One Earth Solar Farm

Volume 7.0 – Other Documents [EN010159]

Statement of Need

February 2025

Document Reference: EN010159/APP/7.1

Revision 01

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 – Reg 5(2)(q)

Contents

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Abbreviations

Abbreviations / Terms	Definitions
AR4/5/6	Allocation Round 4/5/6 of the Contracts for Difference scheme
BECCS	Bioenergy with Carbon Capture and Storage
BESS	Battery Energy Storage System
BEV	Battery Electric Vehicle
CBDP	Carbon Budget Delivery Plan
CCC	The Climate Change Committee
CCGT	Combined Cycle Gas Turbine
CCUS	Carbon Capture Use and Storage
COP2	Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC)
DCO	Development Consent Order
DESNZ	Department for Energy Security and Net Zero
DUKES	Government's Digest of UK Energy Statistics
ETYS	National Grid ESO's Electricity Ten Year Statement
EV	Electric Vehicle
E-W	East-West solar panel layout
FES	National Grid ESO's Future Energy Scenarios
FiT	Feed in Tariff
FSF	Fixed South Facing solar panel layout
GBN	Great British Nuclear
GDA	Generic Design Assessment
GHG	Greenhouse Gas

Abbreviations / Terms	Definitions
GSP	Grid Supply Point
GWh / GW	Gigawatt hour (energy) / gigawatt (power). 1GW = 1,000 MW
ha	Hectare
HAR	Government's Hydrogen Allocation Round
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
kWh / KW	Kilowatt hour (energy) / kilowatt (power). 1MW = 1,000 kW
LCOE	Levelised Cost of Energy
LULUCF	Land Use, Land-use Change and Forestry
MCS	Government's Microgeneration Certification Scheme
MtCO2 / MtCO2(e)	Million tonnes of carbon dioxide / Million tonnes of carbon dioxide equivalent
MWh / MW	Megawatt hour (energy) / megawatt (power)
NDC	Nationally Determined Contributions
NESO	National Energy System Operator (formerly NGESO)
NETS	National Electricity Transmission System
NGESO	National Grid Electricity System Operator (now NESO)
NGET	National Grid Electricity Transmission
NIC	National Infrastructure Commission
NOA	National Grid ESO's Network Options Assessment
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Project

Abbreviations / Terms	Definitions
NZS	Government's Net Zero Strategy
ONR	Office for Nuclear Regulation
PV	Solar Photovoltaics
REPD	Government's Renewable Energy Planning Database
SAT	Single Axis Tracker solar panel layout
SMMT	Society of Motor Manufacturers and Traders
SMR	Small Modular (nuclear) Reactor
SP	Settlement Period (of the GB electricity market)
TEC	Transmission Entry Capacity
TWh / TW	Terawatt hour (energy) / terawatt (power). 1TW = 1,000 GW
WMO	World Meteorological Organisation
ZEV (mandate)	Zero Emission Vehicle (mandate)

1. Executive Summary

1.1.1 One Earth Solar Farm Ltd (the Applicant) is seeking a Development Consent Order (DCO) for a large-scale solar plus storage development, connecting to the National Electricity Transmission System (NETS) at High Marnham (the Proposed Development).

1.1.2 The Secretary of State must have regard to the current suite of National Policy Statements (NPSs) for energy as relevant NPSs and must decide the application for development consent under Planning Act 2008 for the Proposed Development in accordance with those NPSs.

1.1.3 The NPSs confirm that substantial weight should be given to the need for low-carbon generation schemes, such as the Proposed Development, which are covered by the NPSs.

1.1.4 The NPSs confirm that large-scale ground mounted solar farms have a critical role to play in achieving the government's aims and establish a critical national priority (CNP) for low-carbon infrastructure, including large-scale solar farms, because of the decarbonisation, energy security, and affordability benefits that they deliver.

1.1.5 The NPSs also confirm that assets which provide flexibility to the national electricity system, or to the energy system generally, are also needed to achieve national decarbonisation and energy security aims. The NPSs state that government is supportive of solar that is co-located with storage to maximise the efficiency of land use. The Proposed Development, which is a large-scale solar plus energy storage scheme, is therefore fully aligned with the government's aims.

1.1.6 The NPSs explain that the availability of grid connection, suitable irradiance levels, and local topography are key inputs to the selection of sites suitable for large-scale solar generation developments. The number of locations within the UK at which large-scale solar generation is suitable is therefore likely to be limited, and this is a material issue when considering how the UK is to meet the urgent need for low-carbon generation as is set out in the NPSs.

1.1.7 Whilst the NPSs establish that the Secretary of State is not required to consider the specific contribution of any individual project to satisfying the need established in the NPSs, this Statement of Need provides relevant legal, policy, and industry evidence on the urgent need for decarbonisation and action to support the security of electricity supplies in the UK.

1.1.8 This Statement of Need also provides evidence on the substantial benefits brought forwards by large-scale ground mounted solar electricity generation generally, and the Proposed Development specifically, towards meeting the UK's critical strategic needs.

1.1.9 This Statement of Need concludes that the decarbonisation, security of supply, and affordability benefits delivered by the Proposed Development to the national urgent need for low-carbon generation should be accorded substantial weight when assessing the planning balance.

1.1.10 Urgent and unprecedented actions are required on a global scale to halt climate change. A rapid increase in the supply of low carbon electricity is needed for the UK to meet its legally binding climate change targets. Solar generation is a critical part of the UK's strategy to achieve net zero by 2050, a key step towards which is the decarbonisation of the UK's electricity system, which is to be delivered through the government's national mission for 'Clean Power by 2030'.

1.1.11 Government's Clean Power 2030 Action Plan, published in December 2024 [1], reinforces the urgent need for low carbon generation schemes to come forward to pave the way to decarbonising the wider economy by 2050 as we pursue the electrification of heat in buildings, transport, and industry.

1.1.12 However, the Clean Power 2030 Action Plan also confirms that the need for new clean power will not stop at 2030. The continued delivery of low-carbon generation facilities beyond 2030 is necessary to meet future electricity demand growth and achieve essential wider societal carbon savings. 'Clean Power by 2030' prepares the UK for the rapid growth in power demand expected over the 2030s and 40s. It is also important to continue to bring forward schemes in the event that 'Clean Power by 2030' is not achieved.

1.1.13 The capacity ranges set out by government in its Clean Power by 2030 Action Plan [1] provide a foundation to prioritise the most critical infrastructure to meet Clean Power 2030. They are a framework for the National Energy System Operator (NESO) to work with Transmission Owners and Distribution Network Operators to prioritise connection offers for strategically aligned projects that can demonstrate they have the means to deliver. They are not a target nor a cap for pipeline developments.

1.1.14 Progress has been made in the development of different low-carbon electricity generation technologies. However, many of the technologies with potential to play a role in the delivery of a net zero energy system have uncertain delivery timescales. Developments with the proven ability to achieve carbon savings comfortably within in the next decade are essential to keep the UK on its legally binding carbon reduction path. Large-scale solar is one of the most likely technologies to be deliverable at scale against the timeframes required to support net zero.

1.1.15 Many factors are important in the design of a large-scale solar scheme within the context of a particular location, and flexibility in design is important to allow for the scheme to be designed in to optimise its benefits. Optimising the use of existing and available grid infrastructure is necessary in the next decade to achieve the government's national mission for 'Clean Power by 2030' and to meet future electricity demand growth and achieve essential wider societal carbon savings beyond 2030.

1.1.16 The location of the Proposed Development enables it to deliver against the urgency of need, in relation to decarbonisation, security of supply, and affordability. The Proposed Development, if consented, will connect to the National Electricity Transmission System (NETS) at High Marnham. No adverse grid operability effects are anticipated as a result of connecting the Proposed Development to the NETS at the proposed location.

1.1.17 Solar generation contributes to security of supply. Aggregated generation output from portfolios which consist of multiple different renewable technologies, including solar, is more predictable and less variable than single-technology portfolios. Solar generation is needed to support a high level of generation adequacy and generation dependability within the Great British electricity system. Storage facilities also contribute to security of supply by storing energy when it is generated in abundance, and releasing it to the grid when it is needed. Storage facilities also provide grid balancing services which are essential for the continued safe and secure operation of the NETS by helping to address any impacts arising from increasing intermittent renewable generation on the grid.

1.1.18 Solar facilities are already among the cheapest form of electricity generation in the UK and previous government department forecasts indicate that costs will continue to reduce in the future. By generating low carbon electricity at a low marginal cost, large-scale solar power reduces the energy generated by more expensive and more carbon intensive forms of generation. Solar therefore decarbonises the electricity system and lowers the market price of electricity.

1.1.19 In summary, a significant capacity of low-carbon solar generation is urgently needed in the UK. The Proposed Development will, if consented, provide an essential progression to meeting the governmental objectives of delivering sustainable development to enable decarbonisation. By doing so, the Proposed Development will address the climate change emergency that affects everyone's lives and the environment, by ensuring our energy supply is secure, low-carbon and low-cost.

2. Overview

2.1 Document purpose

2.1.1 One Earth Solar Farm Ltd (the Applicant) is seeking a Development Consent Order (DCO) for a large-scale solar plus storage development, connecting to the National Electricity Transmission System (NETS) at High Marnham (the Proposed Development). The terminology used in this document is defined in the **Glossary of Terms and Abbreviations [EN010159/APP/7.17].**

2.1.2 This Statement of Need for solar generation describes how and why the Proposed Development addresses all relevant aspects of government policy, in particular the National Policy Statements EN-1 and EN-3 (NPS EN-1 and NPS EN-3). These Statements were published by the previous government in November 2023 and designated on 17th January 2024 [2], [3]. The decision to consent the Proposed Development must be taken in accordance with the NPSs. NPS EN-1 confirm that there is a demonstrated urgent need for the infrastructure covered by the NPS and establishes a critical national priority (CNP) for nationally significant low-carbon infrastructure, the definition of which includes solar PV.

2.1.3 NPS EN-1 explains that:

"The urgent need for CNP Infrastructure to achieving our energy objectives, together with the national security, economic, commercial, and net zero benefits, will in general outweigh any other residual impacts not capable of being addressed by application of the mitigation hierarchy. Government strongly supports the delivery of CNP Infrastructure and it should be progressed as quickly as possible" [2](Para 3.3.63).

2.1.4 This Statement of Need demonstrates the important contribution the Proposed Development will make to the three national energy policy aims:

- Net zero and the importance of urgently deploying low-carbon generation assets at scale
- Security of supply (geographically and technologically diverse supplies)
- Affordability and reducing exposure to volatile international markets

2.1.5 This Statement of Need for the development of large-scale solar generation demonstrates why the Proposed Development is urgently needed at the scale proposed; why the proposed location is highly suitable for such a scheme; and how the Proposed Development addresses all relevant aspects of established and emerging government energy and climate change policy and commitments.

2.1.6 The government's election manifesto includes their ambition to deliver 'Clean Power by 2030'. This ambition brings forward the ambitions set by the previous government to decarbonise Great Britain's (GB's) electricity supply and support wider decarbonisation with more secure and affordable energy supplies. Further information on their manifesto pledges, which include the tripling of solar capacity by 2030, is included at **Section 3.4** of this Statement. The delivery of large capacities of low-carbon generation, including large-scale solar generation, is a critical part of the government's plans.

2.1.7 Delivering 'Clean Power by 2030' is an important step towards delivering the UK's legally binding target of national net zero carbon emissions by 2050. **Chapter 5** of this Statement provides evidence that delivering net zero requires electricity demand to grow as transport, heat, and industrial energy demand is decarbonised with clean power.

2.1.8 However, government's Clean Power 2030 Action Plan [1] describes that the need for new clean power does not stop at 2030. The continued delivery of low-carbon generation facilities beyond 2030 is necessary to meet future electricity demand growth and achieve essential wider societal carbon savings. It is also important to continue to bring forward renewable energy schemes, in the event that 'Clean Power by 2030' is not achieved.

2.1.9 This Statement of Need therefore provides evidence that solar is a key part of the government's strategy for low-cost decarbonisation of the energy sector. It calls on established and emerging primary analysis and opinion by qualified third parties, to support the need case for the Proposed Development. The Proposed Development is required to ensure that the UK remains on track to meet its legally binding carbon emissions reduction targets, while enhancing national security of supply, and at a cost which, in relation to other electricity generation infrastructure developments, provides value for money for end-use consumers.

2.2 Document Overview

2.2.1 This Statement of Need provides relevant legal, policy, and industry evidence in support of the urgent need for decarbonisation and action to support security of electricity supplies in the UK.

2.2.2 This Statement of Need also provides evidence in support of ground mounted solar electricity generation generally, and the Proposed Development specifically, in relation to the benefit brought towards meeting the UK's critical strategic needs.

2.2.3 This Statement of Need should be read in conjunction with the international and national policy context relevant to the need for and benefits of this Proposed Development, which is described in **Planning Statement [EN010159/APP/5.5]**.

2.2.4 **Chapter 3** of this Statement of Need explains that urgent and unprecedented actions are required on a global scale to halt climate change. A critical step in the strategy to fight climate change, is a full decarbonisation of the GB electricity system by 2035, and it is noted that that the government's election manifesto describes its aim to bring this target forwards to 2030.

2.2.5 **Chapter 4** of this Statement of Need summarises those National Policy Statements (NPSs) which 'have effect' in relation to the Proposed Development. The decision to consent the Proposed Development must be taken in accordance with those NPSs. The NPSs provide that there is a critical national priority (CNP) for nationally significant low carbon infrastructure, including solar development, for both energy security and Net Zero, and that grid connection, irradiance, and site topography are key inputs to the selection of sites suitable for large-scale solar generation developments.

2.2.6 **Chapter 5** provides evidence that decarbonisation will increase demand for electricity and describes the policies and strategies already in-flight which are increasing, or are set to increase, electricity demand.

2.2.7 **Chapter 6** provides an overview of progress in the development of different technologies with potential to play a role in the delivery of a net zero energy system. It highlights the uncertainty of delivery timescales for many technologies, and the opportunity brought forward by developments with the proven ability to achieve carbon savings comfortably within the next decade. Storage assets will support the operation of low-carbon generators to achieve carbon savings.

2.2.8 **Chapter 7** provides evidence on technical considerations associated with the development of solar in the UK including principles associated with the siting and location of large-scale solar schemes and describes factors which are important in the design of a scheme within the context of a particular location.

2.2.9 **Chapter 8** sets out the benefits of the location of the Proposed Development in relation to decarbonisation, security of supply, and delivering against the urgency of need. The chapter also provides evidence on the suitability of the proposed location from a grid operability and connection availability perspective. This chapter should be read in conjunction with The Applicant's **Planning Statement Appendix 1: Site Selection Report [EN010159/APP/5.5]** and the **ES Volume 1, Chapter 4: Alternatives and Design Evolution [EN010159/APP/6.4]** provides an explanation of the site selection process undertaken for the Proposed Development.

2.2.10 **Chapter 9** provides evidence that solar generation contributes to security of supply as part of a multi-technology aggregated generation portfolio. While **Chapter 6** provides evidence for the need for storage facilities to be developed as renewable generation capacity grows, **Chapter 9** describes how co-located solar plus storage schemes can deliver flexibility.

2.2.11 **Chapter 10** provides evidence that solar facilities are already among the cheapest form of electricity generation in the UK and the development of more solar schemes will help to reduce the cost of wholesale electricity.

2.2.12 **Chapter 11** provides the overall conclusions of this Statement of Need which are that a significant capacity of low-carbon solar generation is urgently needed in the UK. Developing this Proposed Development will be an essential step towards meeting the governmental objectives of delivering sustainable development to enable decarbonisation. By doing so, the Proposed Development will address the climate change emergency that affects everyone's lives and the environment, by ensuring our energy supply is secure, low-carbon, and low-cost.

2.3 Description of the Proposed Development

2.3.1 A full description of the Proposed Development is included in the **ES Volume 1, Chapter 5: Description of the Proposed Development: [EN010159/APP/6.5]**. An overview of the Proposed Development and its environmental impacts is provided in the **ES Volume 3: Non-Technical Summary [EN010159/APP/6.22**].

3. The legal and policy background of the need for urgent decarbonisation

3.1 Chapter summary

3.1.1 This chapter describes the global context of international climate change aims, commitments, and actions taken to date, and future actions needed to limit global temperature increase to 1.5°C above pre-industrial levels.

3.1.2 It is important to emphasise the urgency of the need to decarbonise UK energy generation to meet national climate change target and climate budgets.

3.1.3 The urgency required of actions to deliver decarbonisation globally is increasing. Carbon has a cumulative warming effect, and it is well understood that decarbonisation progress to date must accelerate in all countries to limit the temperature increase to 1.5°C above pre-industrial levels.

3.1.4 Actions to deliver a zero-carbon UK society must accelerate for the UK to keep on track with meeting its five-yearly carbon budgets, its 2030 Nationally Determined Contribution (NDC), and its net zero target by 2050.

3.1.5 The need for and the scale of future carbon reduction actions is increasing. The only way that need and scale will decrease in the future, while still limiting global temperature increases, is by delivering actions like the Proposed Development without undue delay.

3.2 Global decarbonisation

3.2.1 The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at the UN Climate Change Conference (COP21) in Paris, France, on 12th December 2015. It entered into force on 4th November 2016.

3.2.2 The overarching goal of the Paris Agreement is to hold “the increase in the global average temperature to well below 2°C above pre-industrial levels” and pursue efforts “to limit the temperature increase to 1.5°C above pre-industrial levels.”

3.2.3 In October 2018, following the adoption by the UN Framework Convention on Climate Change of the Paris Agreement, the Intergovernmental Panel on Climate Change (IPCC), which is the United Nations body for assessing the science related to climate change, published a Special Report on the impacts of global warming of 1.5°C above pre-industrial levels. This report concluded that human-induced warming had already reached approximately 1°C above pre-industrial levels, and that without a significant and rapid decline in emissions across all sectors, global warming would not be likely to be contained, and therefore more urgent international actions to decarbonise are required.

3.2.4 NDCs are at the heart of the Paris Agreement and the achievement of its long-term goals. NDCs embody efforts by each country to reduce national emissions and adapt to the impacts of climate change. Article 4, Paragraph 2 of the Paris Agreement requires each Party to prepare, communicate, and maintain successive NDCs that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions.

3.2.5 The IPCC Working Group III (IPCC WG3) published its Summary of Climate Change as part of the IPCC's Sixth Assessment Report in April 2022 [4]. The IPCC WG3 report notes that although the rate of growth of average global annual greenhouse gas (GHG) emissions was lower between 2010 and 2019 than in the previous decade, average global annual GHG emissions during the last decade were higher than in any previous decade on record.

3.2.6 The IPCC WG3's global GHG emissions for four modelled scenarios are included in **Figure 3-1** of this Statement. The red band shows global annual GHG emissions considering global decarbonisation policies which at the time of writing the report had been implemented. Implemented policies are likely to slow the historical increase in annual emissions but are not yet sufficient to reduce them. In other words, policies which have already been implemented will keep global GHG emissions continuing at their current level through to 2050, rather than reducing them.

3.2.7 The purple, green, and blue bands show the IPCC's conclusions on different decarbonisation pathways, which must be followed to meet three scenarios of global temperature increases.

3.2.8 The purple band shows the decarbonisation path achieved by NDCs to 2030 followed by the decarbonisation path required to limit temperature increase to 2°C above pre-industrial levels with a probability of at least 67%. The red band is higher than the purple band, which implies that policies implemented to date are not sufficient to meet 2030 NDC commitments.

3.2.9 The green band shows the decarbonisation path which will achieve the same outcome as the purple path, by increasing actions in the 2020s and overshooting current NDCs. By urgently increasing decarbonisation actions now, future year-on-year carbon reductions to meet the same outcome can be lower and therefore are likely to be more achievable.

3.2.10 The cumulative warming effect of carbon means that not delivering against plans set out for the 2020s will lead to a greater scale and urgency to future plans and their delivery in order to meet the temperature increase limit set by the Paris Agreement. Delaying decarbonisation actions increases the risk of losing the fight against climate change, whilst in the meantime ongoing climate change events and impacts are unlikely to slow or decrease, putting lives and livelihoods at risk.

3.2.11 The blue band shows the decarbonisation path which will meet the commitments of the Paris Agreement with a probability of 50%.

3.2.12 Conclusions arising from **Figure 3-1** are:

- Current global climate change commitments are likely not sufficient to keep global temperature rise below 1.5°C
- Policies implemented to date fall short even of those commitments
- The delivery of measures will be required beyond 2030 to ensure that the 2050 target is met and sustained

3.2.13 The IPCC WG3 report findings also imply that mitigation after 2030 can no longer establish a pathway which will likely not exceed 1.5°C global temperature increase vs. 1990, during the 21st Century.

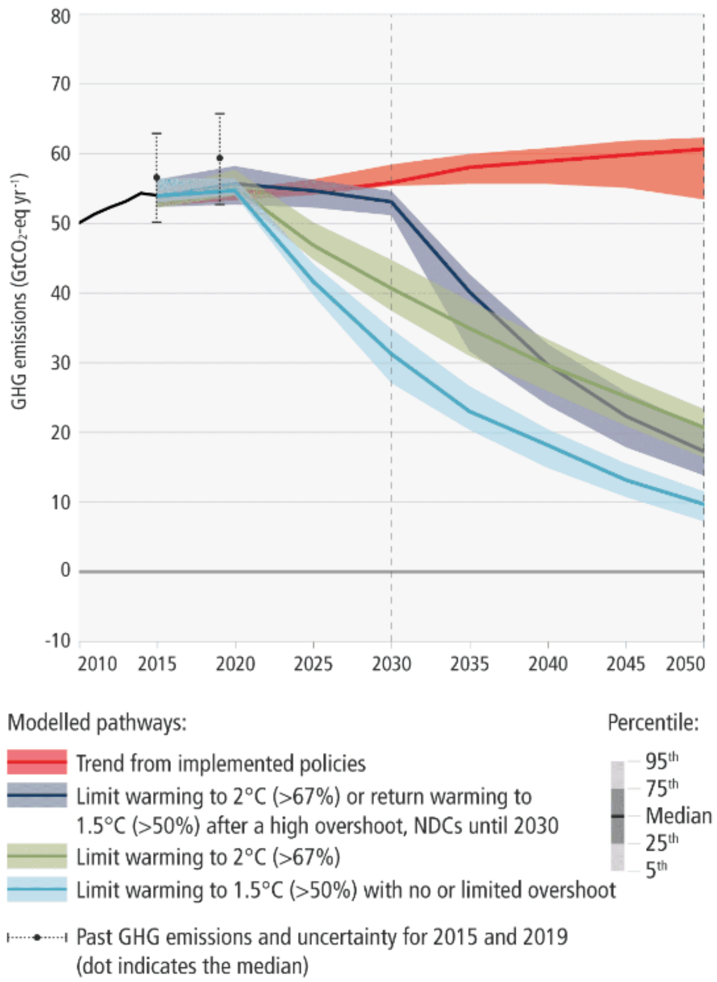


Figure 3-1: Representation of global GHG emissions of modelled pathways [4](Figure SPM.4)

3.2.14 The compelling need for global action to decarbonise continued to be reinforced through the IPCC's 20th March 2023 publication of its 2023 assessment of global climate change. The report concludes that the world is likely to pass a dangerous temperature threshold within the next 10 years, pushing the planet past the point of catastrophic warming — unless nations drastically transform their economies and immediately transition away from fossil fuels [5].

3.2.15 The Synthesis Report of the IPCC's Seventh Assessment Report will be produced after the completion of the Working Group reports and released by late 2029.

3.2.16 In a June 2024 news report which accompanied the publication of its Global Annual to Decadal Climate Update (2024 – 2028) report, the World Meteorological Organisation (WMO) stated that "There is a 47% likelihood that the global temperature averaged over the entire five-year 2024-2028 period will exceed 1.5°C above the pre-industrial era" [6]. This implies that sufficient progress on fighting climate change has not yet been made and more needs to be done in both mitigation and adaption.

3.2.17 The 28th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP28) was held in Dubai in December 2023. COP28 achieved agreement among the parties, to “tripling renewables and doubling energy efficiency.” On a global basis, COP28 concluded the requirement for action to abolish carbon emissions is more urgent now than ever it has been.

3.2.18 The same is true for the UK [7], and in July 2024, the Secretary of State for Energy Security and Net Zero met with past and future COP Presidents to discuss the need for greater urgency in tackling the climate crisis while underlining “the UK’s determination to act as a global leader and reliable partner on climate action” and “the importance of the UK’s renewed domestic leadership in encouraging ambitious action abroad. Climate and clean energy are at the heart of the new government’s agenda. The UK is taking immediate action to unlock investment in onshore wind [and] begin a solar revolution” [8].

