce an Agricultural Land Classification (ALC) report on an a 25.1-hectare site at Plas Power to the west of Wrexham in support of a planning application for a solar farm with associated infrastructure.

2.2 The report's author is James Fulton BSc (Hons) MRICS FAAV who has worked as a chartered surveyor, agricultural valuer, and agricultural consultant since 2004, has a degree in agriculture which included modules on soils and over 10 years' experience in advising farmers on soil structure and cultivation methods and in producing agricultural land classification reports.

2.3 The report is based on site visits conducted on the 10th of September and 28th October 2022. During the site visits conditions were dry and sunny. During the inspection four trial pits were dug, these would ordinarily be to 120cm but in all cases the land became impenetrable before 120cm was reached. In addition to the trial pits an augur was used to take approximately one sample per hectare on the proposed development site with smaller trial pits and stone counts at some of these locations to confirm soil structure and colour where it was not clear from the augur samples. A plan of augur points can be found at ***appendix 1***. The trial pit locations were selected as they were representative of the soils found on site. Where subsoils were inspected with a spade, descriptions of structure have been recorded based on the soil survey field handbook[1]; where an augur has been used the structure is described as good, moderate or poor based on figure 9,10 and 11 in the MAFF[2] (1988) guidance.

2.4 During the first sampling visit subsoil state was very dry making it extremely difficult to determine structure and in some cases, soils were so hard as to prevent auguring at all. The soil state was much better for the second visit and soil horizons could be inspected to allow for an assessment of the site.

2.5 The site extends 25.1Ha of arable and grassland spread across 9 fields or part fields. The elevation of the site ranged from 128m to 168m AOD and is gently sloping.

2.6 Further information has been obtained from the MAGIC website, the Soil Survey of England and Wales, the British Geological Survey, the Meteorological Office and 1:250,000 series Agricultural Land Classification maps.

2.7 The collected information has been judged against the Ministry of Agriculture Fisheries and Food Agricultural Land Classification of England and Wales revised guidelines and criteria for grading the quality of agricultural land. The

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[1] Hodgson, JM (1997) Soil Survey Field Handbook

[2] MAFF (1988) - *Agricultural Land Classification of England and Wales. Revised guidelines and criteria for grading the quality of agricultural land*. MAFF Publications

contents and format of the report is further informed by the BSSS guidance (2022)[3].

2.8 The principal factors influencing agricultural production are climate, site and soil and the interaction between them MAFF (1988)[4] & Natural England (2012)[5].

3. Published Information

3.1 The British Geological Survey 1:50,000 scale map shows the bedrock geology to be Pennine Lower Coal Measures Formation and Pennine Middle Coal Measures Formation – mudstone, siltstone and sandstone. Superficial deposits are described as Till, Devensian – Diamicton.

3.2 The national soils map shows the site to be largely Brickfield 2 Association – Slowly permeable waterlogged fine loamy soils and Nercwys Association – Deep fine loamy soils with slowly permeable subsoils and slight seasonal waterlogging. The two most easterly sample points (23 and 24) are shown to be Neutral restored opencast – Restored opencast coal workings. Slowly permeable seasonally waterlogged compacted fine loamy and clayey disturbed soils. Often stony with thin topsoils.

3.3 The Welsh Assembly Government predictive ALC shows the areas to be grade 3a.

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[3] British Society of Soil Science (2022) – Guidance Document 1 – Working with Soil Guidance Note on Assessing Agricultural Land Classification Surveys in England and Wales

[4] MAFF (1988) - *Agricultural Land Classification of England and Wales. Revised guidelines and criteria for grading the quality of agricultural land*. MAFF Publications

[5] Natural England (2012) - *Technical Information Note 049 - Agricultural Land Classification: protecting the best and most versatile agricultural land*, Second Edition

4. Climate

4.1 Climate has a major, and in places overriding, influence on land quality affecting both the range of potential agricultural uses and the cost and level of production.

4.2 There is published agro-climatic data for England and Wales provided by the Meteorological Office, such data for the subject site is listed in the table below.