3.2.19 COP29 closed in November 2024. At the conference, a new finance goal was agreed which will help countries to protect their people and economies against climate disasters. COP29 was reminded that in 2025 stronger national climate plans (measured through NDCs) become due from all countries. These new climate plans must cover all greenhouse gases and all sectors, to keep the 1.5°C warming limit within reach. The UK delegation clearly signalled at COP29 that the UK plans to ramp up climate actions which are entirely in the interests of the UK economy and peoples [9].

3.3 Decarbonisation in the UK

3.3.1 As a result of its commitments to the Paris Agreement, in June 2019 the UK became the first major economy to legislate for a 2050 net zero GHG emissions target through the Climate Change Act 2008 (2050 Target Amendment) Order 2019 [10].

3.3.2 Decarbonisation is therefore a UK legal requirement.

3.3.3 In December 2020, the UK communicated its NDCs under the Paris Agreement to reduce GHG emissions by at least 68 per cent from 1990 levels by 2030. In April 2021, the then government legislated for the Sixth Carbon Budget (CB6), which requires the UK to reduce GHG emissions by 78 per cent by 2035 compared to 1990 levels.

3.3.4 UK governmental objectives are to ensure the supply of energy to the national energy system always remains secure, reliable, affordable, and consistent with meeting legally binding GHG emissions including the NDC. NPS EN-1 states that government has identified that this will require a step change in the decarbonisation of the UK’s energy system [2](Para 2.3.3), and large-scale ground mounted solar has an important role to play in the UK.

3.3.5 The Climate Change Committee (CCC), a national independent advisory committee, made clear in its Progress Report to Parliament in 2019 [11](2019) that the UK is not on track to meet its fourth (2023-2027) or fifth (2028-2032) carbon budget.

3.3.6 This position was reinforced in the latest 2024 report which states that:

"Urgent action is needed to get on track for the UK's 2030 target … only a third of the emissions reductions required to achieve the 2030 target are currently covered by credible plans. Action is needed across all sectors of the economy, with low-carbon technologies becoming the norm." [11](2024, p8).

And

"The UK should now be in a phase of rapid investment and delivery … Annual offshore wind installations must increase by at least three times, onshore wind installations will need to double and solar installations must increase by five times." [11](2024, p9).

3.3.7 Emissions in the UK have steadily fallen over the last three decades and the UK met its first three carbon budgets covering the period 2008 - 2022 [11](2024, p18). In 2023 emissions were 49.5% below 1990 levels according to provisional estimates [11](2024, p19).

3.3.8 **Figure 3-2** shows historical emissions and performance against historical Carbon Budgets. The CCC's Carbon Budget Delivery Plan (CBDP, yellow) for Carbon Budgets CB4, CB5, and CB6 are also shown, as is the UK's NDC in 2030.

3.3.9 The reduction in carbon emissions required from CB5 to achieve CB6 is significant. The delivery of new low-carbon electricity generation beyond 2030 is essential for progress to towards the government's 2050 net zero legally binding target to continue to be made. The Proposed Development will meet the urgent need for new low-carbon generation to be brought online to contribute towards meeting government's 2050 target.

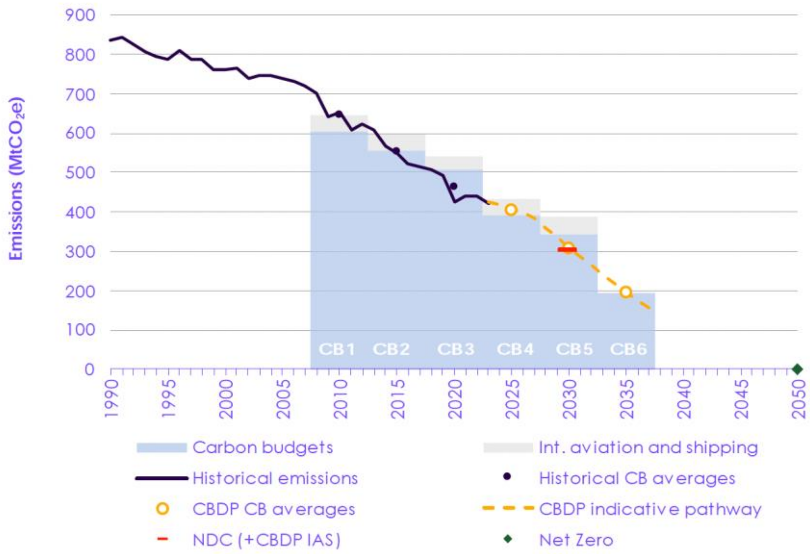


Figure 3-2: UK historical emissions, the CBDP indicative pathway and the UK's targets [11](2024, Figure 1.1)

3.3.10 The CCC concluded that the main driver of carbon emission reductions in 2023 was from electricity supply, largely due to increased electricity imports and reduced electricity exports, as "the UK returned to its normal status as a net importer of electricity, after one year as a net exporter of electricity in 2022" [11](2024, p19), suggesting that there is still work to do to decarbonise electricity generation in the UK. The annual carbon emissions reduction required to meet the UK's 2030 NDCs is 18.8 MtCO2e per year from 2023 to 2030, however the average annual rate over the previous seven years was only 13.8 MtCO2e per year. The CCC report that outside the electricity supply sector, the average annual rate of reduction over the previous seven years was only 6.3 MtCO2e per year. This will need to more than double to 14.3 MtCO2e per year over the next seven years to meet the 2030 NDC.

3.3.11 The CCC conclude that "This will require substantial increases in the rates of reduction in most sectors outside of electricity supply" [11](2024, p17). The decarbonisation of other sectors is largely reliant on the availability of sufficient quantities of low-carbon electricity as a source of energy to substitute for carbon-emitting fuels currently used within those sectors. It therefore follows that the development of new low-carbon electricity generation infrastructure also needs to accelerate.

3.3.12 Progress in decarbonising electricity supply has been delivered by phasing out the generation of electricity from burning coal and instead increasing the share of renewable generation. The CCC conclude that to maintain progress, "We now need to rapidly reduce oil and gas use as well." [11](2024, p8).

3.3.13 Without adequate supply of low-carbon electricity, the urgent requirement for a rapid decarbonisation of other sectors (as will be required to meet future Carbon Budgets) is unlikely to be achieved.

3.4 The UK's strategic plan for decarbonisation

3.4.1 The UK chose to largely decarbonise its power sector by adopting low carbon sources quickly, and invited industry to bring forward new low carbon developments to meet the twin challenge of energy security and climate change [2](Para 4.2.2).

3.4.2 Implementing this strategy by closing generation capacity with high carbon emissions and replacing it with low-carbon renewable energy has delivered significant decarbonisation benefits in the UK to date.

3.4.3 Figure 3-3 shows that carbon emissions associated with the UK's electricity system (green dashed line) have reduced by approximately 70% between 2005 and 2022 (the most recent year for which data is available from this source). Non-electrical emissions have also reduced but by a lower percentage.

3.4.4 The domestic and transport sectors had the highest carbon emissions in 2022. Fossil fuels remain a major source of energy to these sectors. Critically the percentage reductions of emissions in those sectors between 2005 and 2022 were significantly lower than national average emission reductions, at 42% and 21% respectively. Emissions from the domestic sector had also reduced by just 21% when measured excluding reductions in emissions from electricity.

3.4.5 **Figure 3-3** suggests that the transport, domestic, and industrial sectors require a significant intervention to reduce carbon emissions, and that the reduction of emissions from those sectors will be critical if net zero 2050 is to be reached.

3.4.6 The government's strategy to reduce these emissions is to increase low carbon electricity supplies such that electricity may be used to displace fossil fuels from those other sectors. The continued delivery of low-carbon electricity generation facilities beyond 2030 is therefore necessary to reduce emissions from those sectors.

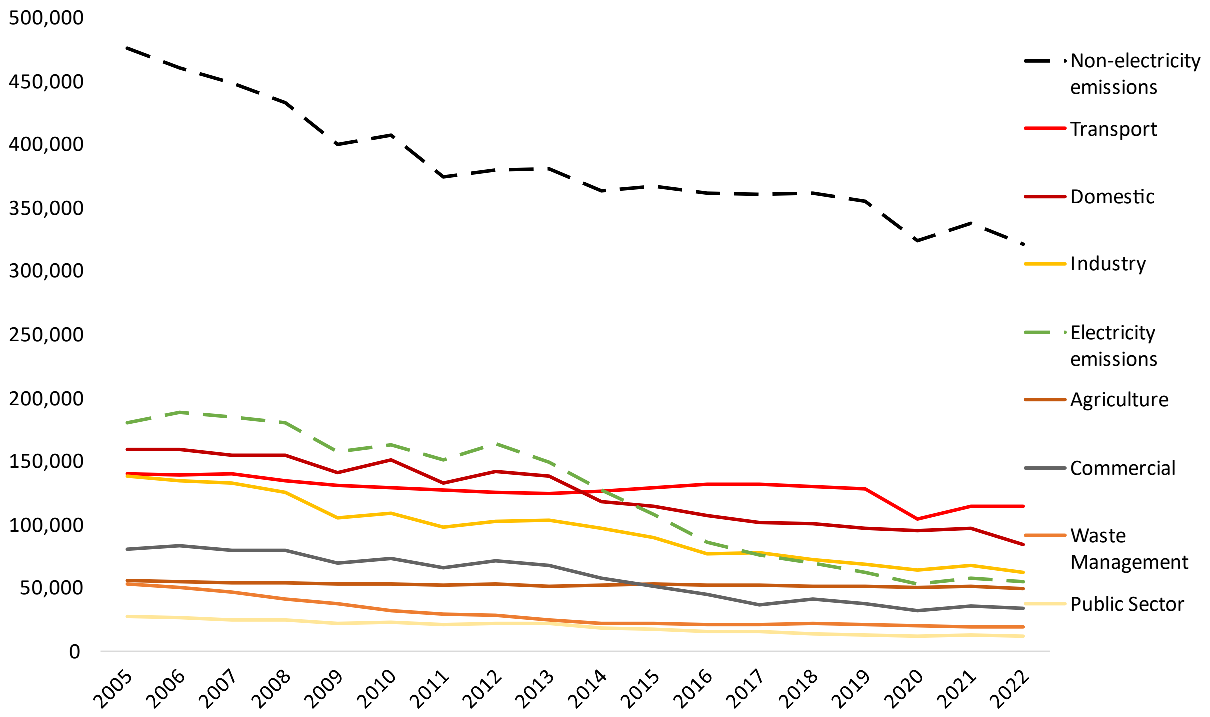


Figure 3-3: National (UK) District GHG Emissions 2005 – 2022 (LULUCF net benefits small and not shown) [12], [Author Analysis]

3.5 Climate Change Committee Progress Report to Parliament, 2024

3.5.1 The CCC published the 2024 edition of their annual Progress Report to Parliament in July 2024. The report leads with the Committee's view that "the new government will have to act fast to hit the country's [climate] commitments" [11](2024, p8).

3.5.2 The Committee summarised that "the cost of key low-carbon technologies is falling, creating an opportunity for the UK to boost investment, reclaim global climate leadership and enhance energy security by accelerating take-up. British-based renewable energy is the cheapest and fastest way to reduce vulnerability to volatile global fossil fuel markets. The faster we get off fossil fuels, the more secure we become" [11](2024, p8).

3.5.3 Further, the Committee assessed that "only a third of the emissions reductions required to achieve the 2030 target are currently covered by credible plans. Action is needed across all sectors of the economy, with low-carbon technologies becoming the norm," and that rapid reductions in the use of oil and gas must also be secured [11](2024, p8).

3.5.4 The Committee's assessment also implies that plans to achieve emissions reductions beyond 2030 are not yet credible and therefore that schemes which come forwards which will help deliver those reductions in that timeframe are also needed.

3.5.5 To deliver this, the Committee recommend that:

- Annual offshore wind installations must increase by at least three times, onshore wind installations will need to double, and solar installations must increase by five times
- Approximately 10% of existing homes in the UK will need to be heated by a heat pump, compared to only approximately 1% today

  The market share of new electric cars needs to increase from 16.5% today to nearly 100%

3.5.6 These recommendations are consistent with a continuing move away from the use of fossil fuels and towards an energy system with electricity at its centre, either directly or through the use of hydrogen, produced at least in part, by the electrolysis of water.

3.5.7 The CCC reported that "indicators for low-carbon technology roll-out are off track, with rates needing to significantly ramp up" to achieve 2030 targets [11](2024, p9), including on engineered removals. While technologies with substantial lead-times continue to be progressed, delivery of essential nearer-term carbon emission reductions will need to come from increasing renewable electricity generation capacity.

3.6 The government's energy strategy

3.6.1 The UK's general election in July 2024 saw a change of government. However, the UK's 2030 NDC remains unchanged at 68 per cent reduction in territorial emissions by 2030 on 1990 levels. The Sixth Carbon Budget (2033-2037) also remains unchanged, requiring the UK to reduce GHG emissions by 78 per cent by 2035 compared to 1990 levels.

3.6.2 In October 2024, the Climate Change Committee provided advice to the government for the UK's 2035 NDC commitment to reduce greenhouse gas emissions to increase to 81% from 1990 to 2035. The Applicant notes, however, that the newly recommended 81% reduction is consistent with the ambition legislated in the Sixth Carbon Budget but has been updated to include International Aviation and Shipping emissions and for a change in accounting methodology [13].

3.6.3 In August 2024, government requested advice on decarbonising the power sector by 2030 from the National Energy System Operator (NESO). NESO published their advice in November 2024, and it is summarised in **Section 3.8** of this Statement.

3.6.4 In December 2024, the Prime Minister reconfirmed the government's mission to make Britain a clean energy superpower. The government has taken onboard NESO's advice to achieve "at least 95% clean power by 2030, while accelerating the UK to net zero" [14](p6) thereby staying on track to "secure our energy supply with home-grown, clean power" [14](p40).

3.6.5 In December 2024, government published the Clean Power 2030 Action Plan. Clean Power 2030 is a step in the UK's journey to achieving its energy policy aims of delivering a secure, low-carbon and low cost electricity supply for consumers on the way to delivering net zero carbon emissions by 2050. This plan explains the need for a rapid expansion in the UK's low-carbon electricity generation capacity and sets out the actions the government proposes to take to deliver that capacity against the timeframes required. See **Section 3.9** of this Statement for more information.

3.6.6 In March 2020, the Energy System Catapult's Innovating to Net Zero report observed that:

"Net Zero narrows the set of viable pathways for the future energy system. Where an 80% target allowed considerable variation in relative effort across the economy, with some fossil fuels still permissible in most sectors, Net Zero leaves little slack." [15](p5).

3.6.7 It therefore follows that the government's proposed approach to achieve net zero, shares many similarities with the approach taken by the previous government. Indeed there is nothing inconsistent between the government's approach and the approach taken by the previous government which would mean a move away from existing policies in support of renewable electricity supplies.

3.6.8 That said, one key difference, is that the urgency of the need to implement measures which deliver decarbonisation is now greater because of the reasons described in **Section 3.2** of this Statement. The government's support for renewable generation going forwards is therefore no lower than the support set out in existing publications and strategies and if anything is emerging to be more supportive, as evidenced by the approval of four large-scale solar DCOs (Sunnica Energy Farm, Mallard Pass Solar Project, Gate Burton Energy Park, and Cottam Solar Project) in the first months of the government's term in office, the first three of which were overdue decisions, and a further two approvals in January 2025 (West Burton Solar Project and Heckington Fen Solar Park).

3.6.9 Government has explained that achieving Clean Power by 2030 is of critical importance and the government's Action Plan delivers a mechanism to prioritise near-term actions in support of that aim. However, the need for new clean power does not stop at 2030. The continued delivery of low-carbon generation facilities beyond 2030 is necessary to meet future electricity demand growth and achieve essential wider societal carbon savings. It is also important to continue to bring forward schemes in the event that ‘Clean Power by 2030’ is not achieved, as is also foreseen by flexibility included in the government’s Action Plan.

3.6.10 This chapter therefore calls on recent publications by government and NESO as well as those published under the previous government, to support the evidence base for the need for large-scale solar in the UK to deliver energy security, decarbonisation, and affordability benefits. The urgency to deliver these benefits has increased under this government.

3.7 Connections Action Plan

3.7.1 Securing a timely grid connection is a critical enabler for low carbon infrastructure to contribute towards a zero-carbon electricity system in the 2030s but grid connection availability is currently constrained.

3.7.2 This section explains critical aspects of the current shortage of grid connections and the challenges with managing new connections to the UK’s electricity system at the pace and scale required to meet government’s targets. The Connections Action Plan describes actions proposed by NESO, Ofgem and government to improve the near-term deliverability of new low carbon generation assets. Government’s Clean Power 2030 Action Plan ([1], see also **Section 3.9**) builds on these proposals to provide a framework for the prioritisation of offers for projects which align with NESO’s advice on connections which are deliverable by 2030, and which can demonstrate that they have the means to deliver.

3.7.3 As government explained in their election manifesto: “The national grid has become the single biggest obstacle to the deployment of cheap, clean power generation and the electrification of industry. With grid connection dates not being offered until the late 2030s, important business and infrastructure investment is being stalled or lost overseas. Labour will work with industry to upgrade our national transmission infrastructure and rewire Britain.” [16](p55).

3.7.4 In November 2023, DESNZ and Ofgem jointly published a Connections Action Plan which states:

“Nearly half of transmission generation projects have a connection date at least five years from now, with some scheduled to wait ten years or more. This is simply too slow and remains the biggest risk to our ability to decarbonise our power system by 2035 …

The Plan is aimed at getting a significant majority of projects connected by their requested connection date, up from 14 per cent today, and to reduce the average delay a project faces in connecting to the transmission network from five years to six months” [17](p7).

3.7.5 The Connections Action Plan includes reforms to the connections process which have been designed to enable viable projects to connect in a timely and cost-effective manner. The reforms are:

- Raising entry requirements, including evidence of landowner permission, to deter speculative connection applications
- Removing stalled projects to release capacity for more viable projects
- Better utilising existing network capacity to reduce connection timelines
- Allocating available network capacity to connect projects that are more ready to progress and are able to make use of capacity sooner

3.7.6 The Connections Action Plan explains that the efficient utilisation of existing networks can defer or negate the need for expensive new infrastructure, which takes time to deliver [17](pp26&27) and that ensuring that existing and future capacity is allocated efficiently will allow timely connection offers, aligned with net zero objectives.

3.7.7 In relation to increasing network capacity, the Connections Action Plan describes that there are two approaches. The first is to increase network build and the second, which is described as “more efficient” and “typically lower cost”, is to “maximise the use of the currently available and planned network capacity” [17](pp40&41).

3.7.8 Capacity allocation is defined in the Plan as an approach to “maximise the benefits of available capacity such that projects that are more ready and able to connect can do so ahead of those which are stalled, while maintaining appropriate opportunities for technologies with varying lead times, in line with net zero pathways” [17](p44).

3.7.9 Schemes which propose to develop technology which will support the move to net zero (such as solar and storage schemes) are aligned with the government’s aims and strategy. Schemes which propose to connect to existing and available connection infrastructure are aligned with the Connections Action Plan reforms.

3.7.10 Ensuring assets can connect to the electricity network where and when they need to is crucial to achieving net zero, as well as to delivering affordability for consumers and maintaining security of supply.

3.7.11 However, there are currently insufficient existing transmission system or distribution network substations suitably located with the capacity available to connect new solar, onshore wind and offshore wind assets required to meet the government’s low-carbon aims.

3.7.12 New substations will need to be proposed, designed and constructed to deliver the government’s ambition and other substations will need to be expanded to connect new schemes. This programme of work will need to occur at the same time as other schemes are connected to existing substations which have available capacity.

3.7.13 All schemes which are able to connect to the grid before 2030 are valuable to deliver the government's ambition to deliver 'Clean Power by 2030'. It is also important to continue to bring forward schemes which can feed the pipeline of connections beyond 2030 to continue to grow the UK's low-carbon electricity generation capability, and also in the event that 'Clean Power by 2030' is not achieved.

3.7.14 Any positive interventions made by the government or other statutory bodies, such as those set out in the Connections Action Plan and in the government's Clean Power 2030 Action Plan (see **Section 3.9**), provide the possibility for prioritisation of schemes which are more ready to deliver, and which meet NESO's queue entry and prioritisation requirements as they evolve.

3.7.15 The Proposed Development is to connect a large-scale solar plus storage asset to the NETS at High Marnham.

3.7.16 The Proposed Development was to connect to the existing High Marnham 275kV substation. NESO has developed plans to upgrade the High Marnham substation and the Chesterfield to High Marnham 275kV circuit to bring offshore wind power generation to the Midlands and beyond. The Proposed Development is not the triggering party for that proposed upgrade, but has accepted an offer to connect to the upgraded infrastructure, once delivered. It therefore remains a key benefit of the Proposed Development within the context of the significant need for new electricity networks infrastructure, that efficient use will be made of existing infrastructure or of infrastructure which is required to be upgraded for other reasons. **Section 8.4** of this Statement provides further details.

3.7.17 Through the design of the Proposed Development, the Applicant seeks to maximise use of the connection capacity which is to be made available to it. The Proposed Development is therefore fully aligned with the direction of travel of relevant policy and action plans in support of achieving the government's ambition to deliver 'Clean Power by 2030'.

3.8 Advice on decarbonising the power sector by 2030

3.8.1 In November 2024, following a request from government, NESO provided their input into the development of the government's plan for 'Clean Power by 2030' by publishing their Clean Power 2030 report [18] in November 2024.

3.8.2 Clean power supports decarbonisation by offering consumers electricity with no carbon emissions for their current demand and also for the future electrification of heating and transportation. This is needed to further displace imports of gas and oil, reducing overall reliance on imported energy in the British energy system and increasing protection for GB consumers from volatile international energy markets. [18](p80).

3.8.3 NESO state that ‘Clean Power by 2030’ is the foundation for wider electrification and for achieving net zero [18](p68). Clean power is needed by 2030 and in preparation for the 2030s, to “ensure the [electricity] system is able to keep pace with accelerated electrification through the 2030s, which is expected to add approximately 19 TWh per year to demand” [18](p67).

3.8.4 NESO state that: “With a short and shrinking window of time, pace must be the primary goal” [18](p6), that “There is no path to clean power without mass deployment of offshore wind, together with onshore wind and solar,” and that “Accelerating build rates now for renewables is crucial to enabling the continued growth of demand due to electrification” [18](p68).

3.8.5 NESO’s pathways “see a doubling of onshore wind capacity from 14GW in 2023 to 27 GW by 2030 and a trebling of solar from 15 GW to 47GW by 2030” [18](p16). Further, “Flexibility is vital in a system with more variable renewables” [18](p7) and NESO pathways include “an increase in grid connected battery storage from 5GW to over 22GW” [18](p8).

3.8.6 NESO’s analysis demonstrates that to achieve ‘Clean Power by 2030’, “offshore wind, onshore wind, solar, batteries [and other key supply technologies] will all need to deploy more on average each year to 2030 than they have ever done in a single year before. This will inevitably stretch supply chains and require accelerated decision making in planning, permitting and awarding of contracts” [18](p9).

3.8.7 Therefore, and in alignment with government’s view (NPS EN-1, Para 3.3.10), NESO conclude that “to manage delivery risk, there is a high value in pursuing multiple options where they exist and encouraging competition between, not just within, different technologies” [18](p7), recommending aiming high on the deployment of critical technologies in any pathway to ‘Clean Power by 2030’ to reduce the risk of under delivery as a whole and also to reduce reliance on any single project [18](p49).

3.8.8 A key enabler of achieving ‘Clean Power by 2030’, is a “connections queue … formed of ready-to-connect projects that align with the Government’s plan for clean power by 2030” [18](p10). Such a queue would help NESO speed up the “critical and challenging” delivery of essential strategic transmission infrastructure needed to achieve ‘Clean Power by 2030’ [18](p34).

3.8.9 NESO observe that:

"The connections queue currently comprises a greater volume of projects than required for 2030 across our pathways. However: a) not all of those projects may be 'ready' or committed to progressing; and b) there may be projects with connection dates after 2030 that could usefully contribute to the 2030 system, for example with lower delivery barriers or lower costs" [18](p61).

3.8.10 The Connections Reform process (see **Section 3.7**) seeks to re-order the connections queue by prioritising projects which are more 'ready' to connect and de-prioritising those which are at an earlier stage of development.

3.9 Clean Power 2030 Action Plan

3.9.1 Government published their Clean Power 2030 Action Plan in December 2024. The plan states that delivering Clean Power 2030:

"Paves the way to decarbonising the wider economy by 2050 as we pursue the electrification of heat in buildings, transport, and industry. By 2050, annual electricity demand is likely to at least double. Clean power by 2030 prepares us for the rapid growth in power demand expected over the 2030s and 40s" [1](p11).