Agro-Climatic Data – Full details can be found at ***appendix 2***

Grid Reference	330019 350727
Altitude (ALT)	153.17
Average Annual Rainfall (AAR)	930.97
Accumulated Temperature - Jan to June (ATO)	1301.01
Duration of Field Capacity (FCD)	207.73
Moisture Deficit Wheat	76.75
Moisture Deficit Potatoes	59.74

4.3 The main parameters used in assessing the climatic limitation are average annual rainfall (AAR), as a measure of overall wetness; and accumulated temperature (ATO), as a measure of the relative warmth of a locality.

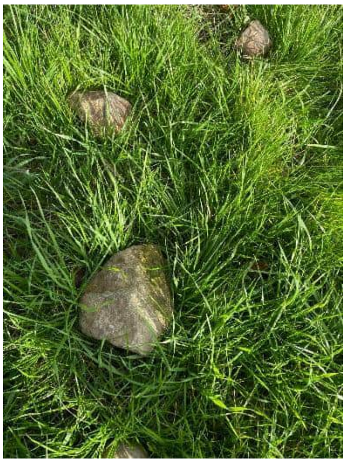
4.4 The AAR and ATO limit the site to Grade 2.

4.5 The site is shown to be in flood zone A – areas at little or no risk of fluvial or coastal/tidal flooding. There was no evidence of flooding seen during the site visit and it is considered that will not result in a limitation to land grade.

5. Stoniness

5.1 There were stones found in almost every sample point on the site. The stones were generally medium to large and occasionally very large. Stones were of various shapes from rounded to tabular and angular. A number of stone counts were carried out alongside estimates.

Very large stones at Sample point 8



Stone count at sample point 12

6. Gradient

6.1 The steepest areas of the site are only a gentle slope with gradient never representing the most limiting factor to land grade.

7. Soils

7.1 The soils found on site largely follow the expectations set by the national soils map. Full information on the sample points along trial pit descriptions and photographs can be found at ***appendix 3***.

7.2 There were two distinct soil types found on site.

Sample points 23 and 24 were a very shallow (15-20cm) very stony medium clay loam topsoil over rock.

The rest of the site was a medium clay loam (occasionally heavy clay loam) topsoil over a slowly permeable gleyed clay loam subsoil from between 25 and 50cm.

7.3 Soil Texture and depth do not provide a direct limitation to land grade across the majority of the site but the soil depth at sample points 23 and 24 does limit the area to grade 3b although this is not the most limiting factor at this sample point.

Interactive Factors

8. Wetness

8.1 An assessment of the wetness class of each sample point was made based on the flow chart at Figure 6 in the MAFF guidance. The wetness class and topsoil texture were then assessed against Table 6 of the MAFF guidance to determine the ALC grade according to wetness. The wetness assessment can be found at ***appendix 4***.

Medium clay loam over slowly permeable clay loam subsoil

8.2 Where the slowly permeable gleyed horizon started at between 25 and 30cm when combined with the FCD of 207.73 result in a wetness class of IV based on Figure 7 in the MAFF guidance. Where the gleyed horizon starts at between 40 and 70cm with a slowly permeable layer starting at 50cm the wetness class is found to be III.

8.3 Table 6 for between 176 and 225 FCD, wetness class IV and medium clay loam topsoil results in a grade 3b limitation. Where the wetness class is III the medium clay loam topsoil gives a limitation of grade 3a and th heavy clay loam topsoil gives a limitation of grade 3b.

8.4 Wetness was not a limiting factor on the shallow soils.

9. Droughtiness

9.1 Droughtiness limits are defined in terms of moisture balance for wheat and potatoes using the formula:

MB (Wheat) = AP (Wheat) - MD (Wheat)

and

MB (Potatoes) = AP (Potatoes) - MD (Potatoes)

Where:
MB = Moisture Balance
AP = Crop Adjusted available water capacity
MD = Moisture deficit

9.2 Moisture deficit for wheat and potatoes can be found in the agro-climatic data and are as follows:

MD (Wheat) = 76.75
MD (Potatoes) = 59.74

9.3 Crop adjusted available water is calculated by reference to the total available water and easily available water which is calculated by reference to soil texture and structural condition and the stone content. The moisture balance was calculated for the trial pit locations and the locations where droughtiness was considered likely to be a limiting factor and can be found at ***appendix 4***

9.4 The very shallow soils and high stone count at sample points 23 and 24 result in droughtiness being the most limiting factor inthis area.