3.9.2 Further, the plan reiterates the energy security and affordability benefits of pursuing a low-carbon future:

"In an era of heightened geopolitical risk, switching fossil fuelled generation for homegrown clean energy from renewables and other clean technologies offers us security that fossil fuels simply cannot provide.

It is crucial we complement renewables with flexible capacity to ensure we can deliver clean power no matter the weather" [1](p21).

3.9.3 However, government also states that "to get this right we need to act – and act quickly – because 6 years is a short time in building energy infrastructure" [1](p18).

3.9.4 Government's definition of Clean Power 2030 is that:

> Clean sources produce at least as much power as Great Britain consumes in total (2023: 56%, [1](p26))

> Clean sources produce at least 95% of Great Britain's generation (2023: 60%, [1](p26))

3.9.5 However, government "will aim to deliver above this ambition where the system and consumer benefits align so that potential challenges in some areas of clean power delivery can be compensated by deployment elsewhere" [1](p25).

3.9.6 To deliver above this ambition, government "accepts the NESO advice on the infrastructure required for 2030 – decisions are required now to ensure the grid needed for the system in 2030 can be put in place" [1](p31) and recognises that the grid connections process needs reform and the queue to connect must be reduced to "prioritise projects needed for 2030, while maintain[ing] a robust pipeline [of projects] beyond 2030" [1](p11).

3.9.7 **Table 3-1** sets out government's 'Clean Power Capacity Range' compared to its view of installed capacity (GW) in December 2024 for major generation technologies.

Table 3-1: DESNZ 'Clean Power Capacity Range', and current installed capacity (GW) [1](Table 1 & Connections Reform Annex, Table 1)

Technology	Current Installed Capacity (*)	DESNZ 2030 'Clean Power Capacity Range'	2035 FES-derived Capacity Range
Offshore Wind	15	43 – 50	72 – 89
Onshore Wind	14	27 – 29	35 – 37
Solar	17	45 – 47	45 – 69
Nuclear	6	3 – 4	4 – 6
Low Carbon Dispatchable Power	4	2 – 7	Up to 25
Unabated Gas	36	35	NA
Batteries	5	23 – 27	24 – 29
Other flexible assets	15	26 – 32	51 – 63

(*) Government's view of the publicly available data for Great Britain at the point of publication of Clean Power 2030 Action Plan

3.9.8 The Capacity Range provides a framework for the prioritisation of offers for projects which:

> Align with NESO's advice on connections which are deliverable by 2030, and
> Can demonstrate that they have the means to deliver

3.9.9 Importantly, government states that NESO's engagement with Distribution Network Operators indicates that an additional 9 to 10GW of rooftop solar projects could deploy before 2030. It is therefore possible that the 2030 Clean Power solar capacity range of 45 to 47GW could yield around 54 to 57GW of installed capacity by 2030, subject to solar PV pipeline of rooftop solar projects [1](Connections Reform Annex, Table 1, Footnote 10).

3.9.10 Therefore, government has

"set out national pathway figures for the capacity which should be prioritised for all technologies, and further regional breakdowns for the capacity which should be prioritised for solar, batteries and onshore wind.

These FES-derived ranges do not constitute a government pathway, but rather an established, public basis through which to provide longer-term certainty on connections" [1](Connections Reform Annex, p5).

3.9.11 Critically, the Clean Power 2030 Action Plan does not seek to limit, constrain or cap the capacity of low carbon generation assets which will be delivered over the coming years. Indeed, quite the opposite is true, and the Clean Power 2030 Action Plan seeks to de-clutter the front end of the connection queue to ensure that a sufficient capacity of low carbon generation assets are able to connect in suitable timeframes.

3.9.12 This is important because connection queues experience attrition therefore to ensure that a sufficient capacity of low carbon generation assets is delivered requires a greater capacity of low carbon generation assets to come forwards in development pipelines (**Section 6.3** of this Statement provides more information on pipeline attrition in the UK).

3.9.13 Further, to ensure that the energy transition delivers value for money for consumers, competition must be enabled in commercial aspects of project delivery and contracting, for example through the Contracts for Difference mechanism (CfD), see **Section 6.3** of this Statement. Competition at contract award also requires a greater capacity of low carbon projects to progress through planning than are required to deliver government's targets.

3.9.14 Indeed, "Whilst the 'Clean Power Capacity Range' provides a foundation to guide rapid policy development and focus delivery, the scenarios developed now cannot be exhaustive or definitive, and it is only right that some optionality is retained" [1](p31).

3.9.15 These factors combine to lead to the conclusion that government is "expecting an increase in planning applications with the Clean Power 2030 target" [1](p55), and indeed planning applications will need to continue to be made if the Clean Power 2030 target is to be met.

3.10 The Energy White Paper

3.10.1 The Energy White Paper [19], published in December 2020, outlined a strategy to transform the energy system, tackling emissions while continuing to ensure secure and reliable supply, and affordable bills for households and businesses.

3.10.2 Solar helped to increase UK renewable generation capacity five-fold between 2010 and 2020 [19](p40).

3.10.3 A low-cost, net zero consistent system is likely to be composed predominantly of wind and solar [19](p43).

3.10.4 Onshore wind and solar will be key building blocks of the future generation mix, along with offshore wind. We will need sustained growth in the capacity of these sectors in the next decade to ensure that we are on a pathway that allows us to meet net zero emissions in all demand scenarios [19](p45).

3.10.5 Solar plays an increasingly important role in supporting an affordable and fair energy system by displacing price-setting gas from the electricity system [19](p30).

3.10.6 Government's Clean Power 2030 Action Plan reconfirms that it is critical for the UK to aim to build "an energy system that is affordable for the long term, keeping our supply secure, and cutting our emissions before it's too late" [1](p18), thereby continuing to increase the UK's low carbon generation capacity to support the decarbonisation of energy demand outside of the traditional electricity sector.

3.11 Net Zero Strategy – Build Back Greener

3.11.1 The Net Zero Strategy (NZS) [20], published in October 2021, set out a long-term plan for the economy-wide transition to net zero that will take place over the next three decades.

3.11.2 The NZS's key policy is for the UK to be powered entirely by clean electricity by 2035, subject to security of supply [20](p20), a policy which is consistent with government's more ambitious aim to deliver Clean Power by 2030 [1], but which has been superseded by it.

3.11.3 The NZS states that a sustained increase to the deployment of land-based renewables such as locally supported onshore wind and solar in the 2020s and beyond is required to meet CB6 [20](p103), [11](2024, p9).

3.11.4 The NZS includes up-to-date evidence of the low cost of large-scale solar globally, which is supporting the necessary increase in capacity of large-scale solar builds in the UK [20](p312).

"Gas will continue to play a role in setting the electricity price for some years to come but, over time, will do so less frequently, as more and more low carbon generation (such as wind and solar) connect to the electricity system … This will help put downward pressure on wholesale electricity prices" [20](p337).

3.12 The British Energy Security Strategy

3.12.1 The British Energy Security Strategy, published in April 2022, set out the immediate need to manage the financial implications of soaring commodity prices in the near term and also the long-term goal of "address[ing] our underlying vulnerability to international oil and gas prices by reducing our dependence on imported oil and gas" [21](p6).

3.12.2 The British Energy Security Strategy recognises the critical role of renewables in accelerating the transition away from fossil fuels [21](p16) by, for example, electrifying home heating and transport, so increasing demand for electricity in future years.

3.12.3 The British Energy Security Strategy introduced the then government's increased ambition for solar generation, supporting a five-fold increase in deployment of solar technology by 2035, recognising the abundant source of solar energy in the UK and an 85% reduction in cost of solar power over the last ten years. [21](p19). The online British Energy Security Strategy includes an explicit ambition for up to 70GW of British solar on roofs and on the ground by 2035.

3.12.4 The government's mission to deliver Clean Power by 2030 is consistent with the themes and measures recommended in the British Energy Security Strategy, albeit the target quanta differ in that the government's ambitions with regard to the scale and pace of delivery of low-carbon electricity generation, are larger, and quicker, than those of the previous government. Indeed, "By accelerating the switch to domestic renewable electricity sources and accelerating the application of clean electricity to the wider energy system, we will be able to reduce our reliance on fossils fuels faster. This enhances energy security, making the UK less vulnerable to global market disruptions or geopolitical tensions that affect energy prices" [1](p21).

3.13 Mission Zero – the Skidmore Review

3.13.1 Mission Zero was published in January 2023 by Rt Hon Chris Skidmore MP, Chair of the then government's Independent Review of Net Zero. The report was commissioned to ask how the UK might deliver its own net zero targets in a manner that was more affordable, more efficient, and in a pro-business and pro-enterprise way. Mission Zero recognises the importance of taking action on net zero. It also recognises the fact that the energy transition is a new economic reality, particularly amid the global reality of the energy security crisis and rising gas and fossil fuel prices in 2022.

3.13.2 Mission Zero reconfirms the global importance of the UK's commitment to achieve net zero and makes recommendations which should be taken forwards, alongside other wider recommendations. It states that the UK should be proud of the steps it has taken so far to achieve net zero, and that climate change and the economy are intertwined. The UK must however move quickly, not only to protect and secure delivery of our national climate commitments but also deliver the economic benefits of moving away from a carbon economy. The review finds that "The benefits of net zero will outweigh the costs" and believes that "This is too important to get wrong" [22](p8).

3.13.3 Sir Patrick Vallance, a former UK Chief Scientific Advisor and recently appointed Minister of State for Science in the Department for Science, Innovation, and Technology (July 2024), explains, in regard to government's national mission for 'Clean Power by 2030', that "We can be the innovators and the implementers, helping ourselves and exporting our solutions worldwide. But if we choose to go slowly, others will provide the answers, and ultimately we'll end up buying these solutions rather than selling them" [16](p48), thereby supporting the commercial imperative to proceed with decarbonisation at pace, as previously described in Mission Zero.

3.13.4 Mission Zero made the following recommendations which are relevant to the growing need for large-scale ground mount solar to be deployed in the UK:

> Priority Mission no. 2: "Full-scale deployment of solar including a rooftop revolution to harness one of the cheapest forms of energy, increase our energy independence and deliver up to 70GW of British solar generation by 2035". The government's Clean Power 2030 Action Plan includes a range of 45 to 47 GW of solar being connected by 2030 and 45 to 69 GW by 2035 [1](Connections Reform Annex, Table 1)

- Priority Mission no. 8: “Working towards gas free homes by 2035 [or earlier]” and Recommendation 1 is to set a legislative target for gas-free homes and appliances. The government’s Warm Homes Plan “will offer grants and low interest loans to support investment in insulation and other improvements such as solar panels, batteries and low carbon heating to cut bills.” [16](p56) which when delivered will reduce domestic reliance on natural gas
- Recommendation 15 is the swift delivery of Zero Emissions Vehicles (ZEVs) and the ZEV mandate to apply from 2024. The government’s election manifesto sets out their support for “the transition to electric vehicles by accelerating the roll out of charge points, [and] giving certainty to manufacturers by restoring the phase-out date of 2030 for new cars with internal combustion engines” [16](p31)
- Priority Mission 8 and Recommendations 1 and 15 add weight to the argument for the need to roll out solar and other renewable generation to meet the growing demand which will arise from their delivery, consistent with the government’s mission to deliver ‘Clean Power by 2030’
- Priority Mission no. 9 is to “Embed nature and habitat restoration … maximising co-benefits for climate and nature wherever possible.” Ground mount solar can deliver on this Priority Mission by delivering biodiversity net gain through its development
- Recommendation 11 is to “Set up a taskforce and deployment roadmaps in 2023 for solar to reach up to 70GW by 2035.” Government’s Clean Power 2030 Action Plan [1] provides a framework for prioritising the connection queue to support 45 to 47GW of solar power being connected to transmission and distribution networks by 2030 and 45 to 69GW by 2035
- Mission Zero recognises the importance of local action and local plans to the achievement of net zero. People and places must be empowered to deliver net zero through a full alignment on a local level with a net zero future through the introduction of a ‘net zero test’. All local authorities will be required to play their part in achieving carbon neutrality in the future. Ground-mounted solar (at both Nationally Significant infrastructure and local planning authority scale) is a leading deliverable low-carbon generation technology which will enable local authorities to deliver against plans to decarbonize on a local level

3.13.5 The government’s mission to deliver ‘Clean Power by 2030’ is consistent with many of the findings of Mission Zero. For example:

- Government’s ‘Clean Power Capacity Range’ provides a foundation to guide rapid policy development and focus delivery of significant new capacities of onshore and offshore wind and solar power

- Great British Energy has been established to put the UK on a "path to become a clean energy superpower" [1](p70)
- Establishing the Mission Control for Clean Power (also called the Clean Power 2030 Advisory Commission), with four strands of activity including: setting and tracking the overall approach to delivering 2030 across the energy system, real time monitoring of progress on UK infrastructure projects critical to 2030, acting as an innovation centre by encouraging discussion among experts, and serving as a convener for the Mission Control approach across government and with industry [23]

3.14 Powering Up Britain

3.14.1 The previous government's Powering Up Britain Strategy, including Powering Up Britain: Energy Security Plan and Powering Up Britain: Net Zero Growth Plan, was published in March 2023. The documents set out how the UK will achieve energy security, promote green growth, and meet its net zero targets.

3.14.2 Powering Up Britain concludes that "We need investment at scale … to rapidly rollout existing technologies … at pace to meet our ambitions for decarbonising power and [lower] wholesale UK electricity prices." [24](a, p9), and observes that "a significant proportion of technologies we will need for 2050 are currently at the demonstration or prototype phase" [24](a, p9). This implies that while the UK should continue to pursue low-carbon technologies, waiting for novel technologies to deliver comes with risk because some of these technologies may not deliver. Therefore the Government's strategy to deliver a rapid rollout of existing technologies, while continuing to invest in new technologies, is of critical importance in the fight against climate change.

3.14.3 Indeed, government's Clean Power 2030 Action Plan explains that "whilst the 'Clean Power Capacity Range' provides a foundation to guide rapid policy development and focus delivery, the scenarios developed now cannot be exhaustive or definitive, and it is only right that some optionality is retained" [1](p31).

3.14.4 It is important to recognise that ground-mounted large-scale solar is a mature technology which is capable of delivering a reliable and rapid rollout once projects are consented, and is one of the cheapest forms of electricity generation that is readily deployable at scale. Therefore, alongside more recent publications, Powering Up Britain recognises the huge potential solar generation can have in decarbonisation.

3.14.5 Powering Up Britain therefore includes the acceleration of renewables deployment as critical to support the delivery of the then government's plans.

3.14.6 Powering Up Britain's Energy Security Plan confirms that the then government was "aiming for 70GW of ground and rooftop capacity together by 2035. We need to maximise deployment of both types of solar to achieve our overall target" [24](e, p37).

3.14.7 In support of the emphasis Powering Up Britain places on the need to maximise the deployment of ground-mounted solar, the strategy states that the "Government seeks large scale solar deployment across the UK, looking for development mainly on brownfield, industrial and low/medium grade agricultural land. The government will therefore not be making changes to categories of agricultural land in ways that might constrain solar deployment" [24](a, p20).

3.14.8 Powering Up Britain makes it clear that the then government expected the operational capacity of both large-scale and rooftop solar to grow in pursuit of net zero. In other words, that development on agricultural land is also anticipated.

3.14.9 Through the establishment of Great British Energy and Mission Control for 'Clean Power by 2030', the government has already set in place organisations to speed the transition towards UK energy security and net zero. Six large-scale transmission connected ground mount solar schemes have been consented by government since they took office in July 2024. Large-scale solar has a critical role to play in their plan to enable a secure and low-carbon energy future.

3.15 Energy Act 2023

3.15.1 In October 2023, the Energy Act 2023 (EA 2023) came into law. The EA 2023 aims to strengthen energy security and support the delivery of net zero and affordable energy bills for households in the long term.

3.15.2 The government press release at the time of Royal Assent [25] describes the key elements of the EA 2023.

3.15.3 The EA 2023 brings heat networks into the remit of the Office for Gas and Electricity Markets (Ofgem), further supporting the UK's whole-system approach to energy, and updates their remit further so that the Office considers net zero targets as part of its everyday decisions.

3.15.4 New measures will also support consumers in their transition to 'smart products' which will pave the way to the automatic response of UK electricity demand at times of abundance or potential scarcity – a key measure if households are to deliver flexibility to the UK's energy system.

3.15.5 On the energy supply side, the EA 2023 legislates for the regulation of nuclear fusion, an important enabler of the UK's prototype fusion ambitions for 2040.

3.15.6 The EA 2023 also introduces a new licensing framework for CO2 and hydrogen transport and storage to help deliver the UK's first carbon capture and hydrogen production sites.

3.15.7 Further provision is made within the EA 2023 to support the growth of offshore wind while ensuring that compensation for any adverse environmental effects is delivered strategically as opposed to being delivered on a scheme-by-scheme basis.

3.15.8 The EA 2023 should therefore be seen as enabling legislation which will support the UK to deliver on technology development to achieve net zero by 2050. Further discussion on those technologies is included in **Section 6** of this Statement.

3.15.9 A forthcoming Energy Independence Act will establish the framework for the government's energy and climate policies.

3.16 Conclusions on decarbonisation policy context

3.16.1 Urgent and unprecedented action is needed on an international scale to meet the commitments established through the Paris Agreement to decarbonise society and stop global warming.

3.16.2 The UK has legally binding targets to decarbonise. The UK is developing new policies and is enhancing existing policies to ensure that those targets are met in a secure and affordable fashion.

3.16.3 However, policies are not yet sufficient to deliver to those national commitments, and delivery against those UK policies is further behind.

3.16.4 Without a rapid increase in the supply of low-carbon electricity, the urgent requirement to decarbonise other sectors (as will be required to meet future Carbon Budgets) is unlikely to be achieved.

3.16.5 Solar generation is increasing in both scale and importance within emerging government policy. Not only for the benefits it delivers to decarbonisation, but also because of the need for secure and affordable energy supplies.

3.16.6 The government has established a framework to support a total of 45 to 47GW of solar capacity to be connected by 2030, alongside ambitious onshore wind and offshore wind growth targets.

3.16.7 To deliver this capacity of solar generation, the equivalent of approximately one large-scale scheme would need to be switched on each and every month between the end of 2024 and 2030.

3.16.8 Schemes such as the Proposed Development which are more ready to build with connection offers in the 2020s are valuable to deliver the government's ambition to deliver 'Clean Power by 2030'. It is important to continue to bring forward such schemes to meet future growth in electricity demand and also in the event that 'Clean Power by 2030' is not achieved.

3.16.9 The Proposed Development will, if consented, make an important and significant contribution towards achieving the government's legally binding net zero target by 2050.

4. National Policy Statements

4.1 Planning policy for Nationally Significant Infrastructure Projects

4.1.1 The legal requirement to achieve net zero underpins the urgent need for the delivery of large capacities of consentable and affordable electricity generation schemes which make best use of GB's natural low-carbon energy resources and available grid infrastructure.

4.1.2 The NPSs were established against obligations made as part of the Climate Change Act 2008 (CCA2008) and were first designated in June 2011. Following a period of revision and consultation, a revised suite of NPSs were designated by the previous government on 17th January 2024.

4.1.3 The overarching National Policy Statement for Energy (NPS) EN-1 [2] sets out national policy for energy infrastructure in England and Wales. It has effect, in combination with NPS EN-3 (for renewable energy infrastructure) [3] and NPS EN-5 (for electricity networks) [26], on recommendations made by the appointed Examining Authority (ExA) to the relevant Secretary of State (at the time of submission, the Secretary of State for Energy Security and Net Zero) on applications for energy developments that fall within the scope of the NPSs [2](Paras 1.1.1 & 1.1.2).

4.1.4 NPS EN-1 states that the Secretary of State should assess all applications for development consent for the types of infrastructure included by the NPS (including solar) on the basis that there is demonstrated urgent need for them, that substantial weight should be given to this need, and that the Secretary of State is not required to consider the specific contribution of any individual project to be satisfied that need is established [2](Paras 3.2.6 – 3.2.8]).

4.1.5 The NPSs include the then government's conclusion that there is a critical national priority (CNP) for the provision of nationally significant low-carbon infrastructure, which includes large-scale solar farms, because a combination of many or all types of such infrastructure is urgently required for both energy security and Net Zero.

4.1.6 NPS EN-1, when combined with the relevant technology-specific energy NPS, provides the primary basis for decisions by the SoS for developments that fall within the scope of the NPSs. NPS EN-1 is clear that the overarching need case and the substantial weight to be given to the need, is the starting point for all assessments of applications for energy infrastructure types which are covered by the NPSs [2](Para 4.2.6).

4.1.7 NPS EN-3 covers those technologies which, at the time of publication, were technically viable at generation capacities of over 50MW onshore and 100MW offshore. Critically, this includes solar generation, and as such the need for this technology is fully covered and established by the NPSs.

4.1.8 By virtue of intended generating capacity of the Proposed Development, the NPSs ’have effect’ in relation to the Proposed Development and are the primary basis on which decisions must be taken.

4.1.9 This Statement of Need for the development of large-scale solar generation reflects the national policy position, that there is a demonstrated urgent need and critical national priority for nationally significant low-carbon infrastructure, including solar generation, and that solar is a key part of the national strategy for low-cost decarbonisation of the energy sector. It builds upon the policy position established in the NPSs to further demonstrate why the Proposed Development is urgently needed at the scale proposed, why the proposed location is highly suitable for such a scheme, and how the Proposed Development also addresses all relevant aspects of established and emerging government energy and climate change policy and commitments.

4.1.10 Section 104 of the Planning Act 2008 (PA2008) makes clear that where an NPS exists relating to the type of development applied for, the Secretary of State must have regard to it as a relevant NPS, and must decide the application in accordance with that NPS. The NPSs provide specific policy in relation to solar development, and the policies set out in NPS EN-1, EN-3, and EN-5 therefore apply as ‘relevant’ NPSs under section 104.

4.1.11 The urgent national need for energy generating stations set out in the NPSs is of great significance to the determination of the Proposed Development. The NPSs establish that:

“Subject to any legal requirements, the urgent need for CNP Infrastructure to achieving our energy objectives, together with the national security, economic, commercial, and net zero benefits, will in general outweigh any other residual impacts not capable of being addressed by application of the mitigation hierarchy” [2](Para 3.3.63).

4.1.12 There is a presumption under the NPSs that the urgent need for CNP infrastructure will outweigh any residual effects in all but the most exceptional cases. This presumption does not apply to residual impacts which present an unacceptable risk to, or interference with, human health and public safety, defence, irreplaceable habitats, or unacceptable risk to the achievement of net zero. Where no such residual impacts exist, the presumption weighs in favour of the need for CNP infrastructure.

4.1.13 Policies within NPSs EN-1, EN-3, and EN-5 are relevant to the Proposed Development and those in accordance with which this Application must be decided are set out in **Chapter 4**.

4.1.14 The urgency of the need for nationally significant low carbon infrastructure established in the NPSs requires actions to be taken in the near-term for that need to be met and therefore the urgent need for the Proposed Development is demonstrated by the urgent need for new energy infrastructure as set out in NPS EN-1 [2](Para 3.3.63).

4.1.15 The government's action to consent six large-scale transmission connected ground mount solar schemes since they took office in July 2024 makes it clear that large-scale solar has a role to play in their view of a secure and low-carbon energy future.

4.1.16 The urgent national need for energy generating stations means that substantial weight should be attributed to the Proposed Development's ability to contribute to meeting that need, in line with NPS EN-1 [2](Para 3.2.7).

4.2 A synthesis of National Policy Statement EN-1 (2023)

4.2.1 The fundamental need for the large-scale infrastructure, which NPS EN-1 considers, recognises the UK's legal commitment to decarbonise to net zero by 2050 and so contribute to holding the increase in global average temperature due to climate change, to well below 2 degrees above pre-industrial levels. The NPS states that:

"Using electrification to reduce emissions in large parts of transport, heating and industry could lead to more than half of final energy demand being met by electricity in 2050, up from 17 per cent in 2019, representing a doubling in demand for electricity. Low carbon hydrogen is also likely to play an increasingly significant role" [2](Para 2.3.7).

4.2.2 The national policy direction established by the previous government is to develop an integrated energy system which relies on low-carbon electricity generation for a significant proportion of its supply. The government's election manifesto supports the continuation of this policy direction albeit with greater speed. As a consequence:

"Demand for electricity is likely to increase significantly over the coming years and could more than double by 2050 as large parts of transport, heating and industry decarbonise by switching from fossil fuels to low carbon electricity. The Impact Assessment for CB6 shows an illustrative range of 465-515TWh in 2035 and 610-800TWh in 2050" [2](Para 3.3.3).

4.2.3 The stated policy objectives for the energy system are "to ensure our supply of energy always remains secure, reliable, affordable, and consistent with meeting our target to cut GHG emissions to net zero by 2050" [2](Para 2.3.3).

4.2.4 Meeting this objective will require a step change in the decarbonisation of our energy system, in particular to deliver a dramatic increase in the volume of energy supplied from low carbon sources [2](Para 2.3.5).

4.2.5 The security, reliability, and affordability of energy supplies is also of critical importance because of the role energy plays in delivering economic prosperity and social well-being [2](Para 2.5.1).

4.2.6 Accelerating deployment of renewables, nuclear, hydrogen, CCUS, and network infrastructure will help address the UK's current vulnerability to international energy prices through the supply of clean, secure, and affordable UK-sourced power on a route to achieving net zero [2](Para 2.5.6).

4.2.7 There is a need for significant amounts of new large-scale infrastructure to meet national energy objectives and the NPS establishes that the need for such infrastructure is urgent [2](Para 3.1.1).

4.2.8 There must always be sufficient electricity to meet demand, with margin to accommodate unexpectedly high demand, unexpected plant closures, or extreme weather events and NPS EN-1 explains that the larger the margin, the more resilient the system will be with dealing with those types of events [2](Para 3.3.1 & 3.3.2).

4.2.9 No single type of electricity infrastructure will be able to meet any UK government's objectives in isolation, so new generators of varied technology, assets that provide flexibility, and new networks will all be needed [2](Para 3.3.4). However, the previous government concluded from its analysis that "a secure, reliable, affordable, net zero consistent system in 2050 is likely to be composed predominantly of wind and solar" [2](Para 3.3.20). The government's election manifesto also calls for significant increases in deployed capacities of wind and solar [16](p51).

4.2.10 The NPS states that decentralised and community energy systems, which by definition would include rooftop solar installations, could lead to some reduction in demand on the main transmission system, but "the government does not believe they will replace the need for new large-scale electricity infrastructure to meet our energy objectives." NPS EN-1 goes on to explain that the connection of large-scale generation facilities via high voltage transmission systems enables the pooling of generation and demand and enables the efficient bulk transfer of power between areas with surplus and areas in deficit [2](Para 3.3.12).

4.2.11 The government's election manifesto sets out that Great British Energy "will deploy local energy production to benefit communities across the country" and that "Local power generation is an essential part of the energy mix and reduces pressures on the transmission grid" [16](pp53-54).

4.2.12 The government's election manifesto also sets out their ambition to "upgrade our national transmission infrastructure and rewire Britain" [16](p55). Alongside this pledge, the consent of four large-scale ground mount solar schemes in the first months of their term in office, has confirmed that new large-scale solar assets are also a part of their plan to deliver 'Clean Power by 2030'.

4.2.13 NPS EN-1 also states that "it is prudent to plan on a conservative basis to ensure that there is sufficient supply of electricity to meet demand across a wide range of future scenarios" [2](Para 3.3.10).

4.2.14 To achieve a decarbonised power sector by 2035 [27], the NPSs conclude that it is necessary to bring forward new renewable electricity generating projects as soon as possible. The need for new renewable electricity generation projects is therefore urgent.

4.2.15 To achieve the government's ambition of delivering 'Clean Power by 2030', the need for new renewable generation projects becomes more urgent still.

4.2.16 The NPS establishes that substantial weight should be given to this need when considering applications for development consent under the PA2008, and the Secretary of State is not required to consider separately the specific contribution of any individual project to satisfying the need established in the NPS [2](Paras 3.2.7 & 3.2.8).

4.2.17 NPS EN-1 explains that large capacities of low-carbon generation will be required to:

> Ensure that there is sufficient electricity to meet increased demand

> Replace output from retiring plants

> Ensure there is sufficient margin in our supply to accommodate unexpectedly high demand

> Mitigate risks such as unexpected plant closures and extreme weather events [2](Section 3.3)

4.2.18 The NPSs conclude that national energy security and net zero ambitions will only be delivered through the development of new low carbon sources of energy at speed and scale [2](Para 4.2.2) and therefore that there is a critical national priority (CNP) for the provision of nationally significant low carbon infrastructure [2](Para 4.2.4). Low carbon electricity generation infrastructure is described as "all onshore and offshore generation that does not involve fossil fuel combustion" [2](Para 4.2.5) and as such large-scale solar generation is classified as CNP infrastructure under NPS EN-1.

4.2.19 The NPS sets the expectation that "For projects which qualify as CNP Infrastructure, it is likely that the need case will outweigh the residual effects in all but the most exceptional cases" [2](Para 4.1.7).

4.2.20 The Proposed Development meets the definition of CNP Infrastructure because it is for the development of greater than 50MW capacity of a low carbon source of energy. As CNP infrastructure, the urgent need for the Proposed Development to achieving the UK's energy objectives, together with the national security, economic, commercial, and net zero benefits, will in general outweigh any other residual impacts not capable of being addressed by application of the mitigation hierarchy [2](Para 3.3.63).

4.2.21 In noting the crucial national benefits of increased system robustness through new electricity network infrastructure projects, NPS EN-1 also recognises the particular strategic importance in the next decade of the role of solar generation in the UK's generation mix.

"As part of delivering [a secure, reliable, affordable, net zero consistent system in 2050], government announced in the British Energy Security Strategy an ambition to deliver up to 50GW of offshore wind by 2030 … and the requirement in the Energy White Paper for sustained growth in the capacity of onshore wind and solar in the next decade" [2](Para 3.3.21).

4.2.22 The siting of new solar capacity is therefore important and the location of points of connection to existing networks to enable that capacity to come forwards, are an important consideration.

4.2.23 In relation to integration technologies, NPS EN-1 states that:

"New generating plants can deliver a low carbon and reliable system, but we need the increased flexibility provided by new storage and interconnectors (as well as demand side response) … to reduce costs in support of an affordable supply. Storage and interconnection can provide flexibility, meaning that less of the output of plant is wasted as it can either be stored or exported when there is excess production." [2](Paras 3.3.5 & 3.3.6).

4.2.24 NPS EN-1 goes on to explain that storage is needed to reduce the costs of the electricity system and increase reliability by storing surplus electricity in times of over-supply, to provide electricity when demand is higher. **Section 6.11** of this Statement explains that storage can achieve the benefits set out in the NPS from stand-alone facilities or facilities co-located with renewable generation facilities.

4.2.25 The local and national benefits which storage assets can provide are also referenced in NPS EN-1 [2](Para 3.3.6), being:

> Maximising the usable output from intermittent low carbon generation

- Reducing the total amount of generating capacity required to meet peak demand
- Reducing the need for new network infrastructure
- Providing a range of balancing services to help operate the electricity system
- Reducing constraints on the electricity network

4.2.26 The role of 'low-carbon hydrogen' is also signalled as likely growing in significance in the UK's future energy system, and therefore supports the need for infrastructure which can generate low-carbon electricity to produce low-carbon hydrogen [2](Paras 2.3.5 - 2.3.7).

4.3 A synthesis of National Policy Statement EN-3 (2023)

4.3.1 NPS EN-3 [3] covers nationally significant renewable energy infrastructure which includes solar photovoltaic (PV) at more than 50MW in England and more than 350MW in Wales [3](Para 1.6.1).

4.3.2 NPS EN-3 bolsters the support for solar development in the UK that was previously provided in the draft 2021 versions, now stating that it has "committed to sustained growth in solar capacity to ensure that we are on a pathway that allows us to meet net zero emissions. As such solar is a key part of the government's strategy for low-cost decarbonisation of the energy sector" [3](Para 2.10.9).

4.3.3 The statement goes on to re-iterate the contribution that solar generation is expected to make to achieving net zero targets and the energy security goals set out in the British Energy Security Strategy, of "a five-fold increase in combined ground and rooftop solar deployment by 2035 (up to 70GW)" [3](Para 2.10.10).

4.3.4 In its election manifesto, the government set an ambition to triple solar capacity by 2030, implying the need for a higher rate of deployment than required to meet the previous government's goals.

4.3.5 Because "Solar farms are one of the most established renewable electricity technologies in the UK and the cheapest form of electricity generation." [3](Para 2.10.13), solar is also expected to bring forwards affordability benefits for consumers.

"Solar farms can be built quickly and, coupled with consistent reductions in the cost of materials and improvements in the efficiency of panels, large-scale solar is now viable in some cases to deploy subsidy-free." [3](Para 2.10.14).

4.3.6 NPS EN-3, states that:

"Government is supportive of solar that is co-located with other functions (for example, agriculture, onshore wind generation, or storage) to maximise the efficiency of land use". [3](Para 2.10.10).

4.3.7 NPS EN-3 also establishes that energy storage, if proposed as part of a solar farm proposal, may be treated as associated development to that proposal [3](Para 2.10.16).

4.3.8 Grid connection, and in particular the likely proximity of schemes to suitable connection points on the transmission network, is also addressed:

"The connection voltage, availability of network capacity, and the distance from the solar farm to the existing network can have a significant effect on the commercial feasibility of a development proposal.

To maximise existing grid infrastructure, minimise disruption to existing local community infrastructure or biodiversity and reduce overall costs applicants may choose a site based on nearby available grid export capacity." [3](Paras 2.10.24 & 25).

4.3.9 NPS EN-3 also lists irradiance and site topography as key inputs to site selection [3](Paras 2.10.19 & 20).

4.3.10 NPS EN-3 suggests anticipated levels of land efficiency for solar generation, recognising both the land take which schemes such as this one requires, but also that evolution in the technology is anticipated and this may bring about efficiency benefits through the life of the Proposed Development:

"Along with associated infrastructure, a solar farm requires between 2 to 4 acres for each MW of output. A typical 50MW solar farm will consist of around 100,000 to 150,000 panels and cover between 125 to 200 acres. However, this will vary significantly depending on the site, with some being larger and some being smaller. This is also expected to change over time as the technology continues to evolve to become more efficient." [3](Para 2.10.17).

4.3.11 The degradation of solar efficiency over time is addressed in NPS EN-3 [3](Para 2.10.55), suggesting that developers may need to account for the light-induced degradation effects on solar panels by overplanting solar panel arrays.

4.3.12 The design life of solar panels should also be considered "when determining the period for which consent is required. An upper limit of 40 years is typical, although applicants may seek consent without a time-period or for differing time-periods of operation." [3](Para 2.10.65).

4.4 A synthesis of National Policy Statement EN-5 (2023)

4.4.1 NPS EN-5 covers new, non-exempt above ground electricity lines over 2km in length whose nominal voltage is expected to be 132kV or above and other kind of electricity infrastructure in England which is constituted as associated development for which consent is sought along with an NSIP [26](Para 1.6.2).

4.4.2 NPS EN-5 explains that "significant amounts of new electricity networks infrastructure is required" [26](Para 2.2.3), something with which the government agrees [16](p55).

4.4.3 NPS EN-5 acknowledges that the siting of new electricity transmission infrastructure is determined by "the location of new generating stations or other infrastructure requiring connection to the network, and/or system capacity and resilience requirements determined by the Electricity System Operator" [26](Para 2.2.2).

4.4.4 If the UK's Centralised Strategic Network Planning process (currently under development by NESO with an aim to consult on a draft methodology in Q2 2025) identifies strategic investments intended to facilitate achieving net zero and decarbonisation targets, "the Secretary of State should have regard to the need case for new electricity networks infrastructure set out in section 3.3 of NPS EN-1" [26](Paras 2.8.2 & 2.8.3).

4.4.5 The Proposed Development is to connect to the NETS at High Marnham. High Marnham is connected to an existing part of the NETS with sufficient capacity to transmit the energy the Proposed Development will generate to consumers in the Midlands and beyond.

4.5 Conclusions on national policy

4.5.1 As set out in **Paragraph 4.1.10**, section 104 of the PA2008 makes clear that where an NPS (e.g. NPSs EN-1, EN-3 and EN-5) exists relating to the type of development applied for (e.g. the Scheme), the Secretary of State must have regard to it as a relevant NPS, and must decide the application in accordance with that NPS.

4.5.2 Solar generation is expected to make an important contribution to the UK's renewable energy generating capacity towards 2050.

4.5.3 The NPSs demonstrate that:

> The need for solar technology (as a renewable source) in GB is urgent and significant and has increased, with nationally significant solar technology now defined as CNP infrastructure

> Large-scale solar is technically and economically feasible
> Large-scale solar can and will bring benefits for the UK
> Flexibility is also needed

4.5.4 Integration technologies, which provide flexibility, will play an essential role in achieving the full decarbonisation of the whole GB energy system, enhancing the benefits brought by low-carbon generation. NPS EN-1 supports the need for integration technologies, and BESS is a suitable and beneficial integration technology.

4.5.5 NPS EN-3 provides policy support for schemes, such as this Proposed Development, which include co-located solar and storage technologies because both technologies are needed and co-location maximises the efficiency of land use. Co-location also maximises utilisation of the grid connection.

4.5.6 These factors manifest in the material contribution brought by solar and storage schemes to the UK's legal decarbonisation targets, the enhancement of security of supply, and the affordability of electricity for GB consumers.

4.5.7 NPS EN-3 provides that grid connection, irradiance and site topography are key inputs to the selection of sites suitable for large-scale solar generation developments.

4.5.8 Therefore, the number of locations at which large-scale solar generation is suitable is likely to be limited, and the number of locations at which co-located large-scale solar plus storage generation is suitable is likely to be limited even further.

4.5.9 This is a material issue when considering how the UK is to meet the urgent need for low-carbon generation as is established in the current NPSs.

5. Electricity demand must grow to deliver net zero

5.1 Chapter summary

5.1.1 This chapter provides information to support and quantify the policy position that future electricity demand will need to grow to a very significant degree in order to achieve net zero. As set out in NPS EN-1:

"[Government] analysis suggests that even with major improvements in overall energy efficiency, and increased flexibility in the energy system, demand for electricity is likely to increase significantly over the coming years and could more than double by 2050 as large parts of transport, heating and industry decarbonise by switching from fossil fuels to low carbon electricity" [2](Para 3.3.3).

5.1.2 Energy final consumption in the UK in 2023 was 1,506TWh, with 18% (269TWh) in the form of electricity [28](Table 1.1au). Electricity demand is expected to grow significantly in the future as carbon-intensive sources of energy are displaced by electrification of other industry sectors, or production of non-carbon energy vectors, such as hydrogen, by use of electricity. Energy efficiency measures may mean that total UK energy consumption decreases in the future, but an increasing share of that consumption will come from electricity generated by low-carbon sources.

5.1.3 The annual National Grid ESO (NGESO) Future Energy Scenarios (FES) documents provide important and relevant information on these points. The FES are discussed in more detail in the following sections. On 1st October 2024, NGESO became the NESO. This Statement references reports and data published before the organisation's name change and therefore refers to the organisation as either NGESO or NESO, depending on context.

5.2 Introducing the FES

5.2.1 NGESO's FES [29] are annual publications which explore strategic, credible choices to propel GB on the route to decarbonisation.

5.2.2 The FES are an important point of view, which contributes to an objective assessment of the need for, and scale of, how much energy GB might need and where it could come from, to build a picture of the ways in which net zero could be reached.

5.2.3 The 2024 FES includes pathways which outline a narrower range of outcomes than the scenarios included in previous FES publications, to help "drive forward Great Britain's strategic investment needs and to support the rapid and fundamental change that is required," [29](2024, p6).

5.2.4 Three of the 2024 FES pathways meet net zero in 2050. A counterfactual that does not meet net zero is presented alongside the pathways.

5.2.5 NGESO recommend that direct comparisons should not be made between previous year's scenarios and the 2024 pathways due to the change in framework. In particular:

> NGESO have included economic modelling where previously their scenarios were cost agnostic. The FES therefore now assesses all three national policy aims of decarbonisation, security of supply and affordability

> Efficiency of location and network infrastructure is also considered through the impact of network constraints in the analysis

5.2.6 The net zero commitment underpins the urgency for new low carbon generation infrastructure to be built and commissioned, and government support for such developments is critical.

5.2.7 The key observation is that in all lower-carbon futures, the electricity sector will not operate in isolation from other energy sectors. Rapid decarbonisation is required across all areas of demand – including residential, transport, industrial, and commercial. Deep electrification of all those areas is required in order to meet net zero, and until widespread electrification is achieved, the need for urgent electrification will increase year-on-year.

5.2.8 The 2023 FES includes an Energy Background Document in which it is stated that:

"A range of technologies with different characteristics can, in combination, help deliver secure, affordable low carbon electricity supplies and harness the potential of domestic renewable resources. More electricity from wind and solar is vital to help UK meet its target for net zero by 2050" [29](2024, Energy Background Document, p15).

5.2.9 The Energy Background Document also provides an example of how strategic coordination and whole system thinking can deliver a secure and affordable energy system built largely on renewables and hydrogen, although in reality, the need for low carbon electricity generation capacity is, based on currently known and deliverable technologies, independent of the scale of adoption of hydrogen in the UK.

"Producing hydrogen via electrolysis can create additional demand when needed to avoid curtailing wind and solar generation and this hydrogen can then be used to generate power at times of peak demand or low renewable output" [29](2024, Energy Background Document, p18).

5.2.10 Consumer engagement in demand side flexibility and demand reduction measures across the pathways is a key component of what makes the pathways differ from each other. All net zero pathways follow government's ZEV mandate for car sales while different take-up rates for hydrogen use in home heating drives differences between the scenarios.

5.2.11 From their look-back at previous years, NGESO has found that "a high usage of renewables is enabling the carbon intensity of electricity generation to continue to fall," [29](2024, p15). NGESO also conclude from their analysis that "Solar power generation remains one of the lowest cost options to meet our energy needs and, if efficiently integrated, can minimise the total system cost." [29](2024, p115).

5.2.12 **Section 10** of this Statement provides additional evidence that, based on current economics, solar generation is likely to be one of the cheapest sources of electricity in both the 2020s and 2050 energy mix. A diverse mix of low-carbon generation will be required to meet national decarbonisation targets.

5.2.13 The pathways analysis was completed prior to 2024's general election, but the government's ambitions to deliver 'Clean Power by 2030' are at least as ambitious as the previous government's ambitions over the next important years. The 2024 FES therefore remains relevant and useful to support the need for the Proposed Development. Indeed, both NESO and the government have based the capacity ranges for 2035 on FES projections in their 2024 Clean Power 2030 [18], and Clean Power 2030 Action Plan publications [1](Connections Reform Annex, p5).

5.3 Trends in UK electricity demand

5.3.1 In the 1990s and early 2000s, GB electricity demand grew only slowly, but from 2005 electricity demand has fallen year-on-year due to:

> A decline in economic growth rate (particularly with the recession of 2009)

> A reduction in the level of electricity intensity as the economy has shifted to less energy-intensive activities

> The introduction of energy efficiency measures including more efficient lighting and technology development more generally [30](p28), [31](p48)

> The COVID-19 pandemic (2020-2021) and cost of living crisis (2022-2023)

5.3.2 Today's view of future GB electricity demand is, however, one of returning growth, through:

- The switching of sources of final-use power for heating and transport from carbon-intensive sources to electricity, the generation of which can be decarbonised using technologies already available today, will put upward pressure on demand
- The least-cost energy efficiency measures, such as introduction of low-voltage LEDs for lighting, have now been implemented across business and domestic sectors
- Economic restructuring in GB away from manufacturing to a service-based economy has largely occurred, however the growth of new high-technology and highly skilled manufacturing, both contributing to national economic growth and prosperity, is likely to place additional pressures on the electricity sector

5.3.3 The FES shows that achieving net zero requires electricity demand to grow. Consequentially, low-carbon electricity supply will need to increase further to meet that demand, including the potential for increased anticipated demand for green hydrogen, which could be produced using renewable electricity to electrolyse water with zero carbon emissions.

5.3.4 The majority of industry projections of GB electricity demand to 2050 are for a significant increase from today's level of circa 300TWh. The amount by which forecasts increase varies according to the level of decarbonisation of non-energy sector demand, and the source of that decarbonisation. For example, hydrogen is an important energy vector which may be able to help decarbonise hard to reach sectors of transport, space heating and heavy industry. Off-grid hydrogen production would require the generation of low-carbon power, but this would be counted outside of the transmission system demand projections for 2050 (i.e. in addition to the views included in the following list):

- The NPSs foresaw a doubling of current demand [2](Para 2.3.7), i.e. to circa 600TWh
- NGESO present a range from 533TWh for their counterfactual pathway to between 667 and 700TWh for the three net zero pathways [29](2024, p26)
- The National Infrastructure Commission forecasts 465 – 595TWh [32](p35)
- The Energy Systems Catapult forecasts 525 – 700TWh [15](pp23 & 27)]
- The CCC's sixth carbon budget presents a range from 550 – 680TWh [34](Table 3.4.a)
- The government's impact assessment for Carbon Budget 6 (CB6) presents a range from 610 – 800TWh [2](Para 3.3.3), [33](p29)
- The 2020 Energy White Paper presents a range from 575 – 665TWh [19](p42)

> Mission Zero suggests that “electricity demand by 2050 could be roughly double today’s level of total electricity demand” [22](Paras 287 & 299)

> The Connections Action Plan projects electricity demand of between 570-770 TWh by 2050 depending on how net zero is met [17](pp68 – 70)

5.3.5 The increasing level of future demand is relevant to the need for low carbon generation capacity because sufficient capacity must be developed to meet that demand. Further, as indicated in Mission Zero and borne out historically by industry data, in the future, demand on winter days “could be double that of milder days” [22](Para 299). Therefore, timing demand to periods of high supply, or with supply, will be important, as will building sufficient generation capacity to meet demand under a variety of weather conditions. NPS EN-1 states that “it is prudent to plan on a conservative basis to ensure that there is sufficient supply of electricity to meet demand across a wide range of future scenarios” [2](Para 3.3.10).

5.3.6 **Figure 5-1** shows how NGESO’s forecasts for electricity demand in Great Britain developed from 2019 (prior to the UK’s 2019 commitment to net zero), through 2023 to 2024. Each annual forecast is represented as a shaded area ranging from the lowest forecast demand scenario to the highest scenario per delivery year, for those scenarios which met the 2050 climate targets of the time.

5.3.7 Without the drive to electrify traditionally non-electric sectors such as heat and transport, GB electricity demand reduced year-on-year.

5.3.8 Current forecasts for future GB electricity demand have increased significantly. Increased electrification of transport, heat, and industrial demand is essential for the achievement of net zero and is a key driver for the increase in future electricity demand.

5.3.9 The range of demand provided by recent sources shows a shallow increase in forecast GB electricity demand over the coming five years as the aforementioned policies start to take hold. The forecasts then ramp up significantly around the end of the 2020s and thereafter. For the avoidance of doubt, the UK electricity demand forecasts shown include the use of electricity in the production of hydrogen.

5.3.10 2024 FES system demand forecasts include electric vehicle (EV) electricity demand which follows the ZEV mandate, removing some uncertainty from previous forecasts, but the use of hydrogen across multiple sectors is included only in later years because progress in developing hydrogen production in the UK has been slower than planned.

5.3.11 Since the UK made its 2019 commitment to net zero, forecast GB electricity demand in 2050 has converged towards a range from 650 – 700TWh. Achieving net zero in the UK will require a significant increase in electricity demand in all scenarios.

5.3.12 It is implicit that the trajectories shown in **Figure 5-1** can only be met (and therefore net zero achieved) if there is sufficient operational low-carbon electricity generation capacity to generate the low-carbon energy demanded by consumers.

5.3.13 In 2023, 285TWh of consumer demand was met by 166TWh of low-carbon generation and 119TWh of carbon intensive generation. Consumer demand across the three net zero FES pathways in 2030 averages 330TWh. Therefore low-carbon generation will need to increase by approximately 164TWh between 2024 and 2029 to deliver 'Clean Power by 2030'.

5.3.14 Consumer demand across the three net zero FES pathways in 2040 averages 530TWh. Therefore low-carbon generation will need to increase by approximately a further 200TWh between 2030 and 2039 to keep power clean through the 2030s.

5.3.15 The capacity of new low-carbon schemes which will need to come on-line prior to 2030 to achieve 'Clean Power by 2030' is unprecedented. However, an even greater capacity of new low-carbon schemes will need to come on-line in the 2030s to keep power clean through to 2040 as other sectors also decarbonise.

5.3.16 This provides evidence for the need for new low-carbon generation facilities to continue to come on-line into the 2030s, to meet that anticipated growth in demand.