10. AGRICULTURAL LAND CLASSIFICATION

10.1 The Agricultural Land Classification provides a framework for classifying land according to which its physical or chemical characteristics impose long-term limitations on agricultural use. The limitations can operate in one or more of four principle ways: they may affect the range of crops that can be grown, the level of yield, the consistency of yield and the cost of obtaining it.

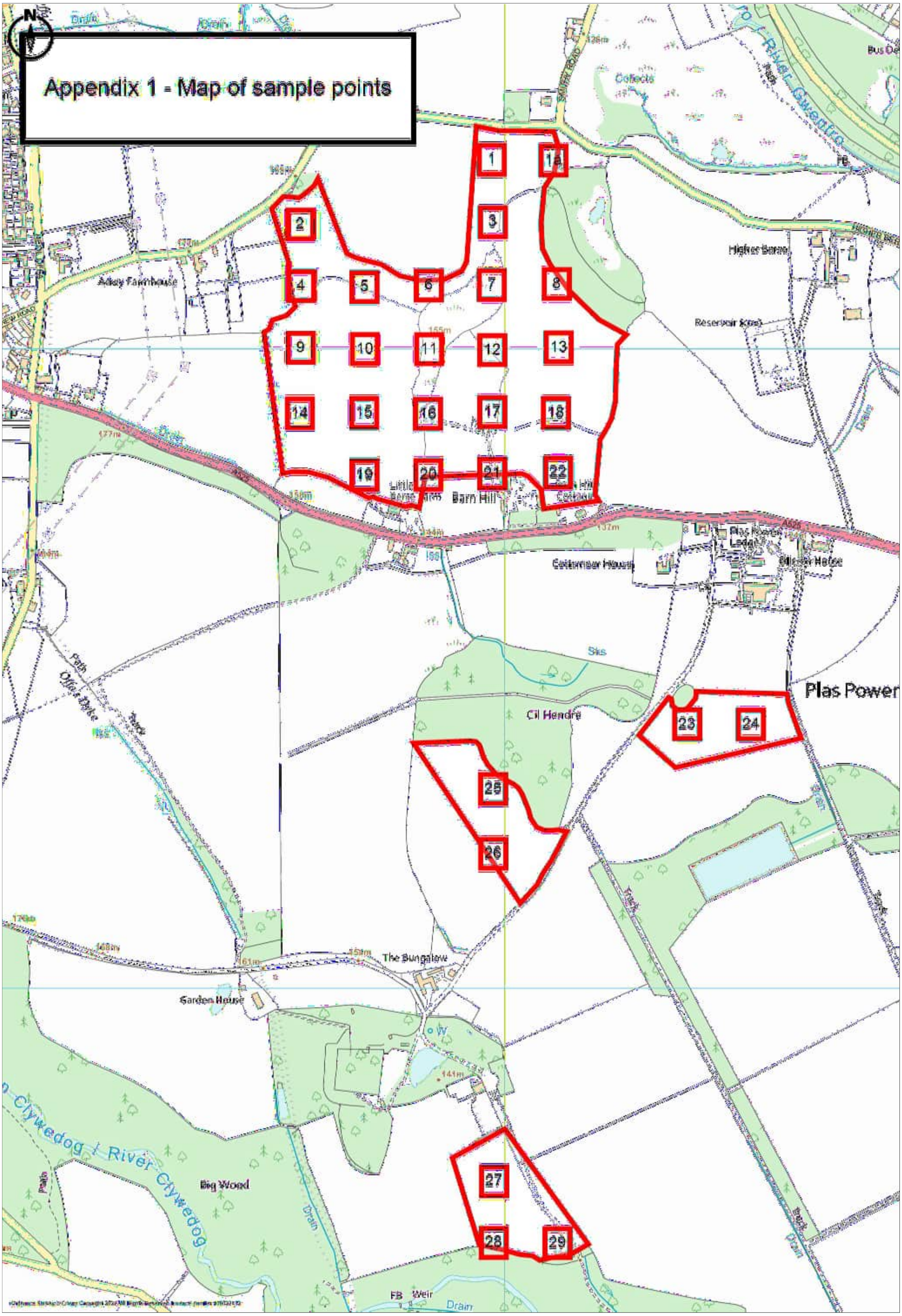
10.2 The principle physical factors influencing agricultural production are climate, site and soil and the interactions between them which together form the basis for classifying land into one of 5 grades; grade 1 being of excellent quality and grade 5 being land of very poor quality. Grade 3 land, which constitutes approximately half of all agricultural land in the United Kingdom is divided into 2 subgrades – 3a and 3b. A full definition of all of the grades can be found at ***appendix 5.***