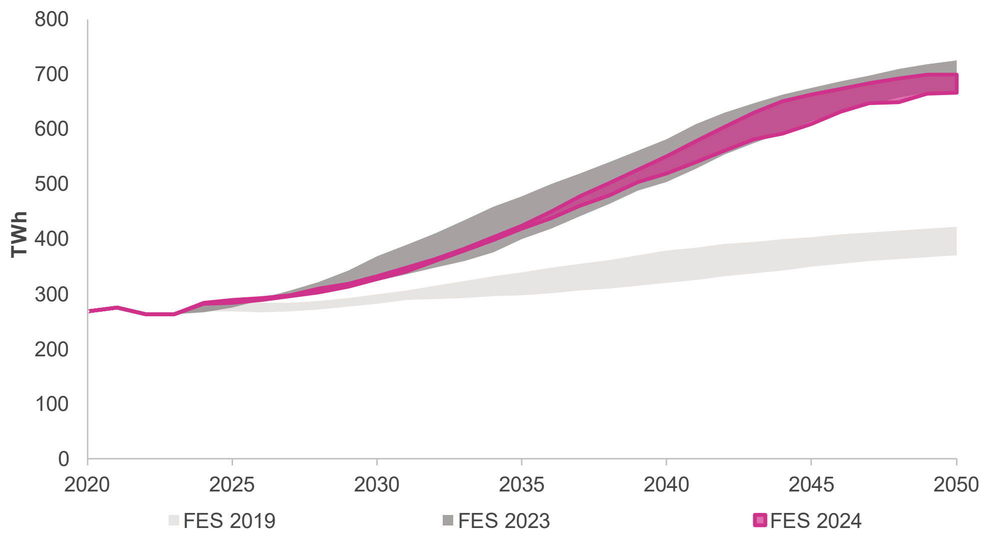


Figure 5-1: Evolution of UK electricity demand projections (2019, 2023 & 2024) [29], [Author Analysis]

5.4 Transport policies underpin a growth in future electricity demand

5.4.1 Surface transport is currently the largest source of UK GHG emissions. Surface transport accounted for just under one quarter of the UK's 2022 emissions, [11](2024, Figure 1.3, Charts and Data). Continuing the shift to low emission vehicles will give a significant boost to UK decarbonisation.

5.4.2 Growth in the use of EVs is expected to create significant new demands on the electricity network. Having proposed a ban on the sale of all new petrol and diesel vehicles to be effective from 2030 [35] alongside a ban on sales of new hybrid vehicles by 2035, the previous government, in September 2023, announced that the UK's ban on the sale of new petrol and diesel cars would be pushed back to 2035, allowing petrol and diesel cars to be purchased new up to that date, and permitting second hand trades thereafter.

5.4.3 The Zero Emission Vehicle (ZEV) mandate was introduced by the previous government on 1st January 2024. It demands that at least 22% of all cars and 10% of all vans sold in Britain in 2024 are pure electric, rising to 80% of cars and 70% of vans by 2030, and 100% of each by 2035.

5.4.4 The government's election manifesto includes their intent to restore the phase-out date of 2030 for new cars with internal combustion engines, bringing forward the additional future electricity demand versus the ZEV mandate trajectory [16](p31).

5.4.5 Although this policy reversion has not been formally announced, the government has signalled that the majority of new cars sold in the UK will have to be fully electric by 2030 [16](p31).

5.4.6 The Society of Motor Manufacturers and Traders (SMMT) reported a 17.8% increase in Battery Electric Vehicle (BEV) sales in the UK in 2023 versus 2022, and 16.5% of all new vehicle purchases in the UK in 2023 were BEV [36]. In 2024, BEV sales were up a further 21.4% year-on-year, to 19.6% of all new vehicle purchases in the UK.

5.4.7 Reducing costs and improvements in the range of EVs, inter-brand competition encouraged by the ZEV mandate and improving charging infrastructure are expected to encourage consumers to choose EVs over petrol and diesel cars.

5.4.8 The eventual and necessary transition of all cars from fossil fuels to support net zero will continue due to their lower run costs, improving performance, increasing model choices, and zero emission capability.

5.4.9 The net zero FES pathways include an increase in annual electricity demand in the UK of ~27TWh in 2030 and 101 – 127TWh by 2050. [29](2024, Chart EC.07).

A growing use of hydrogen in the surface transport sector could further increase electricity demand through the need to produce hydrogen via electrolysis.

5.4.10 The Electric Vehicle Infrastructure Strategy (March 2022) [37] facilitates the adoption of electricity into transport and sets the expectation, by 2030, of there being around 300,000 public charge points as a minimum in the UK, up from just 64,642 on 1st July 2024 [38]. The government's election manifesto describes that they will "support the transition to electric vehicles by accelerating the roll out of charge points" [16](p31).

5.4.11 The UK has put leadership of a low-carbon transport revolution at the heart of its Industrial and Clean Growth strategies and regards EVs as a critical new technology which will be vital in the fight against climate change. Commitments by both the previous and current government to invest in 'gigafactories' for the mass production of batteries and EV supply chain, [39], [40], [16](p30) provide evidence that, there is strong political support for the rapid development and rollout of EVs, with which will come significant additional electricity demand. Indeed, as the SMMT data shows, the rollout of EVs has already begun.

5.4.12 To support efforts in the decarbonisation of heavier transport (e.g. road freight, rail and air), government pledged to invest £140 million in 2021/22 across hydrogen-powered freight trials and the delivery of 4,000 zero emission buses [19](p94). The application of hydrogen as a fuel for flight and rail, and in industrial energy-intensive processes, is also progressing.

5.5 Energy policies for homes underpin a growth in future electricity demand

5.5.1 In 2023, the domestic sector accounted for approximately 36% of the UK's electricity demand and 44% of the UK's demand for natural gas [29](2024, Tables ED1 & ED3).

5.5.2 Government-backed energy efficiency schemes seek to improve the insulation of the UK's homes as well as reduce demand from lights, appliances and services.

5.5.3 Reducing UK domestic electricity demand will support the move to a zero-emissions electricity system. Flexibility in consumption, either through variable 'time of use' tariffs or demand flexibility schemes may allow consumers to support the flexibility needs of a low-carbon electricity system.

5.5.4 Improved insulation and improved boiler efficiency may help reduce domestic demand for gas and thereby reduce carbon emissions associated with the use of gas in the home. However, the domestic use of gas must be substituted out for either electricity or hydrogen for domestic carbon emissions to fall to zero or very close to zero. The CCC state that, by 2030, "approximately 10% of existing homes in the UK will need to be heated by a heat pump, compared to only approximately 1% today," for the UK to reach its 2030 climate targets [11](2024, p9).

5.5.5 The Energy White Paper sets out an aim to increase the rate of installation of home electric heat pumps from 30,000 per year to 600,000 per year by 2028. The British Energy Security Strategy aims to ensure that by 2050 all UK buildings will have low-carbon heating, and reconfirmed [21](p12) the then government's intent to phase out the sale of new and replacement gas boilers by 2035 – an intent which was replicated in Powering Up Britain and confirmed by the then government in September 2023. Beyond 2035, certain gas boiler replacements will no longer be permitted.

- A Warm Homes Plan to offer grants and low interest loans to support investment in insulation and other improvements such as solar panels, batteries and low carbon heating
- Work with the private sector to provide further private finance to accelerate home upgrades and low carbon heating
- Ensuring that homes in the private rented sector meet minimum energy efficiency standards by 2030

5.5.6 FES 2024 pathways show flat residential demand against 2023 levels, however in the 2030s residential demand is shown to increase as the domestic use of gas is systematically reduced and replaced by electricity. Net zero pathways in 2050 show increases in residential electricity demand of between 68% and 79% vs. 2023 levels, primarily due to the electrification of home heat and cooking.

5.6 Peak electricity demand is also expected to grow

5.6.1 The future daily profile of electricity demand is less easy to forecast into the future, but estimated peak demand (its highest instantaneous level) remains a key determinant of required installed generation capacity.

5.6.2 **Figure 5-2** illustrates NGESO's forecast of peak GB power demand (using NGESO's Average Cold Spell methodology) out to 2050. In the three net zero pathways, peak demand is anticipated to range between 62GW and 65GW by 2030 (2023, for comparison, was 58GW); between 89GW and 103GW in 2040, and between 104GW and 119GW in 2050 [29](2024, Figure ES.03).

5.6.3 All net zero pathways show an increase in peak demand from as early as 2025, driven by underlying industrial and commercial demand growth (through substitution of other energy sources) and the electrification of heating and transport.

5.6.4 Historically, electricity peak demand has tended to occur on winter weekday evenings, when industrial and commercial demand overlaps with residential.

However, NGESO state that “as the share of renewable electricity supply increases, electricity peaks could occur at other times” [29](2024, p101), an important point relating to security of supply, which is discussed in **Chapter 9** of this Statement.

5.6.5 EVs and hydrogen vehicles will require the deployment of additional electricity generation capacity and may also act as integration measures for renewable and baseload generation, capable of shifting load from when demand is high, to periods where supply is higher.

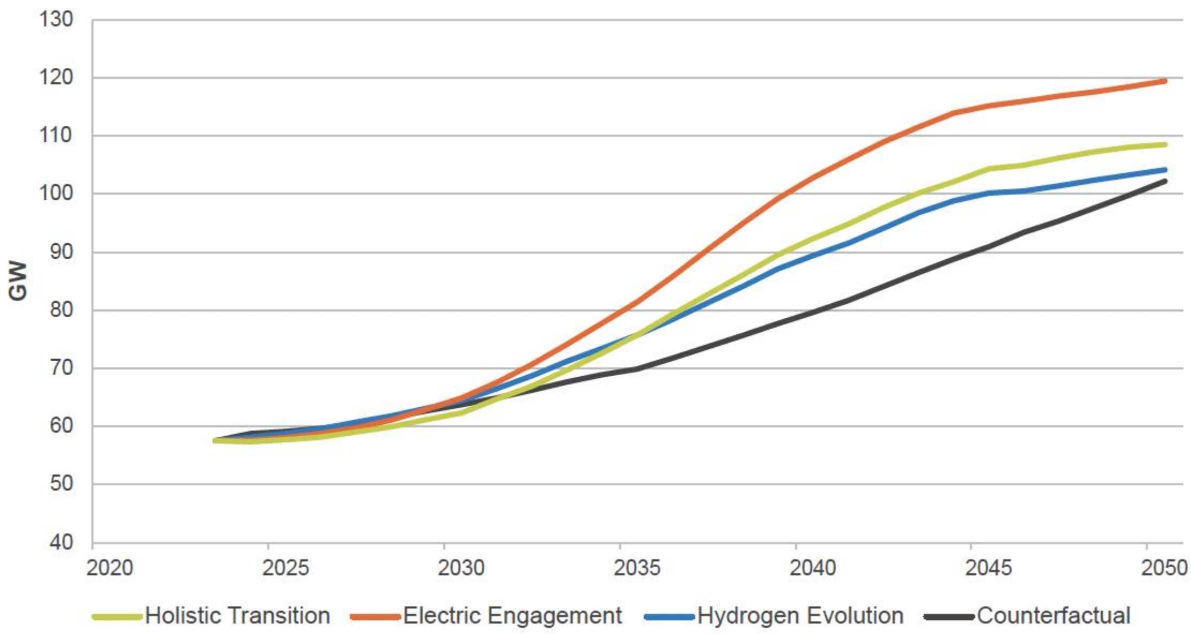


Figure 5-2: Electricity average cold spell peak demand (GW, including losses) [29](2024, Figure ES.03)

5.6.6 Sufficient electricity generation capacity will need to be deployed to be able to meet instantaneous demand, as well as forecast annual demand, under normal and unfavourable weather conditions, supporting the need for significant growth in UK low-carbon electricity generation capacity.

5.7 Conclusions on future electricity demand

5.7.1 Policies are already in place to substitute electricity for fossil fuel as a source of energy in non-traditional sectors in the UK, and many of those policies have started to deliver both on a national and local basis.

5.7.2 GB electricity demand will increase during the 2020s as a result of this substitution, supporting the urgent need for new low-carbon electricity generation facilities to come forward to meet demand.

5.7.3 Peak electricity demand is uncertain but is likely to grow. Significant capacity of new, low-carbon generation will be required to meet both peak demand and electricity needs across a wide range of weather conditions, which may increasingly occur outside of the traditional winter peak periods due to the anticipated increase in electricity consumption through electrification of non-traditional sectors and the increased share of electricity supplies from a range of renewable generation technologies.

5.7.4 The capacity of new low-carbon schemes which will need to come on-line prior to 2030 to achieve 'Clean Power by 2030' is unprecedented. However, an even greater capacity of new low-carbon schemes will need to come on-line in the 2030s to keep power clean through to 2040 as other sectors also decarbonise.

5.7.5 Rapidly increasing low-carbon supplies will reduce the cost and carbon content of produced electricity in the UK as is explained in **Section 10** of this Statement. Lower cost and lower carbon energy supplies will incentivise other sectors to move away from fossil fuels to electricity.

5.7.6 Increasing UK-located low-carbon generation capacity will also prevent an increase in UK electricity demand from increasing GB consumers' exposure to volatile energy prices and reducing GB security of supply.

5.7.7 Without a rapid increase in low-carbon supply, the decarbonisation of other sectors is less likely to occur due to potentially unfavourable commercial factors, and potentially heightened supply risk amid growing demand. This could place at risk progress which needs to be made on decarbonising other sectors to achieve national carbon reduction targets in 2030 and beyond.

5.7.8 The Proposed Development will contribute to meeting GB's growing electricity demand and will therefore be a critical enabler of achieving the UK's decarbonisation and energy security aims.

6. Delivering net zero through clean electricity supplies

6.1 Chapter summary

6.1.1 This chapter reviews selected current policy support and development / delivery in technologies which are being tasked to support the delivery of net zero.

6.2 Current and future generation mix

6.2.1 The Net Zero Strategy's key policy is for the UK to be powered entirely by clean electricity by 2035, subject to security of supply [20](p20).

6.2.2 Electrification is a key strategy to deliver decarbonisation in the UK and the previous government targeted a zero-carbon electricity system by 2035 [27]. The government has signalled an increase in that ambition by establishing a mission to deliver 'Clean Power by 2030' [16](p51). By growing the UK's low-carbon electricity generation capacity, the carbon emissions associated with the electricity we use to light our homes and power our appliances will decrease.

6.2.3 By growing the UK's low-carbon electricity generation capacity further, electricity can be used instead of carbon emitting fuels in other non-traditional sectors (e.g. petrol in transport) and further decarbonisation can be achieved. The decarbonisation of all sectors is essential for the UK to meet net zero [11](2024, p8).

6.2.4 To decarbonise the UK's electricity system, less electricity must be sourced from carbon emitting generation capacity. Low-carbon generation capacity must therefore be developed both as a substitute for carbon emitting capacity, and to increase the amount of electricity generated to meet additional, non-traditional demand.

6.2.5 It is important to clarify that this Statement of Need does not seek to justify or promote the exclusion of any other generation technologies from the future GB generation mix.

6.2.6 **Figure 6-1** shows historical electricity generation in the UK from 1996 to 2023 by fuel source, measured in terawatt hours (TWh, 1 TWh = 1,000,000 MWh), and the resulting average grid carbon intensity, measured in gCO2(e)/kWh.

6.2.7 **Figure 6-1** shows that Coal + Oil generation reduced from approximately a one-half share of UK generation in 1996 to nearly zero by 2023. The last UK coal fired power station closed in September 2024 and Coal + Oil generation will therefore be zero from 2025 onwards.

6.2.8 Low-carbon generation, including renewable wind and solar, increased from near zero in 1996 to over 40% of UK generation in 2022.

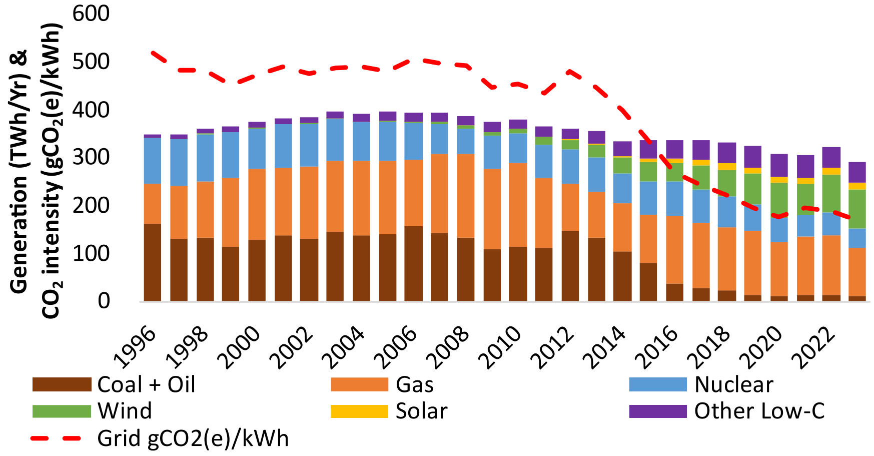


Figure 6-1: Historical Electricity generation (TWh/Yr) and carbon intensity (gCO2(e)/kWh) [28](Tables 5.6 & 5.14)

6.2.9 Nuclear has reduced from generating over one quarter of the UK's electricity needs in 1996, to just 14% in 2023. Gas has contributed approximately 40% of UK generation each year throughout much of the period shown.

6.2.10 GB Grid carbon intensity reduced from over 500 gCO2(e)/kWh in 1996 to 171 gCO2(e)/kWh in 2023, a reduction of 67%, while electricity generation reduced by just 17% over that period.

6.2.11 The carbon intensity of the GB Grid has reduced since 1996 due to a regulatory increase in the cost of emissions from high-carbon intensity generation assets, the subsequent closure of coal plants in the UK, and a significant increase in low-carbon, low-marginal cost generation (predominantly wind and solar) since 2010. **Section 10.2** of this Statement of Need explains how GB electricity market arrangements support this essential shift.

6.2.12 As well as providing views on future national electricity demand, the FES pathways provide projections for how that demand will be met. **Figure 6-2** shows projected electricity generation in the UK from 2023 to 2050 by fuel source, measured in terawatt hours under NGESO's 'Holistic Transformation' pathway, and the resulting average grid carbon intensity, measured in gCO2(e)/kWh.

6.2.13 The 'Holistic Transformation' pathway shown in **Figure 6-2** shows that wind generation will need tp increase from 96TWh in 2023 to 467TWh in 2050. Nuclear generation more than doubles from 42TWh to 97TWh over the same timeframe. Solar generation must increase approximately seven-fold, from 16TWh to 115TWh. Under a 'Hydrogen Evolution' pathway, where solar capacity deployment is the lowest of NGESO's net zero pathways, solar generation must increase approximately five-fold, to 76TWh in 2050.

6.2.14 These low-carbon generation sources, if delivered, will provide the much-needed electricity required to reduce grid carbon intensity from current levels to zero or lower in 2035, aligned with government decarbonisation targets. To achieve the government's mission to deliver 'Clean Power by 2030', the rollout of low-carbon and negative carbon emissions generation will have to be similar in pace and scale to that included in NGESO's current net zero pathways.

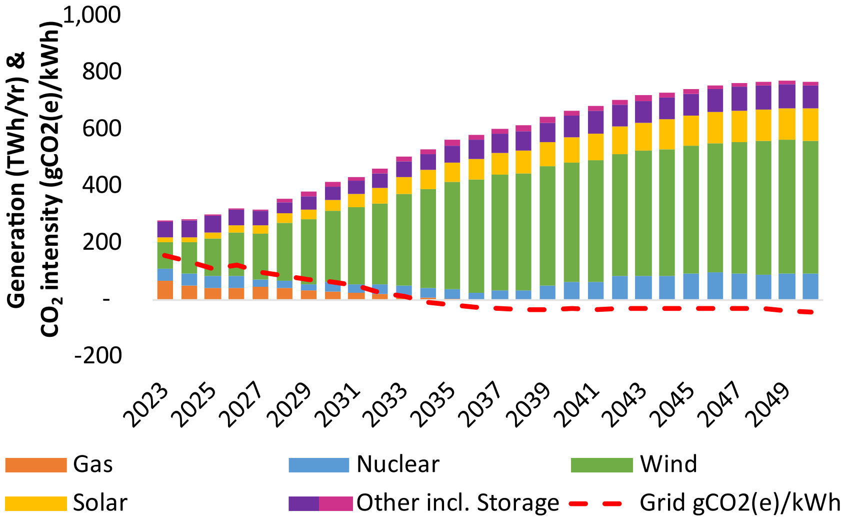


Figure 6-2: Projected electricity generation (TWh/Yr) and carbon intensity (gCO2(e)/kWh) [29](2024, Tables ES.08-11 & ES1 – 'Holistic Transformation')

6.2.15 Critically, grid carbon intensity reaches zero at the same time as unabated gas generation ceases. Carbon Capture, Usage, and Storage (CCUS) technology must be deployed at scale and integrated into the existing gas generation network, for gas technology to have a role in the future electricity system. Abated gas generation (i.e. gas plus CCUS) is included in the purple 'Other' category in **Figure 6-2**. **Figure 6-2** also shows only the generation and not the power consumption of storage assets (e.g. Pumped Storage (Hydro) or batteries).

6.2.16 The UK is also pursuing a strategy of interconnection with other markets. Interconnectors are physical cables through which energy can flow in either direction. Market forces determine which direction the energy flows, from low price to high price markets.

6.2.17 Interconnectors can support energy security but, as the British Energy Security Strategy states, "If we're going to get prices down and keep them there for the long term, we need a flow of energy that is affordable, clean and above all, secure. We need a power supply that's made in Britain, for Britain" [21](p3).

6.2.18 Government's Clean Power 2030 Action Plan is consistent with this point and states that "By accelerating the switch to domestic renewable electricity sources and accelerating the application of clean electricity to the wider energy system, we will be able to reduce our reliance on fossils fuels faster. This enhances energy security, making the UK less vulnerable to global market disruptions or geopolitical tensions that affect energy prices" [1](p21).

6.2.19 The UK has traditionally been an importer of energy from European markets, however NESO's FES pathways show that the UK will be a net exporter of energy from the 2030s. However, interconnectors may play an important role in meeting UK electricity demand at certain times of the day or year. For simplicity, interconnector flows have been excluded from **Figure 6-2**.

6.2.20 The share of UK electricity generation which is to be met by onshore and offshore wind power is projected to increase from 34% in 2023 to approximately 60% by 2050 under all net zero pathways. However, the UK's approach to electricity supply will be more resilient to and secure against variations in the weather, technical failures and market forces through being the multi-technology approach proposed by government (and the previous government) and incorporated in NGESO's FES pathways.

6.2.21 NPS EN-1 states that "We need to ensure that there is sufficient electricity to always meet demand; with a margin to accommodate unexpectedly high demand and to mitigate risks such as unexpected plant closures and extreme weather events" [2](Para 3.3.1).

6.2.22 Government's Clean Power 2030 Action Plan is consistent with this and states that "Our 2030 mission will grow the UK's overall generation capacity and expand our network infrastructure so that we can safely and securely meet changing demand patterns in 2030 and beyond …" [1](p24) by ensuring that by 2030, in a typical weather year, "Clean sources produce at least as much power as Great Britain consumes in total" (2023: 56%) [1](pp25&26).

6.2.23 The expected growth in electricity demand leads to a need for increased capacities of electricity generation. The national shift from dispatchable carbon-emitting generation to low-carbon renewable generation also implies a growth in electricity generation capacity.

6.2.24 **Section 5.3** of this Statement describes the scale of electricity demand required to be met by new generation facilities to achieve 'Clean Power by 2030' and then maintain clean power through to 2050.

6.2.25 To improve the likelihood of being able to ensure system adequacy from renewable generators in all but the most unlikely of meteorological situations, a large capacity of interconnected assets from as broad as possible a range of technologies and geography may be beneficial.

6.2.26 Figure 6-3 shows, for the same 'Holistic Transformation' pathway, the significant increase in installed capacity of each technology required to meet the output projections shown previously in **Figure 6-2**.

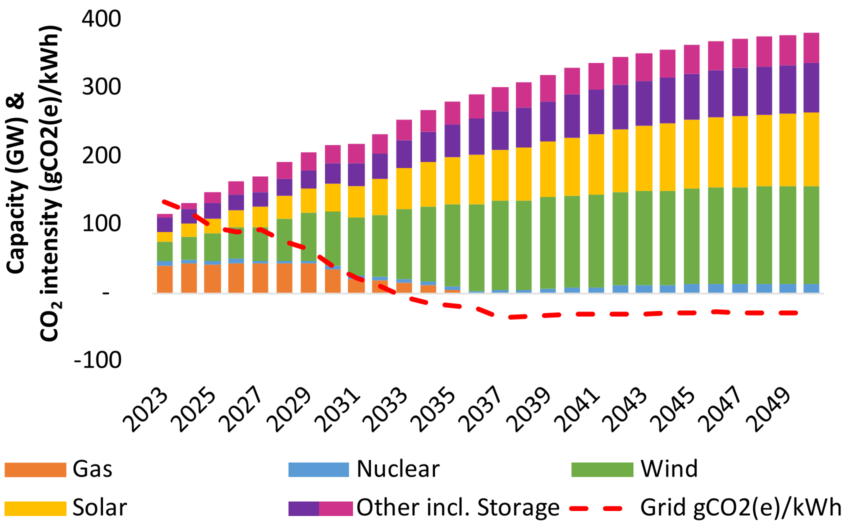


Figure 6-3: Projected electricity generation capacity (GW) and carbon intensity (gCO2(e)/kWh)
[29](2024, Tables ES.09 & ES1 – 'Holistic Transformation')

6.2.27 Figure 6-3 shows that electricity generation capacity must increase to three-fold current installed capacity in order to generate sufficient output to meet demand in 2050. This is consistent with the capacity ranges set out by government in its Clean Power 2030 Action Plan [1](Table 1).