10.3 This assessment sets out that the site is variously limited by both wetness and droughtiness.

10.4 The breakdown of land by classification is:

Grade 3a:	1.6 Ha	6.4%
Grade 3b:	21.5 Ha	83.7%
Grade 4:	2.0 Ha	7.9%

10.5 A plan of the land grading can be found at ***appendix 6***.


Appendix 1 - Map of sample points
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Adwy Farmhouse
Higher Barn
Reservoir (Cov)
Barn Hill
Plas Power Lodge
Plas Power
Cil Hendre
The Bungalow
Garden House
Big Wood
River Gwenfro
River Clywedog
Offa's Dyke
Path
Track
Drain
FB
Weir
Collects
Bus Dep
155m
177m
126m
141m

Appendix 2 – Climatic Data

Site Details: Plas Power

Grid reference (centre of site): 330019 350727

Altitude: Mean 153.17m AOD

Climatic data from surrounding locations:

Grid Reference	ALT	AAR	LR_AAR	ASR	ATO	ATS	MDW	MDP	FCD
33003500	112	903	0.8	400	1348	2246	83	68	204
33003550	95	790	0.7	375	1365	2265	89	76	183
33503500	65	754	1.1	340	1403	2309	100	89	175
33503550	61	751	1	340	1405	2311	100	89	173

Altitude Adjusted

Grid Reference	AAR	ATO	FCD	MDW	MDP	Proximity Adjustment
33003500	935.94	1301.07	208.76	76.47	59.40	94.90%
33003550	830.72	1298.69	188.89	80.18	64.38	2.87%
33503500	850.99	1302.49	189.02	84.16	68.21	1.62%
33503550	843.17	1299.93	186.33	84.09	68.10	0.62%