6.2.28 To provide some points of comparison further along the UK's route to net zero, the NIC anticipate that 129 – 237GW of renewable capacity must be in operation by 2050, including 56 – 121GW of solar, 18 – 27GW of onshore wind, and 54 – 86GW of offshore wind [32](p19).

6.2.29 Energy Systems Catapult (ESC) projections are comparable capacities. 165 – 285GW of capacity will be required in 2050, including 18 – 80GW of solar [15](pp23&27). The ESC includes higher expectations of future nuclear capacity than other analyses, anticipating 20 – 38GW of nuclear versus 11 – 22GW (NGESO) and just 5GW (NIC).

6.2.30 Approximately ten percent of NGESO's 'Holistic Transition' capacity pathway in 2050, or 44GW, is expected to be short duration storage, shown in pink inFigure 6-3**.**

6.2.31 . Long Duration Storage, including Pumped Hydro and hydrogen, is included within the purple 'Other' data series. Further information on electricity storage is included in **Section 6.11** of this Statement.

6.2.32 The quantity of new generation capacity required in the UK to meet its net zero targets is enormous, and unprecedented in relation to capacity growth seen at any previous time. Yet such projections have been broadly consistent between different expert bodies and between years, since the net zero target was written into law in 2019.

6.2.33 NPS EN-1 also articulates the view that it is prudent to plan infrastructure development on a conservative basis “to ensure that there is sufficient supply of electricity to meet demand across a wide range of future scenarios” [2](Para 3.3.10). Prudence would imply not over-relying on technologies which are yet to be proven, have long development lead-times, or which have historically experienced funding difficulties. For this reason, NGESO’s pathways include major contributions from wind and solar generation rather than CCUS, hydrogen or nuclear generators. Government’s Clean Power 2030 Action Plan is consistent with this fact [1](Table 1).

6.2.34 Such an expansion of capacity, across many technologies, does not come without risk. It is very possible, if not probable, that one or more technologies will miss their targets. This would increase the need for technologies which are successfully being deployed to accelerate their deployment further, in compensation.

6.2.35 Challenges will come through international competition in supply chains, technology and labour markets, and also in grid connection. FES 2023 reiterated the obvious point that “sufficient electricity connection capacity is vital” to support capacity projections [29](2023, p132).

6.2.36 This is a key point of government’s Clean Power 2030 Action Plan in which government has stated that “we need to act – and act quickly – because 6 years is a short time in building energy infrastructure. We are not alone in wanting to rebuild our energy system and are competing with other countries for investment and to secure supply chains [and] …it can take over a decade to develop and build renewables projects” [1](p18).

6.2.37 Grid is a finite but critical enabler to decarbonisation both in terms of absolute scale and timing to connect. NPS EN-3 recognises the benefit to decarbonisation and consumers of using already available grid infrastructure:

“To maximise existing grid infrastructure, minimise disruption to existing local community infrastructure or biodiversity and reduce overall costs applicants may choose a site based on nearby available grid export capacity” [3](Para 2.10.25).

6.2.38 The CCC also continue to identify grid connection as a potential brake to beating climate change and delivering energy security. They recommend that the government ensures that “electricity networks have the capacity to meet growing need due to changes to sources of electricity and increased demand across sectors” [11](2024, p95). The implication of this recommendation is that, in their view, network capacity and connections are not currently adequate to meet UK needs.

6.2.39 Put simply, to fight climate change, we need to make the most of the infrastructure we have available, and we will need to build more. This context provides further support for the Applicant's proposal to develop a large-scale solar facility with co-located storage as associated development at an existing point of connection, which connects into existing and available section of the transmission system. **Section 8** provides more information on this point.

6.3 Development Pipelines

6.3.1 The following sections in this chapter provide additional evidence in relation to the main categories of renewable generation technologies tasked to support the delivery of a low-carbon and secure electricity system by 2035, and their contribution to decarbonisation, security of supply, and affordability.

6.3.2 New energy projects follow a uniform high-level development process.

- The first step is to secure a grid connection offer and define the project cognisant of technical, environmental, land, and planning constraints. Data on current and potential future connections for large-scale projects is available on NESO's Transmission Entry Capacity (TEC) Register [41]
- The second step is to apply for and obtain planning consent. The government's Renewable Energy Planning Database (REPD) [42] provides insight into determined and yet to be determined renewable energy projects at all scales nationally
- The third step is to secure revenues for the project. System adequacy is primarily managed through GB's Capacity Market in which eligible assets compete at annual auctions for capacity payments in return for providing an equivalent firm supply of capacity to the electricity system

6.3.3 Reforms to the grid connection process which are currently being implemented are addressing the bottleneck that Ofgem, NESO and government have identified in near-term delivery. Hitherto, the barriers to obtaining a grid connection and the obligations on developers to progress subsequent development steps were low. This has led to a plethora of projects in the connections queue. Many of these are not sufficiently advanced to deliver to the timeframes required for Clean Power 2030, yet they hold their position in the connection queue thus potentially delaying other projects which are able to support Clean Power 2030 from coming to delivery.

6.3.4 Government's Clean Power 2030 Action Plan states that at the time of publication, the connections queue consists of nearly 750GW of projects. Connections reform seeks to reshape the connections queue to ensure that those projects which are more ready to deliver are prioritised.

6.3.5 To do this, government has set 'capacity ranges' to assess the 'strategic alignment' of projects with the capability to deliver a connection in the timeframes required for Clean Power 2030. However, "whilst the 'Clean Power Capacity Range' provides a foundation to guide rapid policy development and focus delivery, the scenarios developed now cannot be exhaustive or definitive, and it is only right that some optionality is retained … until more clarity on which scenario is most likely is available" [1](p31).

6.3.6 Importantly, the capacity ranges for 2035 do not constitute a government pathway [1](Connections Reform Annex, p5) and therefore should not be interpreted as a cap or ceiling on the requirement for low carbon electricity generation capacity.

6.3.7 Net zero 2050 will require a very large capacity of low carbon generation to be delivered, which is much larger than the capacity ranges set out in the Clean Power 2030 Action Plan. The Action Plan is therefore a framework to support the rapid delivery of projects at the front end of the UK's critical journey to net zero, and the need for projects to come forwards to 'feed' the plan remains urgent and absolute.

6.3.8 Indeed, government is "expecting an increase in planning applications with the Clean Power 2030 target" [1](p55).

Mechanisms for supporting low-carbon electricity generation

6.3.9 Wind and solar technology were first included as eligible technologies in the Capacity Market in 2019, however the Capacity Market is not open to assets which already hold Contracts for Difference (CfD) contracts (and vice versa). The inclusion of renewable generation technologies in the Capacity Market underlines the contribution renewable energy can make to system adequacy and system security:

"The system is typically better off with intermittent capacity than without it – wind farms, for example, can contribute to overall security of supply" [43](p114).

6.3.10 The CfD scheme is the government's main mechanism for supporting low carbon electricity generation.

6.3.11 The CfD scheme was introduced under the Energy Act 2013 to incentivise investment in renewable energy by providing developers of projects with high upfront costs and long lifetimes with direct protection from volatile wholesale prices. CfDs also protect consumers from paying increased support costs when electricity prices are high.

6.3.12 Renewable generators located in Great Britain that meet the eligibility requirements can apply for a CfD by submitting bids into CfD Allocation Rounds, in which a range of different renewable technologies compete directly against each other for a contract.

6.3.13 The Low Carbon Contract Company's CfD Register [44] and the EMR Delivery Body's Capacity Market Registers [45] hold data on contract award.

Attrition from project development pipelines

6.3.14 Although lists and registers provide important evidence towards current and future generation capacities, the listing of a scheme on any grid connection register, a planning database or a commercial contract register, does not guarantee that the scheme will come forwards.

6.3.15 For example, in February 2023 NGESO shared their analysis that "only 30-40% of projects [schemes] in the [connections] queue make it to fruition" [46]. **Section 3.7** of this Statement describes reforms being taken under the Connections Action Plan to deter speculative connection applications and remove stalled schemes from the connections queue.

6.3.16 Of the 243GW of projects of all technologies listed on the REPD in late 2024, just 51.3GW are operational and 39.3GW will not move forwards due to having been refused planning consent, being abandoned (by the developer), or planning permission having expired.

6.3.17 Analysis of the CfD Register [44] shows that even schemes which have achieved consent, and a revenue contract are not guaranteed to deliver. 81 schemes with CfDs have registered a reduction to the capacity of the CfD Unit or have had their CfD terminated:

- Offshore wind: four schemes (1,408MW) terminated, 1,494MW reduction on 21 schemes still going forward
- Onshore wind, including Remote Island Wind: five schemes (341MW) terminated, 81MW reduction on 14 schemes still going forward
- Biomass / Waste / CHP / Advanced Conversion schemes: thirteen schemes (292MW) terminated, 25MW reduction on two schemes still going forward
- Solar PV: ten schemes (288MW) terminated, 77MW reduction across 12 schemes still going forward

6.3.18 Developers may elect to terminate CfD contracts for a variety of reasons, including change of ownership or commercial opportunities outside of the CfD framework. Reducing the capacity allocated to a CfD contract may also improve the commercial performance of a scheme under certain market conditions. However, the risk of non-delivery rises on capacity which has not yet commenced its CfD contract, and which has dropped out, of or been terminated from, its CfD contract.

6.3.19 However, NPS EN-1 states that it is the government's view that infrastructure development should be planned on a conservative basis [2](Para 3.3.10), without over-relying on technologies which are yet to be proven, have long development lead-times, or which have historically experienced funding difficulties.

6.3.20 This data and corresponding analysis suggests that it is not prudent to assume the full delivery of pipeline projects listed on various registers, because it is highly unlikely that a significant proportion of that capacity will be commissioned.

6.4 Offshore Wind

6.4.1 The UK is a world-leader in offshore wind technology and government's Clean Power 2030 Action Plan capacity ranges seek to deliver a total of 43 to 50GW of operational capacity by 2030, up from 15GW operational at the time of writing this report [29](2024, Table ES1), [1](Table 1).

6.4.2 None of NESO's 2024 FES pathways meet the government's election manifesto target of quadrupling offshore wind capacity by 2030, and only one meets the previous 50GW target, highlighting the massive scale of renewable infrastructure required to meet net zero. Of the three net zero pathways, offshore wind capacity in 2030 ranges between 43.4GW and 53.6GW, generating between 165TWh and 192TWh of low-carbon energy each year.

6.4.3 Offshore wind is expected to produce a significant proportion of the UK's future low-carbon electricity needs, however the government's proposals (and those of the previous government) take a multi-technology approach to the future electricity system, in part to provide security of supply through variable weather conditions.

6.4.4 Offshore wind is not tasked with meeting and cannot be expected to meet future UK electricity needs on its own.

6.4.5 **Figure 6-4** superimposes FES forecast ranges for offshore wind capacity from 2019, 2023 and 2024, with each range shown as a shaded area covering the pathway with the lowest forecast capacity to the highest capacity in each year. Historic installed capacity is shown by the yellow line in 2020-2023.

6.4.6 **Figure 6-4** shows that the range of future offshore wind capacity forecasts for different FES pathways increased from FES 2019 to FES 2023. The range of capacity forecasts made in 2024 is narrower than the 2023 forecasts and growth slows from the late 2030s in comparison to the 2023 forecast.

6.4.7 The UK's net zero commitment in 2019 manifested in FES pathways as a further increase in offshore wind capacity, shown by the dark grey range in **Figure 6-4.**

6.4.8 (the 2023 forecast) being higher than the light grey 2019 forecast.

6.4.9 The blue triangle shows the top end of the 2035 capacity range and the red diamond shows the government's 2030 capacity range for offshore wind capacity, both sourced from government's Clean Power 2030 Action Plan [1](Connections Reform Annex, Table 1).

6.4.10 To achieve the top end of the 2035 capacity range, installations would need to track the most aggressive FES 2024 pathway for the next ten years.

6.4.11 To achieve the 2030 capacity range, an even more aggressive deployment rate is needed over the next five years.

6.4.12 This underscores the need for offshore wind schemes to come forwards for delivery in the 2030s as well as to continue to come forwards beyond 2030 to deliver the ongoing need for the technology in the UK. However, government's Clean Power 2030 capacity ranges do not underestimate the practical constraints associated with delivering offshore wind capacity over the next 10 years.

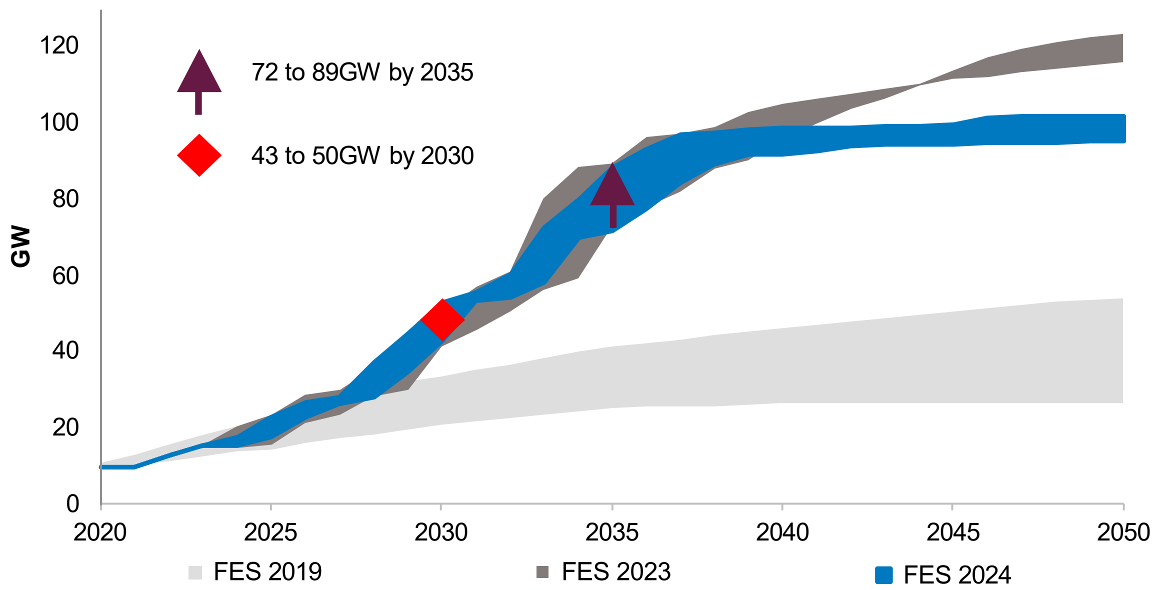


Figure 6-4: Evolution of UK projections of offshore wind capacity
(2019, 2023 & 2024)
[29], [Author Analysis]

6.4.13 At the end of January 2025, the TEC register [41] lists a total of 32.1GW of offshore wind capacity which has not yet connected but is scheduled to connect before 2030 bringing the UK's total operational offshore wind capacity to 47.5GW in 2030, if all the pipeline delivers. This is broadly in line with both the most ambitious FES pathways and is within the government's current 2030 capacity range of 43 to 50GW [1](Table 1), but does not include project attrition and therefore cannot guarantee to deliver sufficient capacity to meet the government's ambition. This will increase the need for capacity to come forwards to feed government's Clean Power 2030 Action Plan and to deliver beyond 2030 to keep the UK on track for net zero 2050.

6.4.14 Delivering the many schemes with connection agreements in the late 2020s and beyond will be dependent on a significant number of onshore and offshore transmission network reinforcement works. The Connections Action Plan makes clear the level of network development required to facilitate the connection of 43 to 50GW of offshore wind to the UK electricity network by 2030. The risks associated with the delivery of these pipelines should not be understated.

6.4.15 While it is not a given, there is potential for any network development delays to affect multiple offshore wind schemes. This is important because NESO's approach to offshore transmission development is currently favouring a network of connections with transmission assets being shared by multiple schemes. Previously offshore transmission assets have been developed for individual schemes [17](p62). The impact of a delay on the delivery of an offshore transmission development may therefore be felt across more than one scheme.

6.4.16 Schemes which are preparing for planning consent submission appear on the government's Renewable Energy Planning Database [42]. The relationship between projects listed on the TEC Register and projects listed on the REPD is not one-to-one because developers may take different approaches to planning and delivery for example in the phasing of schemes for consent and delivery.

6.4.17 Data from the REPD [42] shows that 46 offshore wind farms took on average over 6 years from submitting their planning applications, to achieving commercial operation. Achieving planning consent took approximately two years, leaving on average nearly 4.5 years to construct and commission each scheme.

6.4.18 The TEC Register lists 21 offshore wind schemes comprising 21.3GW proposing to connect in the period January 2024 – December 2028. In order to meet these dates, prior project development timelines suggest that it is likely that planning consent must have already been secured. The REPD lists 21 offshore wind schemes comprising 21.2GW in 'awaiting construction' or 'under construction' status (excluding 1.8GW listed as 'built' on the TEC register). All consented offshore wind capacity must deliver at historical development rates to keep on track with NESO's FES pathways (Figure 6-4), however not all capacity is commercially contracted

6.4.19 On receipt of planning consent, offshore wind developers are currently eligible to compete with other projects for CfDs, although government is developing proposals which would change the CfD participation rules to allow fixed bottom offshore wind facilities to participate in upcoming CfD auctions before planning consent has been secured [1](p57).

6.4.20 10.2GW of offshore wind schemes have secured but not yet commenced their CfDs. Many of these projects are still in construction, but approximately 1.9GW are already operating, suggesting that their contracts will soon commence.

6.4.21 The data therefore suggests that 21.3GW of offshore wind is not yet operational but has an agreement with NESO to connect in 2028 or earlier, and a similar capacity has secured planning consent but is not yet operational. However, only 10.2GW of that capacity has already secured a CfD. A CfD, or alternative funding mechanism, will be required for the balance of consented capacity to proceed to construction and operation.

6.4.22 However, the number of schemes which have secured funding and commenced construction still does not indicate a commitment by or obligation on the promoter to deliver that project at all or, if it does, at a particular generation capacity. Indeed, government’s Clean Power 2030 Action Plan recognises that a range of outcomes of negotiations and contract award processes is possible for assets with long development lead-times, including offshore wind. Therefore, government has retained optionality in its prioritisation framework until there is further clarity on progress towards delivering the capacity ranges indicated [1](p31).

6.4.23 In July 2023, for example, the previous developer of Norfolk Boreas wind farm (1.8GW) announced that it was halting development of its because it “no longer made financial sense to continue” [47]. Norfolk Boreas, Norfolk Vanguard West and Norfolk Vanguard East, with a combined planned capacity of 4.2GW, were purchased by RWE in December 2023. Development of the schemes has now resumed.

6.4.24 CfD Allocation Round 5 (AR5) was held in summer 2023. The Allocation Rounds follow a competitive process, so information on project prequalification for the allocation round is not published. When AR5 results were published in September 2023, however, no contracts had been awarded to offshore wind projects.

6.4.25 The Allocation Round Price Cap for AR5 was £44/MWh in 2012 money (equivalent to approximately £61.40/MWh in 2024). One possible conclusion of the AR5 result, is that developers required a strike price of more than £61.40/MWh to make their projects economically viable yet could not be awarded a contract at a higher value than the Price Cap and therefore no contracts were awarded to offshore wind projects in AR5.

6.4.26 In November 2023 the then government increased the Administrative Price Cap for offshore wind in advance of CfD AR6 which opened in March 2024.

6.4.27 AR6 results were published in September 2024. 3.4GW of new offshore wind secured contracts for delivery in 2028/29 at a strike price of £58.87/MWh (2012 money, equivalent to approximately £82.10/MWh in 2024) [44].

6.4.28 The backlog of offshore wind projects not contracted through AR5 may have contributed to an over-subscription in future Allocation Rounds as schemes unsuccessful in previous rounds and schemes which have recently secured planning competed for contracts. Greater competition in allocation rounds may drive price down, but only to a level of commercial acceptability.

6.4.29 The UK's current offshore wind pipeline shows great potential to deliver significant decarbonisation and energy security benefits. However, it is clear from recent scheme and contracting progress that delivery of the pipeline should not be taken for granted.

6.4.30 The next Contracts for Difference Allocation Round, AR7, is currently scheduled to be held in 2025 and AR8 will follow in 2026. Based on project development rates, these two allocation rounds may represent the last opportunity to contract new UK offshore wind capacity which has a chance of delivering before 2030.

6.4.31 It is therefore not a given that the government's ambition for 43 to 50GW of offshore wind by 2030 will be met, or even that NESO's FES pathways for the technology class will be achieved by 2030.

6.4.32 Any shortfall in the delivery of offshore wind projects against NESO's pathways will need to be made up for instead by other technologies prior to 2030 and / or adds to the need to develop schemes which will deliver in the 2030s to make up for any shortfalls prior to 2030 as well as continued to keep power clean beyond 2030.

6.5 Onshore Wind

6.5.1 FES reports that 13.7GW of GB onshore wind capacity was operational in 2023 [29](2024, Table ES.07), rising to 14GW at the end of 2024 [1](Table 1).

6.5.2 In 2015 the then government placed an effective moratorium on further onshore wind development in England. According to the REPD, operational onshore wind capacity in England increased by just 0.7GW between the end of 2015 and January 2024.

6.5.3 FES net zero consistent pathways cover a range of 23 – 27GW of onshore wind operational by 2030, which increases to 32 – 42GW by 2050 [29](2024, Table ES.07). Government's Clean Power 2030 Action Plan has set a capacity range of 27 to 29GW for operational onshore wind in 2030 [1](Table 1).

6.5.4 In September 2023, the previous government announced a proposed lift on the ban on onshore wind in England, by introducing changes to the National Planning Policy Framework (NPPF).

6.5.5 The government reversed the moratorium in July 2024 by revising planning policy to place onshore wind on the same footing as other energy development in the National Planning Policy Framework (NPPF). This is to support the delivery of the Clean Power 2030 Action Plan.

6.5.6 With the moratorium having been in place for such a long time, onshore wind development pipelines in England are currently thin. Re-establishing a pipeline of onshore wind schemes in England may take some time.

6.5.7 NESO's TEC Register [41] shows that no new onshore wind schemes in England and Wales have agreements to connect to the Transmission system before 2026, and only 4.1GW hold agreements to connect before 2030. Other schemes totalling approximately 2.7GW have been accepted to connect to the English and Welsh electricity distribution networks, with just 1.1GW proposing to connect in England with a connection date of 2037. However the REPD shows that just 39 applications for a total of 800MW of onshore wind have been made but are not yet determined in England and Wales. 42 schemes for a total of 360MW are awaiting construction. Just one 35MW development in Wales secured a CfD as part of AR5, and a total of 73MW of capacity in AR6, mainly for delivery in 2027/28.

6.5.8 Data from the REPD also shows that onshore wind schemes that achieve planning consent in Great Britain take between five and seven years to pass through the planning system (average duration between commercial operations date and planning application submission date, for successful onshore wind schemes listed on the REPD). Pre-application development may last for two or more years beforehand although this will be highly scheme specific.

6.5.9 It is therefore not a given that the changes to the NPPF will deliver the required generation capacity to meet even its share of NESO's least optimistic projections for the technology class, or the government's ambition to double onshore wind capacity by 2030.

6.5.10 The UK will therefore need to look to Scotland to support an increase in onshore wind capacity through the next circa five years.

6.5.11 The REPD pipeline for Scotland shows 7.6GW of consented schemes which are not yet operational (just 1.5GW of these are listed as under construction) as well as 8.7GW of applications in Scotland which have not yet been determined.

6.5.12 The REPD also shows that of the total capacity of Scottish onshore wind schemes listed in the REPD as having been determined, only 54% has been consented (17.6GW consented of 32.5GW determined). If historical consent rates continue into the future with a pace consistent of that of the past, the Scottish pipeline of onshore wind schemes is not of a sufficient scale to deliver the range of onshore wind required by 2030 in NESO's net zero compatible scenarios.

6.5.13 Therefore, relying solely on Scottish onshore wind to deliver against the NESO's projections is also not a prudent approach to delivering progress against the UK's decarbonisation and energy security targets.

6.5.14 The UK's Contracts for Difference Allocation Round 6, results of which were published in September 2024, allocated contracts to 1GW of onshore wind, predominantly in Scotland and predominantly delivering in 2027/28.

6.5.15 Any shortfall in the delivery of onshore wind schemes against government's Clean Power capacity range will need to be made up for instead by other technologies.

6.6 Nuclear

6.6.1 GB operational nuclear capacity is, at the time of submission of this report, at 6GW, down from over 9GW in 2020. Two stations (2.4GW) are due to close in March 2027 +/- one year and a further two stations (also 2.4GW) are due to close in 2030 +/- two years [48].

6.6.2 The government has committed to "extending the lifetime of existing plants" [16](p52), but operational lifetime is limited at these four stations by irreversible engineering processes deep inside the reactor cores and any extension is not a guarantee of operation up to that date.

6.6.3 It therefore remains highly unlikely that any significant lifetime extension commitments will be made by the operator in these station's final years of operation. An ongoing programme of inspection and testing will continue to inform the operator, with oversight from the UK's independent nuclear regulator, on the ability of these stations to operate safely until their next programmed inspections and towards their current estimated closure dates.

6.6.4 Therefore, by as early as 2028, it could be the case that only one currently operational nuclear power station, Sizewell B (1.2GW) will be operating in the UK. Operator EDF is likely to seek permission to extend the life of this reactor by 20 years to 2055. A 60-year operational lifetime is common for the nuclear technology in use at Sizewell B.

6.6.5 Nuclear power is a low-carbon power source, therefore the likely closure within the next five years of 4.8GW of capacity, which has historically generated c.30TWh/year of low-carbon electricity, will need to be made up by other low-carbon sources of electricity, just to prevent an increase in grid carbon intensity over the next five years. Government's Clean Power 2030 Action Plan includes a capacity range of 3 to 4GW for nuclear power [1](Table 1).

6.6.6 New nuclear has been a part of every government's energy strategy since the mid-2000s and many barriers to nuclear development have been removed over the last decade. For example, site selection (the National Policy Statement for Nuclear Power Generation, although validity of this NPS has now expired), early regulatory approval of reactor designs (the Generic Design Assessment (GDA) process) and revenue and back-end cost certainty through the CfD, a key element of the 2013 Electricity Market Reform, and the Funded Decommissioning and Waste Management Plan. The Energy Act 2013 also created a body corporate, the Office for Nuclear Regulation (ONR) to regulate, in Great Britain, all nuclear licensed sites.

6.6.7 The nuclear development process is neither easy, nor short. Nuclear projects have long development and construction lead times with many regulatory and commercial approvals and decision points along the way. Hinkley Point C development started in earnest in the late 2000s and civil site construction commenced in 2016. Hinkley Point C is still under construction.

6.6.8 The government has committed to "get Hinkley Point C over the line" [16](p52), but it was announced in January 2024 that the plan to start commercial operations has already been further delayed to between 2029 and 2031 [49], due to construction delays. Government's Clean Power 2030 Action Plan advises that the first unit at Hinkley Point C (1.6GW) is scheduled for completion between 2029 and 2031, however "there are uncertainties associated with having Hinkley Point C online by the end of the decade, given delays in the past few years" [1](p81).

6.6.9 Sizewell C, which is proposed to be a replica of Hinkley Point C, received a Development Consent Order in July 2022 but remains uncommitted, although non-nuclear construction ground and associated development works have commenced.

6.6.10 In November 2022, the then government took a £700 million stake in Sizewell C and became a 50% shareholder in the project's development with EDF. A further £511 million was made available "to continue project development and prepare the Suffolk site for construction" [50]. Since September 2023, the government have been working together with EDF to raise private capital investment for the project. In December 2023, the then government invested an additional £1.3 billion in the project, consolidating its position as the majority shareholder [51].

6.6.11 In August 2024 government announced the Sizewell C Development Expenditure (Devex) Subsidy Scheme of up to £5.5 billion to "enable continued support to the development of the proposed new nuclear power plant Sizewell C (SZC) to the point of a Final Investment Decision (FID)" [52]. Government stated an intention to take a Final Investment Decision on whether to proceed with the project at Phase 2 of the Spending Review, which will conclude in late spring 2025 [53](Para 3.76).

6.6.12 If a Final Investment Decision is taken early in the government's term of office, and formal construction commences soon afterwards, overlaying Hinkley Point C's construction programme would see first commercial operation at Sizewell C well into the second half of the 2030s. Construction efficiencies may be secured through replication of construction methods from Hinkley Point C to Sizewell C, but are not guaranteed.

6.6.13 Great British Nuclear (GBN) was launched in 2023, as an 'arms-length body' with its first priority being to "administer a competitive process to select the best small modular reactor (SMR) technologies from around the world. This SMR technology selection process will underpin government's commitment to two nuclear Project Final Investment Decisions during the next Parliament [i.e. the parliament sitting at the date of writing this Statement], with at least one of these being into an SMR project" [54].

6.6.14 SMRs are nuclear facilities which are proposed to achieve economies of scale through multiples of projects, rather than the size of a single project. Modular construction of nuclear facilities is largely anticipated to be factory based, requiring only the installation of prefabricated components in situ. In this way, learning can be applied during subsequent manufacturing in a controlled environment, delivering anticipated rewards in terms of construction duration, cost, and quality.

6.6.15 The first three SMR designs are now being assessed under GDA by the ONR, a process which has previously taken three or more years. SMRs will require the construction of approved manufacturing facilities prior to delivery of the first unit. Although SMRs may bring decarbonisation and energy security benefits to the UK, the first SMR unit is very unlikely to be operational in the UK within this decade.

6.6.16 In October 2023, GBN down-selected six companies through the initial stage of a nuclear technology competition, successful companies were considered to "offer the greatest confidence in being able to make a final investment decision in 2029" and be "most able to deliver cutting-edge technology by [the] mid-2030s" [55]. GBN are currently assessing four bids made for government development support contracts, two companies are now no longer taking part in the competition.

6.6.17 In February 2025 government proposed reforms to the planning regime to incorporate small nuclear reactors and enable developers to identify the best sites for their projects, rather than constraining development to just eight sites previously identified [56].

6.6.18 Any reactor which succeeds in becoming commercially operational, whether large or small, will need to pass through GDA, select a suitable site, secure grid connection and secure a Development Consent Order. Offsite manufacturing facilities may also require nuclear-level consenting and approval. Reactor operating companies will need to secure a Nuclear Site Licence and become both intelligent customer and controlling mind of the end-to-end design, operation, and decommissioning of the site.

6.6.19 Revenue mechanisms will also need to be developed, funding secured, and then the process of construction and installation commenced, and facilities commissioned.

6.6.20 It is clear that nuclear development does not come without risk. In the 2010s, three mature GW-scale reactor projects progressed towards Financial Investment Decision, but only one, Hinkley Point C (EDF, 3.2GW) has been taken forwards to construction. The other two (Wylfa and Moorside) were discontinued in 2019 and 2017 respectively, due primarily to commercial matters.

6.6.21 It is therefore not yet the case that the existence of a governmental plan for nuclear, and companies currently participating in that plan, can be relied upon to deliver the potential benefits of such a plan.

6.6.22 In the FES 2024 net zero pathways, NGESO assumes the closure of two existing nuclear stations prior to 2030 and the commissioning of Hinkley Point C reactor between 2029 and 2031, in line with developer announcements. SMRs appear from 2034 at the earliest, and Sizewell C commissions in the second half of the 2030s.

6.6.23 Achieving even the minimum of the four FES pathways require that Sizewell C will go ahead, but operation is not forecast to be until 2036 in the most optimistic net zero FES pathway and 2039 in the other two. **Figure 6-5.**

6.6.24 shows the average and the range of the annual nuclear capacity projections for NESO’s net zero compatible FES projections.

6.6.25 Further, this analysis suggests that, based on recent experience, no nuclear facility other than Hinkley Point C will be able to join the existing Sizewell B reactor on the grid before 2035, the previous government’s target date for full decarbonisation of the electricity system, and the closure of 4.8GW of existing nuclear power before 2030, the year by which the government aim to have delivered clean power, may be inevitable.

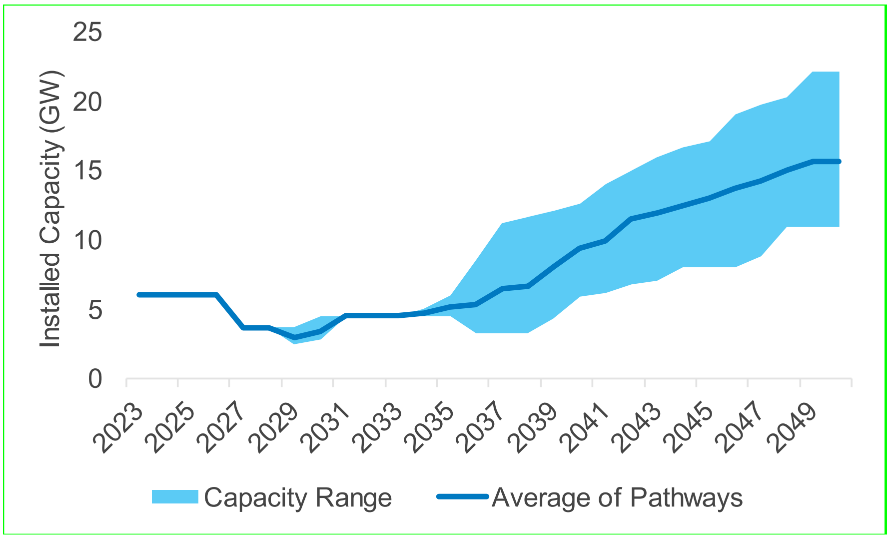


Figure 6-5: FES future nuclear capacity pathways 2023-2050
(GW)
[29](2024, Table ES.21), [Author Analysis]

6.6.26 In October 2023, the then government also published 'Towards Fusion Energy 2023', the next stage of the UK's nuclear fusion energy strategy [57].

6.6.27 The UK's nuclear fusion strategy sets out two objectives. Firstly, a UK demonstration of commercial viability of fusion from a UK prototype plant which delivers net energy, and secondly the development of a world-leading fusion industry.

6.6.28 Not detracting from the important activity of fusion research and development, it is relevant for the purpose of examination of this scheme to place this exciting prospect in the UK into context. In support of the first objective:

"the STEP Programme will design, develop and build, by 2040, a prototype fusion power plant capable of delivering net energy" [53, p20].

6.6.29 EA 2023 legislates for fusion regulation, an essential pre-requisite for developers to plan prototype projects.

6.6.30 Any possible decarbonisation contribution from nuclear fusion will therefore not materialise in time to support the then government's target to decarbonise the electricity system by 2035, and it is not yet clear that achieving government's fusion targets, including a successful demonstration STEP project, will enable nuclear fusion to make a net contribution to decarbonisation from any facilities following STEP, prior to 2050.

6.7 Unabated fossil fuels and abatement technologies

6.7.1 NESO's FES shows that 29.4GW of CCGT (Combined Cycle Gas Turbine) generation capacity was operational in the UK in 2023, and in 2023 this capacity contributed nearly one quarter of the UK's total annual generation output. 6.5GW of other gas-fired generation capacity, including Open Cycle Gas Turbines, smaller gas reciprocating engines, and gas-fired combined heat and power was also operational in 2023 [29](2024, Table ES1).

6.7.2 Currently all UK CCGT (and other gas-fired) capacity is fully unabated, meaning that the CO2 emitted as a by-product of generating electricity is released to the atmosphere and contributes to global warming. Progressing towards a zero-carbon electricity system requires the decarbonisation of these assets, or the replacement of their generation capacity with alternative low-carbon sources. The most significant decarbonisation requirement is on the CCGT fleet.

6.7.3 However, it is important to note that the Government's definition of Clean Power by 2030 allows for up to 5% of Great Britain's electricity generation to come from unabated fossil fuels (down from 40% in 2023) [1](pp26&26).

6.7.4 Decarbonisation of the fuel used to generate electricity in the CCGT fleet can be achieved by burning hydrogen. Capturing carbon emissions and storing them away from the atmosphere would also decarbonise the assets and is dependent upon the deployment at scale of Carbon Capture Usage and Storage (CCUS).

6.7.5 FES 2024 net zero pathways include gas schemes with carbon capture operating from 2033 at the earliest. Deploying CCUS more quickly will provide a greater capacity of low-carbon dispatchable generation to the market to complement renewable generation assets in meeting demand. Deploying CCUS more quickly than the FES 2024 pathways is important to support government's ambition to deliver 'Clean Power by 2030'.

6.7.6 The net zero FES pathways include 18.8 – 34.7GW of dispatchable low-carbon generation in operation in 2040, from a base of 0 – 1.3GW in 2030.

6.7.7 CCUS is also required to facilitate Bioenergy with Carbon Capture and Storage (BECCS), as described in **Section 6.9**.

6.7.8 Powering Up Britain aimed to deliver four operational CCUS clusters to capture and store 20-30 million tonnes of carbon dioxide (MtCO2) by 2030 [24](a, p21). This was confirmed by the previous Prime Minister in September 2023 [58].

6.7.9 CCUS has a key role in the UK's Net Zero Strategy. It is a prominent feature of the National Infrastructure Strategy [59], Energy White Paper [19] and Industrial Decarbonisation Strategy [60]. Previous governments have recognised that "the technology has not been delivered at scale and significant risks remain" [59](p53) but recent progress has been made in developing and consenting projects as well as developing a commercial framework to support the technology. The government's CCUS Deployment Pathway seeks to secure an option to deploy CCUS at scale during the 2030s, subject to costs coming down sufficiently.

6.7.10 However, the CCC note in their 2024 Progress Report to Parliament, that "progress on developing engineered removals is behind schedule and achieving the Government's ambition to remove at least 5 MtCO2 per year by 2030 is increasingly challenging" [11](2024, p81).

6.7.11 CCUS deployment is currently progressing under a cluster approach with Track 1 and Track 2 projects now identified and under development.

6.7.12 Eight projects were selected from the Track 1 cluster sequencing process for CCUS to proceed to negotiations for government support. Three are part of the East Coast Cluster and five are part of the HyNet Cluster. Both clusters have previously been identified as funding recipients.

6.7.13 HyNet report the potential to reduce CO2 emissions by 10 million tonnes every year by 2030 by producing and transporting hydrogen to end users through a network of dedicated pipes, while also capturing the associated CO2 emissions and piping them in a separate pipe to an undersea storage facility. The HyNet Carbon Dioxide Pipeline was granted a Development Consent Order in March 2024. The Hynet North West Hydrogen Pipeline planning application, is now expected to be submitted to the Planning Inspectorate in 2025, delayed from early 2024.

6.7.14 The East Coast Cluster aims to capture and store an average of around 23 MtCO2 per year by 2035, with three selected Track 1 projects aiming to connect to the cluster by 2027.

6.7.15 The Net Zero Teesside project, a Track 1 CCGT + CCUS project with associated CO2 transportation infrastructure, which is part of the East Coast Cluster, was granted a Development Consent Order in February 2024. In the Decision Letter, the Secretary of State recognised the urgent need for gas-fired electricity generation with CCS infrastructure as set out in EN-1 and determined that the project would help deliver the UK's net zero commitment by 2050. Therefore, the project would be in line with government's wider policy statements on energy and climate change.

6.7.16 A planning application for a second part of the East Coast Cluster, the Humber Low Carbon Pipelines project, was withdrawn by previous developer National Grid Carbon Limited in January 2024. The project was to construct CO2 and hydrogen transportation pipelines to connect various emitters and generators in the Humber region and is now being taken forward under a separate DCO application by new owner, Northern Endurance Partnership.

6.7.17 Both HyNet and East Coast Clusters provide the possibility of directly capturing and storing emissions from CCGT and Biomass electricity generation facilities located close to the clusters as well as the opportunity to decarbonise heavy industry in the areas local to the proposed pipelines.

6.7.18 Progress has been made on project definition, design, and consenting in recent years. EA 2023 provides a licensing framework for CO2 transport and storage. In December 2024, government announced that financial close had been reached for East Coast Cluster projects with construction due to commence in 2025 ahead of operation from 2028 [61].

6.7.19 The Cluster approach, when it is delivered, will provide abatement for a significant proportion of the UK's operational CCGT fleet and other industrial carbon emissions. However, an extension of the UK's CCUS or hydrogen pipelines will be required to take emissions out of the many CCGT facilities which are not near to an existing or proposed cluster.

6.7.20 A prudent approach to future energy supply would suggest that sufficient progress in decarbonising the existing UK CCGT fleet should not be assumed by 2030.

6.7.21 Therefore. other low-carbon supplies may be required to make up for facilities which have by 2030 not yet been abated in order to secure the government's aim to deliver 'Clean Power by 2030', and keep power clean through to 2050 and beyond.

6.8 Hydrogen

6.8.1 The previous government's 2021 UK Hydrogen Strategy [62](p2) explains that hydrogen has "the potential to overcome some of the trickiest decarbonisation challenges facing our economy", especially in enabling the decarbonisation of industry and land transport, and as a potential substitute for current carbon-intensive marine and aviation fuels.

6.8.2 Currently most hydrogen is produced by converting methane to hydrogen and carbon dioxide (this is known as 'blue hydrogen'). As blue hydrogen production emits carbon as a by-product, the development of blue hydrogen facilities will require CCUS capability to achieve net zero carbon. CCUS clusters with hydrogen and carbon dioxide pipelines are hoped to become operational in the second half of the 2020s.

6.8.3 Hydrogen can also be produced through the electrolysis of water (this is known as 'green hydrogen'). The 'green' label for electrolysed hydrogen presumes that the input electricity used in the hydrogen production process is itself low-carbon, therefore, there are no carbon emissions associated with the process.

6.8.4 Green hydrogen production relies on considerable amounts of renewable energy to electrolyse water. Electrolysis currently accounts for approximately 1% of global hydrogen production. However, a growth in electrolysis capability and capacity opens out the prospect of using renewable generation to produce hydrogen, in potentially significant quantities.

6.8.5 Powering Up Britain confirms the then government's ambition for up to 1 GW of electrolytic hydrogen and up to 1GW of CCUS-enabled hydrogen in operation or construction by the end of 2025, subject to affordability and value for money. [24](a, p22). Progress in the Hydrogen Allocation Rounds (HARs) for electrolytic hydrogen [63] implies that this ambition is unlikely to be met. Government expected to "award contracts totalling up to 250MW of capacity from HAR1, subject to affordability and value for money. We aim for contracts to be awarded in Q4 2023, with first projects becoming operational in 2025." Eleven schemes totalling 125MW of capacity were awarded contracts under HAR1 in December 2023 and are currently at various stages of development.

6.8.6 The second HAR closed for applications in April 2024 and intends to award up to 875MW of capacity, taking the combined capacity of the first two allocation rounds to 1GW if fully subscribed.

6.8.7 The consultation document related to market engagement for HAR 2 [64] describes that, despite the previous government's aim to deliver 1GW by 2025, projects will be able "to select a delivery year between March 2026 until March 2029" [64](p8). This suggests that the government's initial Hydrogen capacity aims will not be met, and the potential for demonstration Hydrogen projects to be delayed.

6.8.8 Delaying the bulk production of hydrogen will also delay the benefits arising from its use. The development of fully commercial, at-scale schemes will encourage further development and rollout, but secure supplies will be needed to entice early adopters to showcase this new technology.

6.8.9 NGESO's FES 2023 estimates that between 110 and 186TWh of electrical energy will be required annually in the UK by 2050 to produce hydrogen through electrolysis to meet its many potential end-uses [29](2024, Table ES.K). The wide range of future demand estimates is due to different net zero compatible scenarios producing hydrogen in different ways. The Energy System Catapult foresee the need for "a new low carbon hydrogen economy … delivering up to 300TWh per annum, roughly equivalent to electricity generation today" and concluding that "electricity generation itself may have to double, or even treble if most hydrogen is to be produced by electrolysis" [15](pp6 & 36).

6.8.10 Hydrogen remains an interesting and valuable technology to support net zero. Once hydrogen has been produced, it can be stored, transported, and used in a range of applications as a substitute for natural gas or other carbon intensive fuels. EA 2023 lays the foundations for a future which includes hydrogen technology by creating provisions for business modes for hydrogen production, transport, and storage.

6.8.11 The government plans to allocate £500 million to support the manufacturing of green hydrogen [16](p27) and also plans to introduce a market intervention to de-risk investment in hydrogen to power technology, and support its accelerated deployment [65].

6.9 Biomass

6.9.1 FES 2024 stated that 4.3GW of Biomass generation was operational in the UK in 2023, producing approximately 30TWh of low-carbon electricity [29](2023 Table ES1).

6.9.2 The previous government's Biomass Strategy, published in 2023 reaffirmed that "Only biomass use that complies with strict criteria is considered to be low carbon and to deliver genuine CO2 emissions savings" [66](p6).

6.9.3 Building on the already green credentials of the technology, the Biomass Strategy sets a vision to continue to use sustainable biomass in power generation in the 2020s. The Biomass Strategy aimed to transition away from unabated uses of biomass by 2035 by incorporating, where possible and with priority, BECCS to make biomass use net negative carbon emissions.

6.9.4 Recognising that "Biomass can play a significant role in decarbonising nearly all sectors of the economy" the previous government also stated that "Biomass is not a silver bullet, and neither is carbon capture. We will rely on a range of solutions to achieve net zero" [66](p4).

6.9.5 BECCS is not currently operating at scale in the UK, however demonstration and commercial scale plants are operational in other countries. Active work is therefore being undertaken in government and industry to develop business models which support biomass and the delivery of low-carbon electricity as well as negative emissions through the deployment of CCUS to deliver BECCS in the UK.

6.9.6 Consideration is also being made within government as to whether new or refurbished biomass plants must, on commissioning, be fit to deploy carbon capture in the future.

6.9.7 Against the backdrop of national biomass capacity reducing as existing plant reach the end of their commercial life, FES net zero pathways include BECCS capacities coming on line progressively from 2030 towards an operational capacity of approximately 2GW by 2035 and 3.4 – 4.7GW by 2050 [29](2024, Table ES1). In January 2024, the then Secretary of State approved plans to convert two existing biomass units at Drax Power Station to BECCS.

6.9.8 BECCS will be dependent upon the delivery of CCS infrastructure to support the capture of emissions, and any shortfall in the delivery of BECCS schemes against the FES pathway projections will need to be made up for instead by other technologies.

6.10 Solar Power

6.10.1 The government's solar photovoltaics deployment information resource [67] records installed and operational solar capacity in the UK. The government's data shows that at the end of November 2024, the UK had 17.6GW of operational capacity, of which 0.4GW was located in Northern Ireland.

6.10.2 UK Solar has generated over 10TWh annually since 2017, rising to 13.9TWh in 2023 [28](Table 5.6). UK solar generation makes an important and reliable annual contribution to meeting national demand. Solar is well placed to play the role it has been ascribed in recent government publications, including those summarised in **Chapter 3** of this Statement.

6.10.3 **Figure 6-6** following shows how solar capacity has grown in the UK each year since the records began in 2010.

6.10.4 Growth in UK solar capacity has been characterised by two phases, the first was supported by the Feed in Tariff (FiT) scheme, that entered into law by the Energy Act 2008 and took effect from April 2010. This phase is denoted by the yellow columns in Figure 6-6

6.10.5 The FiT scheme paid a guaranteed £/MWh revenue to owners of solar installations (and other renewable generation assets) with a capacity lower than 5MW.

6.10.6 **Figure 6-6** shows that the scheme was effective in increasing solar capacity over the period 2010 to 2015. A tariff reduction was announced in December 2015, reflecting reducing installation costs and therefore less of a requirement to incentivise new installations. Annual installations reduced over 2017 and 2018 (light brown columns) as capacity accredited by the scheme before the 2015 tariff announcement continued to be constructed.

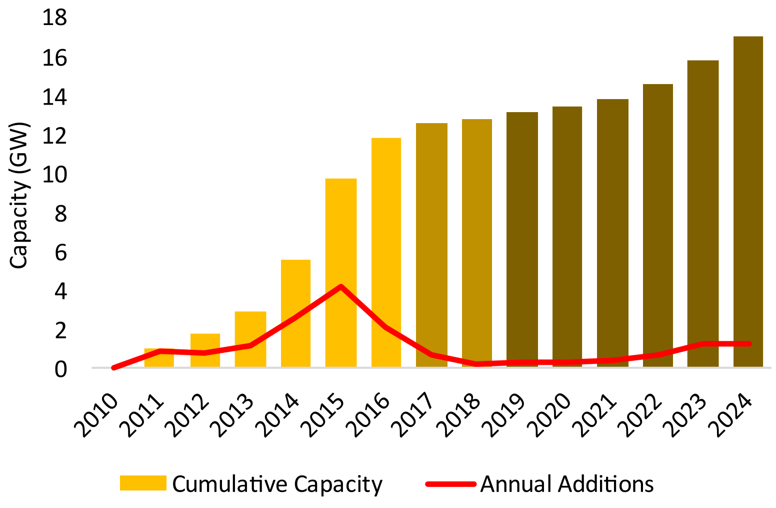


Figure 6-6: Cumulative and annual installed solar capacity in the UK
(GW, 2010 – 2024)
[67], [Author Analysis]

6.10.7 The FiT scheme closed to new applicants in 2019, and solar capacity growth since 2019 has been supported by market revenues only (dark brown columns).