Appendix 3 - Plas Power (Wrexham) - Sep 22

		Topsoil					Subsoil 1						Subsoil 2						Subsoil 3	
Sample No	Altitude	Depth	Texture	Colour	Stoniness	Mottles	Depth	Texture	Colour	Stoniness	Mottles	Structure	Depth	Texture	Colour	Stoniness	Mottles	Structure	Depth	Texture
1	139	0-25	MCL	10YR 3/3	5%		25-50	CL	10YR 4/4	5%	FOB	WMSAB	50-80	CL	10YR 5/3	5%	CO	WMAB	80	IMP
1a	135	0-25	MCL	10YR 3/3	5%		25-60	CL	10YR 5/3	5%	CO	Poor	60	IMP						
2	165	0-30	MCL	10YR 3/3	5%		30-50	CL	10YR 5/3	5%	CO	Poor	50	IMP						
3	140	0-20	MCL	10YR 3/3	5%		20-50	CL	10YR 4/4	5%	FOB	Moderate	50-70	CL	10YR 5/3	5%	CO	Poor	70	IMP
4	164	0-30	MCL	10YR 3/3	5%		30-50	CL	10YR 5/3	5%	CO	Poor	50	IMP						
5	157	0-25	MCL	10YR 3/3	5%		25-50	CL	10YR 5/3	5%	CO	Poor	50	IMP						
6	153	0-30	MCL	10YR 3/3	5%		30-50	CL	10YR 4/4	5%	FOB	Moderate	50-80	CL	10YR 5/3	5%	CO	Poor	80	IMP
7	145	0-30	HCL	10YR 3/3	5%	CO	30-50	CL	10YR 4/4	5%	FOB	Moderate	50-80	CL	10YR 5/3	5%	CO	Poor	80	IMP
8	141	0-30	MCL	10YR 3/3	15%		30-50	CL	10YR 5/3	5%	CO	Poor	50	IMP						
9	164	0-25	MCL	10YR 3/3	10%		25-50	CL	10YR 5/3	5%	CO	Poor	50	IMP						
10	158	0-25	MCL	10YR 3/3	10%		25-50	CL	10YR 5/3	5%	CO	Poor	50	IMP						
11	151	0-30	HCL	10YR 3/3	5%	CO	30-50	CL	10YR 4/4	5%	FOB	Moderate	50-70	CL	10YR 5/3	5%	CO	Poor	70	IMP
12	144	0-30	MCL	10YR 3/3	5%		30-50	CL	10YR 5/3	5%	CO	Poor	50	IMP						
13	143	0-25	MCL	10YR 3/3	15%		25-50	CL	10YR 5/3	5%	CO	Poor	50	IMP						
14	164	0-25	MCL	10YR 3/3	5%		25-50	CL	10YR 5/3	5%	CO	Poor	50	IMP						
15	157	0-25	MCL	10YR 3/3	5%		25-50	CL	10YR 5/3	5%	CO	Poor	50	IMP						
16	151	0-25	MCL	10YR 3/3	10%		25-50	CL	10YR 5/3	5%	CO	Poor	50	IMP						
17	147	0-25	MCL	10YR 3/3	10%		25-80	CL	10YR 5/3	5%	CO	Poor	80	IMP						
18	148	0-30	MCL	10YR 3/3	10%		30-70	CL	10YR 5/3	5%	CO	Poor	70	IMP						
19	168	0-25	MCL	10YR 3/3	15%		25-80	CL	10YR 5/3	5%	CO	Poor	80	IMP						
20	158	0-30	MCL	10YR 3/3	5%	CO	30-80	CL	10YR 5/3	5%	CO	Poor	80	IMP						
21	151	0-30	MCL	10YR 3/3	5%	CO	30-60	CL	10YR 5/3	5%	CO	Poor	60	IMP						
22	148	0-25	MCL	10YR3/3	5%		25-80	CL	10YR 5/3	5%	CO	Poor	80	IMP						
23	132	0-20	MCL	10YR3/3	25%		20	IMP												
24	128	0-15	MCL	10YR 3/3	25%		15	IMP												
25	147	0-30	MCL	10YR 3/3	<5%		30-50	MCL	10YR 5/3	<5%	CO	Poor	50	IMP						
26	143	0-30	MCL	10YR 3/3	5%		30-50	MCL	10YR 5/3	<5%	CO	Poor	50	IMP						
27	134	0-25	MCL	2.5Y 3/3	15%		25-50	MCL	10YR 5/3	<5%	CO	Poor	50	IMP						
28	135	0-30	MCL	2.5Y 3/3	15%		30-50	MCL	10YR 5/3	<5%	CO	Poor	50	IMP						
29	132	0-30	MCL	2.5Y 3/3	15%		30-50	MCL	10YR 5/3	<5%	CO	Poor	50	IMP						
	153.17																			

Appendix 3b – Trial Pit Descriptions

Sample Point No. 1	
Horizon 1	0-25cm Dark brown (10YR 3/3) medium clay loam with 5% small hard subrounded stones
Horizon 2	25-50cm Dark yellowish brown (10YR 4/4) clay Loam with a weak medium subangular blocky structure, firm consistence, few ochreous and black mottles and 5% small hard subrounded stones.
Horizon 3	50-80cm Brown (10YR 5/3) clay loam with a weak medium angular blocky structure, firm consistence, common ochreous mottles and less than 0.5% biopores
Pictures	

Horizon 1	Horizon 2
	

Slowly permeable layer	From 50cm
Gleying	From 50cm
Wetness Class	III
Wetness limitation	3a
MB Wheat	49.94
MB potatoes	48.19
Droughtiness Limitation	1
Soil depth limitation	1
Stoniness limitation	1

Sample Point No. 17	
Horizon 1	0-25cm Dark brown (10YR 3/3) medium clay loam with 5% small hard subrounded stones
Horizon 2	25-50cm Brown (10YR 5/3) clay loam with a weak medium angular blocky structure, firm consistence and less than 0.5% biopores
Pictures	
Horizon 1 	Horizon 2 
Slowly permeable layer	From 25cm
Gleying	From 25cm
Wetness Class	IV
Wetness limitation	3b
MB Wheat	3.39
MB potatoes	24.19
Droughtiness Limitation	2
Soil depth limitation	1
Stoniness limitation	1

Sample Point No. 23	
Horizon 1	0-20cm Dark brown (10YR 3/3) medium clay loam with 25% medium and large hard subangular tabular stones
Horizon 2	20cm – Impenetrable due to rock layer
Pictures	

Horizon 1

Slowly permeable layer	None
Gleying	None
Wetness Class	I
Wetness limitation	1
MB Wheat	-49.56
MB potatoes	-59.81
Droughtiness Limitation	4
Soil depth limitation	3b
Stoniness limitation	4

Sample Point No. 25	
Horizon 1	0-25cm Dark brown (10YR 3/3) medium clay loam with 5% small hard subrounded stones
Horizon 2	25-50cm Brown (10YR 5/3) clay loam with a weak medium angular blocky structure, firm consistence and less than 0.5% biopores
Pictures	

Horizon 1	Horizon 2
	

Slowly permeable layer	From 25cm
Gleying	From 25cm
Wetness Class	IV
Wetness limitation	3b
MB Wheat	3.39
MB potatoes	24.19
Droughtiness Limitation	2
Soil depth limitation	1
Stoniness limitation	1

ANALYTICAL REPORT

Report Number	**34263-22**	**W250**	**AMET PROPERTY**
Date Received	**15-SEP-2022**		**HENWICK BARN**
Date Reported	**27-SEP-2022**		**BULWICK**
Project	**SOIL**		**CORBY**
Reference	**AMET PROPERTY**		**NORTHANTS**
Order Number			**NN17 3DU**

Laboratory Reference		**SOIL578904**	**SOIL578905**	**SOIL578906**	**SOIL578907**						
Sample Reference		**PLAS 25TS**	**PLAS 25SS**	**PLAS 1ATS**	**PLAS 20TS**						
Determinand	**Unit**	**SOIL**	**SOIL**	**SOIL**	**SOIL**						
Coarse Sand 2.00-0.63mm	% w/w	7	6	10	6						
Medium Sand 0.63-0.212mm	% w/w	12	16	14	16						
Fine Sand 0.212-0.063mm	% w/w	18	19	16	18						
Silt 0.063-0.002mm	% w/w	38	38	37	38						
Clay <0.002mm	% w/w	25	21	23	22						
Stones >50mm	% w/w	0.0	0.0	0.0	0.0						
Stones 20-50mm	% w/w	2.0	0.0	0.0	1.5						
Stones 2-20mm	% w/w	0.9	1.9	2.6	1.8						
Organic Matter LOI	% w/w	5.1	3.2	7.5	6.2						
Neutralising Value as CaCO3 eq.	% w/w	<1	<1	1.7	1.0						
Neutralising Value as CaO eq.	% w/w	<1	<1	<1	<1						
Textural Class **		MCL	MCL	MCL	MCL						

Notes

Analysis Notes	The sample submitted was of adequate size to complete all analysis requested.
	The results as reported relate only to the item(s) submitted for testing.
	The results are presented on a dry matter basis unless otherwise stipulated.
Document Control	**This test report shall not be reproduced, except in full, without the written approval of the laboratory.**

ANALYTICAL NOTES			
Report Number	**34263-22**	**W250**	**AMET PROPERTY**
Date Received	**15-SEP-2022**		**HENWICK BARN**
Date Reported	**27-SEP-2022**		**BULWICK**
Project	**SOIL**		**CORBY**
Reference	**AMET PROPERTY**		**NORTHANTS**
Order Number			**NN17 3DU**

Notes	
Reported by	** Please see the attached document for the definition of textural classes. *Myles Nicholson* Natural Resource Management, a trading division of Cawood Scientific Ltd. Coopers Bridge, Braziers Lane, Bracknell, Berkshire, RG42 6NS Tel: 01344 886338 Fax: 01344 890972 email: enquiries@nrm.uk.com

ADAS (UK) Textural Class Abbreviations

The texture classes are denoted by the following abbreviations:

Class	Code
Sand	S
Loamy sand	LS
Sandy loam	SL
Sandy Silt loam	SZL
Silt loam	ZL
Sandy clay loam	SCL
Clay loam	CL
Silt clay loam	ZCL
Clay	C
Silty clay	ZC
Sandy clay	SC

For the *sand, loamy sand, sandy loam* and *sandy silt loam* classes the predominant size of sand fraction may be indicated by the use of prefixes, thus:

vf Very Fine (more than 2/3's of sand less than 0.106 mm)
f Fine (more than 2/3's of sand less than 0.212 mm)
c Coarse (more than 1/3 of sand greater than 0.6 mm)
m Medium (less than 2/3's fine sand and less than 1/3 coarse sand).

The subdivisions of *clay loam* and *silty clay loam classes* according to clay content are indicated as follows:

M medium (less than 27% clay)
H heavy (27-35% clay)

Organic soils i.e. those with an organic matter greater than 10% will be preceded with a letter O.

Peaty soils i.e. those with an organic matter greater than 20% will be preceded with a letter P.

Appendix 4 - Wetness and droughtiness assesment

	Wetness Assesment			Grade	Grade by
	Depth to		Wetness	According to	most limiting
Sample No	SPL	Gley	Class	Wetness	factor
1	50	40-70	III	3a	3a
1a	25	<40	IV	3b	3b
2	30	<40	IV	3b	3b
3	50	40-70	III	3a	3a
4	30	<40	IV	3b	3b
5	25	<40	IV	3b	3b
6	50	40-70	III	3a	3a
7	50	40-70	III	3b	3b
8	30	<40	IV	3b	3b
9	25	<40	IV	3b	3b
10	25	<40	IV	3b	3b
11	50	40-70	III	3b	3b
12	30	<40	IV	3b	3b
13	25	<40	IV	3b	3b
14	25	<40	IV	3b	3b
15	25	<40	IV	3b	3b
16	25	<40	IV	3b	3b
17	25	<40	IV	3b	3b
18	30	<40	IV	3b	3b
19	25	<40	IV	3b	3b
20	30	<40	IV	3b	3b
21	30	<40	IV	3b	3b
22	25	<40	IV	3b	3b
23			I	2	4
24			I	2	4
25	30	<40	IV	3b	3b
26	30	<40	IV	3b	3b
27	25	<40	IV	3b	3b
28	30	<40	IV	3b	3b
29	30	<40	IV	3b	3b

Appendix 5 - Description of ALC Grades

Grade 1 - excellent quality agricultural land Land with no or very minor limitations to agricultural use. A very wide range of agricultural and horticultural crops can be grown and commonly includes top fruit, soft fruit, salad crops and winter harvested vegetables. Yields are high and less variable than on land of lower quality.

Grade 2 - very good quality agricultural land Land with minor limitations which affect crop yield, cultivations or harvesting. A wide range of agricultural and horticultural crops can usually be grown but on some land in the grade there may be reduced flexibility due to difficulties with the production of the more demanding crops such as winter harvested vegetables and arable root crops. The level of yield is generally high but may be lower or more variable than Grade 1.

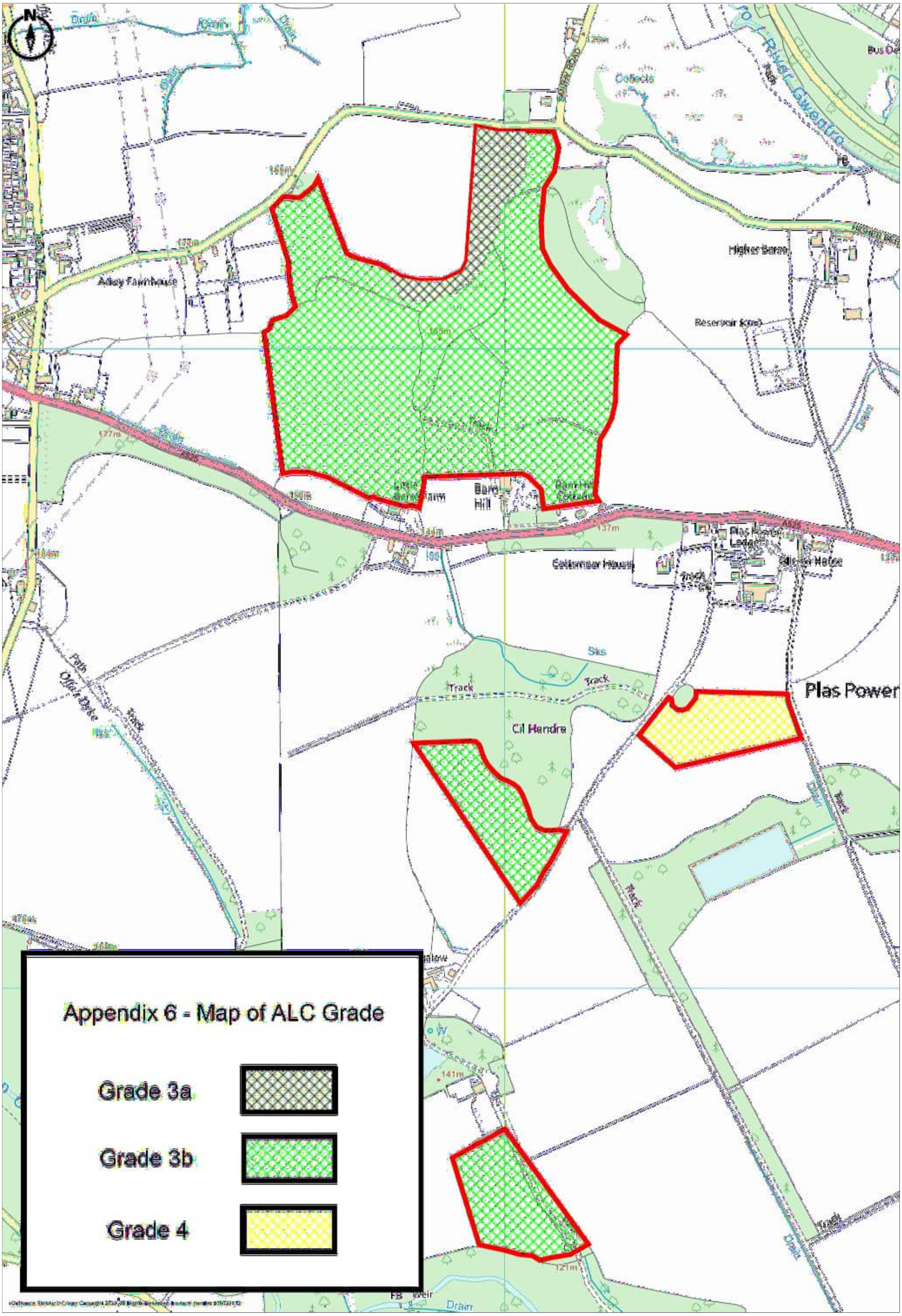
Grade 3 - good to moderate quality agricultural land Land with moderate limitations which affect the choice of crops, timing and type of cultivation, harvesting or the level of yield. Where more demanding crops are grown yields are generally lower or more variable than on land in Grades 1 and 2.

Subgrade 3a - good quality agricultural land Land capable of consistently producing moderate to high yields of a narrow range of arable crops, especially cereals, or moderate yields of a wide range of crops including cereals, grass, oilseed rape, potatoes, sugar beet and the less demanding horticultural crops.

Subgrade 3b - moderate quality agricultural land Land capable of producing moderate yields of a narrow range of crops, principally cereals and grass or lower yields of a wider range of crops or high yields of grass which can be grazed or harvested over most of the year.

Grade 4 - poor quality agricultural land Land with severe limitations which significantly restrict the range of crops and/or level of yields. It is mainly suited to grass with occasional arable crops (e.g. cereals and forage crops) the yields of which are variable. In moist climates, yields of grass may be moderate to high but there may be difficulties in utilisation. The grade also includes very droughty arable land.

Grade 5 - very poor-quality agricultural land Land with very severe limitations which restrict use to permanent pasture or rough grazing, except for occasional pioneer forage crops.



Promap
LANDMARK INFORMATION

Plotted Scale - **1:8000**. Paper Size - **A4**