6.10.8 Annual installations are shown by the red line. Additions in the period January to November 2024 have been pro-rated to provide a comparative annual run rate for 2024. Annual installations peaked at 4.2GW in 2015 and averaged 1.1GW over the period 2010 to 2024.

6.10.9 Solar has undergone significant technological advances in scale and commercial efficiency, and the UK has many areas of commercially viable solar irradiation. It is therefore important to make best use of this natural, renewable energy resource to meet the UK's legal carbon emission reduction obligations.

6.10.10 The previous government stated that it expected a 5-fold increase in the deployment of solar by 2035 [21](p19) equivalent to 70GW of operational capacity by the same date. In its Clean Power 2030 Action Plan, government has set a capacity range of 45 to 47GW for solar by 2030 and 45 to 69GW by 2035 [1](Table 1, and Connection Reforms Annex, Table 1).

6.10.11 Importantly, to achieve either of these aims, solar capacity (excluding rooftop capacity, see commentary to **Table 3-1** of this Statement) will have to increase by over 4GW each year starting from 2024, i.e. new installations in every year of the government's current term in office, will have to be higher than the UK's previous single highest record of annual installations.

6.10.12 The FES 2024 net zero pathways for solar consider 28 – 40GW installed capacity in 2030, 50 – 85GW in 2040, and 72 – 108GW in 2050 [29](2024, Table ES.14). In every scenario, a pathway to net zero includes a significant future increase in solar capacity beyond that which is installed or in development today, as shown in **Figure 6-7.**

6.10.13 **Figure 6-7** superimposes FES forecast ranges for solar capacity from 2019, 2023 and 2024, with each range shown as a shaded area covering the pathway with the lowest forecast capacity to the highest capacity in each year. Historic installed capacity is shown by the yellow line in 2020-2023.

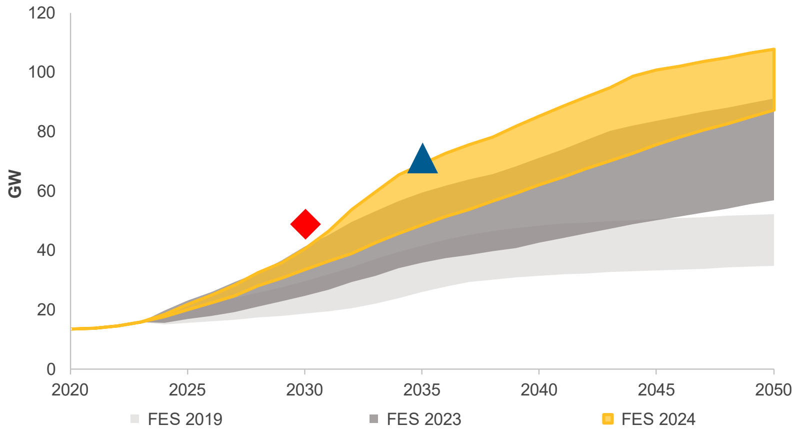


Figure 6-7: Evolution of future solar capacity forecasts in the UK
(GW, 2019, 2020 & 2023)
[29], [Author Analysis]

6.10.14 **Figure 6-7** shows that the range of future solar capacity forecasts for different FES pathways increased from FES 2019 to FES 2023, and again to the most recent publication.

6.10.15 The UK's net zero commitment in 2019 manifested in FES pathways as a further increase in solar capacity, shown by the dark grey range in Figure 6-7 (the 2023 forecast) being higher than the light grey 2019 forecast.

6.10.16 The blue triangle shows the top end of the 2035 capacity range and the red diamond shows the government’s 2030 capacity range for solar capacity, both sourced from government’s Clean Power 2030 Action Plan [1](Connections Reform Annex, Table 1).

6.10.17 To achieve the top end of the 2035 capacity range, installations would need to track the most aggressive FES 2024 pathway for the next ten years.

6.10.18 To achieve the 2030 capacity range, an even more aggressive deployment rate is needed over the next five years.

6.10.19 This underscores the need for solar schemes to come forwards for delivery in the 2030s as well as to continue to come forwards beyond 2030 to deliver the ongoing need for the technology in the UK.

6.10.20 Year-on-year cost reductions have made solar technology progressively more attractive (and now preferential) compared to many other forms of electricity generation, promoting the commercial rationality for the UK to prioritise the development of solar capacity. The incorporation of a cost perspective in the 2024 FES is therefore likely to be one reason why capacity installation pathways have increased from the 2023 forecast to the 2024 forecast. Solar capacity helps to address energy affordability challenges (see **Chapter 10**) as well as meet the already urgent need for schemes to come forwards to support decarbonisation and energy security aims.

6.10.21 Each of the annual ranges of future installed solar capacity in Figure 6-7**a** may be explained by the extent to which other low carbon technologies including onshore and offshore wind, nuclear, CCUS, and BECCS are deployed in the UK. Delays or shortfalls in the deployment of any technologies versus their FES pathways will require a compensatory acceleration or expansion in the deployment of other technologies for the UK to remain on track to achieve net zero.

6.10.22 In this context, the urgent development of large capacities of technologies which are proven in development and operation is clearly a prudent approach and is consistent with the government's conservative approach to infrastructure development described in NPS EN-1 [2](Para 3.3.10). This is also consistent with government setting capacity ranges to increase the deployment of different technologies by 2030 and 2035 which maintain some optionality until more clarity is available on achieved and forecast progress [1](p31).

6.10.23 The solar sector is proven in operation with over 17GW of installed capacity already reliably delivering zero-carbon electricity to the UK's electricity system. The solar sector is also proven in delivery because of its short development duration and is therefore well placed to deliver to the urgent need for low-carbon generation.

6.10.24 Data from the REPD [42] quantifies the average duration from planning submission to operation of a solar farm in the UK is 1.4 years (over an average of 1,308 projects) with a 1-year construction timeframe post consent.

6.10.25 Larger projects may take longer to consent and construct. 14 solar projects with capacity over 40MW are listed as operational in the REPD. These projects took on average 2 years from planning submission to operation, of which construction lasted on average 1.4 years.

6.10.26 This data is in stark contrast to historical development timescales in the UK for onshore wind (see **Section 6.5**), offshore wind (see **Section 6.4**) and nuclear power (see **Section 6.6**).

6.10.27 However, many large-scale schemes have target operational dates which are determined by available grid connection dates. Large-scale schemes may therefore follow a development plan to coordinate with those dates. Larger schemes of over 50MW capacity are also required to apply for development consent under the PA2008, with different statutory timelines to smaller schemes, which may affect the time elapsed from planning submission to operation as NSIP schemes start to deliver.

6.10.28 At first view, solar pipelines look healthy but must be viewed with caution, particularly in relation to the analysis included at **Section 6.3** of this Statement regarding the attrition of projects and capacity from pipelines and registers prior to commercial operation. Clean Power 2030 will be achieved only if the pipeline of credible and viable projects which are ready to proceed (such as this scheme) continually feeds the connections and contracting process through the intervening years.

6.10.29 Solar schemes can be developed stand-alone or co-located with storage or other generation technologies. Both stand-alone and co-located schemes play essential roles in contributing to the three pillars of energy policy: decarbonisation, security of supply, and affordability.

6.10.30 **Section 6.11** of this Statement explains that storage is an essential part of the future energy system. **Section 7.9** explains that the co-location of storage with renewable generation has benefits, however it is not necessary (and nor is it a policy requirement) that all renewable energy schemes are co-located with storage.

6.10.31 Stand-alone solar schemes (and schemes using other renewable generation technologies) are already prevalent and will likely continue to be prevalent in the UK's future electricity system.

6.10.32 **Figure 6-9** shows that in each of the three FES pathways which are compatible with net zero, the capacity of solar generation always outstrips that of storage. It is therefore anticipated by the Electricity System Operator, that the future electricity system will consist of both stand-alone solar (and other renewable) projects, as well as co-located projects.

6.10.33 Stand-alone renewable schemes generate, from a renewable source, zero-marginal carbon electricity. Therefore, stand-alone schemes also provide an essential contribution to reaching net zero.

6.10.34 The TEC Register [41] lists 3.1GW of stand-alone solar and 21.4GW of co-located solar projects with connection dates prior to 2030. The TEC register does not record the capacity of individual technology types within an application. Therefore, it is more precise to state that solar technology is proposed to be installed at projects which comprise a total of 24.5GW of connection capacity to the NETS prior to 2030.

6.10.35 A point of connection is absolutely necessary for a developer to secure for a development to be viable to take forwards and in many cases grid connection can be secured prior even to engaging local landowners. The current scarce nature of grid connections in GB, coupled with expectations of large capacities of connections being required in the future, prioritises the procurement of grid entry connection capacity as a critical project development activity.

6.10.36 The cost of securing and holding a grid connection for a potential scheme is also not prohibitive in relation to development costs as a whole. It is therefore understandable that the current ‘connection queue’ capacity is very high. This does not however mean that all capacity in the connections queue will make it to commercial operation, and the Connections Action Plan resolves to de-prioritise less-ready schemes in the connections queue, and prioritise those which are more advanced in their development.

6.10.37 Planning consent is required for all schemes greater than micro-scale. The REPD lists 14.5GW of consented projects awaiting construction but only 2.4GW is currently under construction. Of the total 16.9GW with planning consent, 3GW of these schemes are of a nationally significant scale.

6.10.38 Applications totalling a further 7.2GW of solar capacity have been submitted to planning authorities other than the Planning Inspectorate but have not yet been determined. Given average development durations, it is possible for successful schemes to deliver in 2025 or 2026, subject to their grid connection dates (which are not listed on the REPD).

6.10.39 A further 2.5GW of capacity in England, across 8 schemes, has been submitted to the Planning Inspectorate but has not yet been determined. Grid connection dates for these schemes range from late 2027 to 2031.

6.10.40 A further 24 schemes, totalling approximately 10GW, are at the pre-application stage with the Planning Inspectorate, including the Proposed Development, with application submission dates estimated before the end of 2025 (up to 20 schemes) 2026 (four schemes). Grid connection dates for these schemes range from 2025 to 2033.

6.10.41 At best, therefore, approximately two-thirds half of the capacity of solar schemes with agreements to connect to the NETS prior to 2030 has so far engaged with the Planning Inspectorate. It is not a given that all capacity which comes forward proceeds to the development consent / planning stage, or will be successful in its planning application, or will proceed onwards through commercial contracting, investment decisions, construction and ultimately to operation.

6.10.42 In relation to revenue contracting, the pipeline is even further constrained although results of the government’s recent CfD allocation rounds support solar’s ability to deliver to shorter timeframes than other renewable generation technologies. Solar secured contracts to deliver the majority of contracted capacity in CfD Allocation Rounds AR4 and AR5 delivering in 2025 (1.6GW) and 2028 (1.1GW) [44].

6.10.43 A further 3.3GW of solar was awarded a CfD in AR6, delivering in 2026/27 (1.1GW) and 2027/28 (2.2GW).

6.10.44 However, data also suggests that an attrition or stall rate could be significant. Approximately only 10% of potential pre-2030 connected capacity has already passed through planning and secured a revenue contract.

6.10.45 It is the Applicant's view that if a significant capacity of solar generation is not built out to a scale comparable with the projections provided by NGESO and others, then the UK will be highly unlikely to continue to reduce its carbon emissions over the coming decade, and ultimately meet its legally binding net zero target.

6.10.46 The size of the pipelines for solar schemes is encouraging across all scales of development, but the data shows that the attrition of schemes through the development process is a real risk to the delivery of that capacity.

6.10.47 A significant proportion of low-carbon schemes currently listed on registers will not become operational, and with that as context, bringing this Proposed Development forwards will be a critical step in the development and delivery of large-scale solar capacity in the UK.

6.11 Flexibility

6.11.1 Government's Clean Power 2030 Action Plan describes the need for flexibility in the UK's future energy system:

"As we build an energy system reliant increasingly on variable renewables, improving the flexibility of the wider electricity system is key … A significant increase in short-duration flexibility of 29-35 GW across battery storage, consumer led flexibility and interconnection capacity from 2023 levels will reduce the amount of more costly generation and associated network infrastructure that needs to be built, whilst maintaining security of supply" [1](p14).

6.11.2 Flexibility is delivered through interactions between both supply (generation) and demand (consumption) to help the national energy system function safely and efficiently. The full operation of flexible assets within that system requires them to both store energy from (or save) and release energy to (or use more) the energy system in response to market drivers, as will subsequently be explained.

6.11.3 The overriding themes for the GB electricity market in the coming decade are those of decarbonisation through an increase in deployment of renewable generation, and higher demand due to the electrification of heat, transport, and industrial demand, while meeting Security of Supply standards and affordability aims.

6.11.4 This means a move away from dispatchable fossil-driven assets and towards renewable plant: a theme which will alter the needs of the GB electricity system. System security of supply will need to address:

> Changing patterns of, and variability in, residual demand (demand net of renewable output)
> A reduction in the proportion of synchronous plant connected and available to support system frequency
> A shift in the location of generation reflecting resource (wind and solar) distribution

6.11.5 Figure 6-8 illustrates the events, consequences and value drivers over different timeframes for flexibility in the GB electricity market. Greater variability in residual demand (i.e. demand net of renewable generation supplied) will increase the need for flexibility solutions across multiple timeframes.

6.11.6 Flexibility is needed to maximise the use of renewables when there is an abundance of generation, and to fill the supply gaps in periods of shortfall.

6.11.7 Storage provides flexibility. Flexibility is the ability to shift in time or location the consumption or generation of energy. Flexibility is also the ability to shift energy from one medium (vector) to another, e.g. electrical energy to gravitational potential energy through Pumped Storage schemes, and back again.

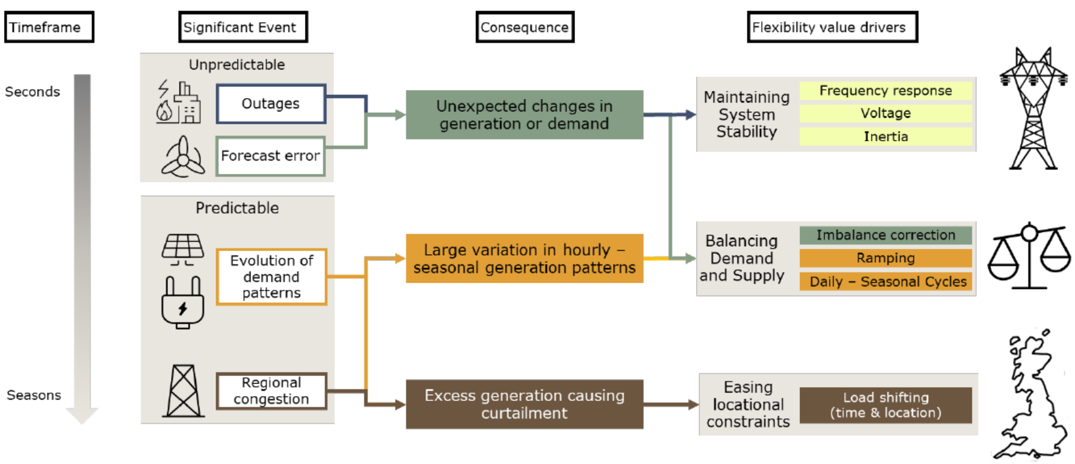


Figure 6-8: Drivers of Flexibility Requirements
[68]

6.11.8 NPS EN-1 sets out the policy position in favour of electricity storage:

"Storage has a key role to play in achieving net zero and providing flexibility to the energy system, so that high volumes of low carbon power, heat and transport can be integrated." [2](Para 3.3.25).

6.11.9 Storage facilities need to be able to import energy and export energy. Sources of energy import are discussed later in this section.

Types of Flexibility

6.11.10 Storage has the capability to deliver flexibility over different timeframes and can be categorised as:

> Short Duration Storage (SDS) with durations of four hours or lower, suited to addressing short duration balancing needs

> Medium Duration Storage (MDS) with durations of over four hours, up to 12 hours, suited to addressing within day balancing

> Long Duration Storage (LDS) with durations of over 12 hours, required for multi-day and seasonal balancing needs

6.11.11 Here, 'duration' refers to the amount of energy a storage facility can hold, rather than the time for which energy can be efficiently stored between import (charge) and export (discharge).

6.11.12 SDS addresses the increasing need for flexibility in matching supply with demand within-day, i.e. balancing increasing levels of renewable electricity supply with demand and providing system services to support the operation of a high-renewable electricity system.

6.11.13 LDS addresses the view that, in the future, the electricity system is expected to exhibit greater seasonal variability and provide for the potential of periods of days or weeks where there may prolonged excesses, or shortfalls, of renewable output.

6.11.14 Extreme but rare extended periods of low renewable generation (sometimes referred to as 'Dunkelflaute' events) possibly lasting up to several weeks have the potential to pose a security of supply risk. There is still considerable uncertainty around forecasting when these events will occur and how long they will last, so there is a need for both sufficient storage capacity and generation capacity to manage security of supply through these periods while also supporting decarbonisation targets.

6.11.15 Conversely, enduring periods of high renewable generation can better contribute to overall electricity system decarbonisation if abundant generation can be stored rather than curtailed.

6.11.16 LDS assets are an important part of the anticipated solution to help manage both types of events, but these are not the events which SDS assets, such as those which form part of the Proposed Development, are designed to address.

6.11.17 There are many technologies which have potential to provide grid scale electricity storage functions, ranging from pumped storage hydro schemes, BESS, or more novel technologies such as liquid air storage, compressed air storage for SDS, or hydrogen with potential for LDS application. Pumped storage hydro schemes have been in existence for over 50 years. BESS are becoming increasingly commonplace in the UK. Other novel technologies are now being designed and developed with varying timescales for deployment.

6.11.18 Key differentiators between storage technologies are not only how energy is stored but is also how much energy can be stored, and for how long it can be stored, from both a technical and commercial basis.

6.11.19 NPS EN-3 also describes the government's support for solar which is co-located with storage [3](Para 2.10.32).

6.11.20 Storage systems which are co-located with solar in the UK have so far tended to be SDS systems because SDS systems complement the generation profile of solar facilities and provide system functions which support the operation of the solar facility by (among other functions) balancing supply with demand.

6.11.21 The co-location of MDS or LDS systems with solar has not yet been proposed in the UK but future advances in technology may make this a viable possibility.

6.11.22 BESS are short duration electricity storage systems.

Quantifying future flexibility needs

6.11.23 FES 2024 net zero pathways indicates that storage and interconnection (flexibility) capacity will need to increase (from 15.8GW in 2023) to 38.8 – 45.7GW in 2030 and 56.9 – 76GW by 2050 to balance supply and demand both within the GB system and across borders. Net zero pathways show Short Duration Storage system capacity increasing from 4.7GW in 2023 to 22.8 – 27.8GW by 2030, 31.1 – 38.6GW by 2040 and 36 – 44GW by 2050 [29](2024, Table ES1). Government's capacity ranges for batteries and other flexible assets for deployment by 2030 and by 2035 are included at **Table 3-1** of this Statement.

6.11.24 As renewable generation capacity increases on the GB electricity system, so too will the total capacity of operational storage systems to balance an increasingly variable supply portfolio with demand across timeframes ranging from milliseconds to seasons.

"Storage and interconnection can provide flexibility, meaning that less of the output of plant is wasted as it can either be stored or exported when there is excess production. They can also supply electricity when domestic demand is higher than generation, supporting security of supply. This means that the total amount of generating plant capacity required to meet peak demand is reduced" [2](Para 3.3.6).

6.11.25 Figure 6-9 shows FES solar and Short Duration Storage capacity projections from 2024 to 2050. The annual projections for SDS capacity (y-axis) are plotted against the annual projections for solar capacity (x-axis) for each of the three FES net zero pathways. The data has been re-cast to show increases versus a 2023 baseline. Figure 6-9 shows anticipated growth in SDS capacity as a function of increasing solar capacity.

6.11.26 Each pathway follows a similar trend. An increase of 10GW of solar (i.e. increasing GB installed solar capacity from c.16GW as at the time of submission to c.26GW) corresponds to a projected increase of c.15GW of SDS (i.e. increasing GB installed storage capacity to c.20GW). An increase of 40GW of solar capacity corresponds to an increase of c.25GW of SDS.

6.11.27 The data shows that SDS capacity initially needs to increase by c.1500MW per 1000MW of solar capacity growth, but NGESO's current pathways show that growth can then settle to c.250MW per 1000MW of solar capacity growth thereafter.

6.11.28 This analysis provides an indication of the scale of the need for SDS in the UK electricity system, however, it will not be solely a growth in solar capacity, but more likely a growth in the capacity of all renewable generation, which drives the requirement to increase capacity of many types of storage technology.

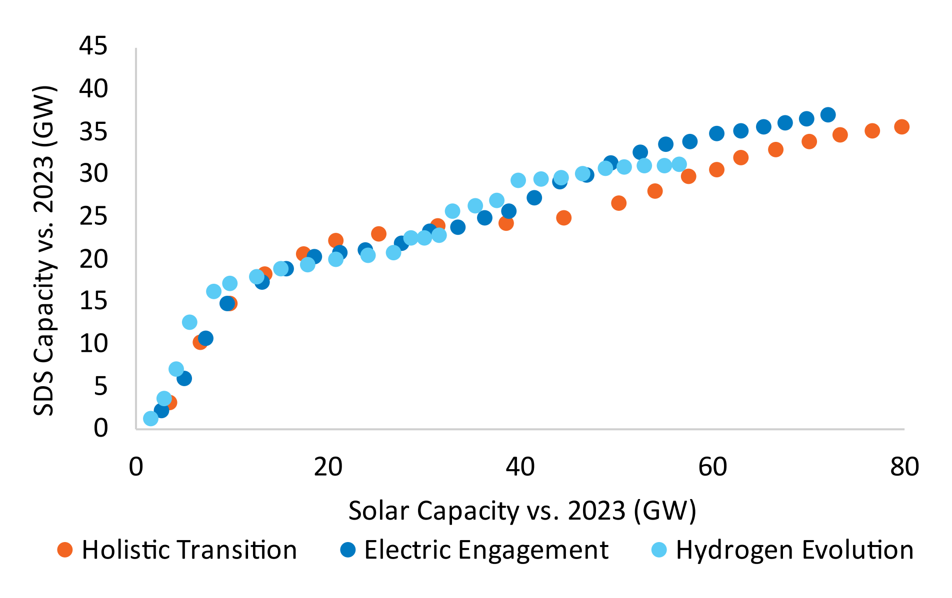


Figure 6-9: Growth in Short Duration Storage capacity vs. Solar Capacity
(GW, 2024 – 2050)
[29](2024, Tables ES.09 & ES1), [Author Analysis]

Co-location and stand-alone schemes

6.11.29 As both renewable generation capacity and storage capacity are expected to increase, projects which seek to connect to grid connection points which can accommodate storage facilities may propose to bring forwards co-located storage facilities as associated development to the main (renewable generation) development, as envisaged by NPS EN-3 [3](Para 2.10.16).

6.11.30 As described in **Section 6.11**, storage facilities may also be developed as stand-alone from any renewable generation schemes.

6.11.31 Developments may identify location-specific reasons why storage schemes will not be co-located with renewable generation schemes, but it is important to recognise that stand-alone storage schemes are already commonplace in GB. Such schemes have already and are likely to continue to come forwards, delivering decarbonisation and energy security benefits as part of the UK's electricity system through their own grid connections. It is not necessary (nor is it a policy requirement) that all storage is co-located with a renewable energy scheme but as NPS EN-1 makes clear, co-location is an approach which is supported because it can help to maximise the efficiency of land used by a scheme.

6.11.32 Figure 6-9 shows that in each of the three FES pathways which deliver net zero, the capacity of operational solar generation outstrips that of operational storage capacity at all times. It is therefore anticipated by the Electricity System Operator, that the future electricity system will consist of both stand-alone solar schemes (and by extension other renewable schemes), as well as co-located schemes.

6.11.33 However, where grid connections offers enable the co-location of renewable generation with storage, a scheme which includes both may be proposed and by doing so would – among other reasons – ensure that the greatest use can be made of the scheme's grid connection infrastructure.

6.11.34 However, projects which are being brought forwards as stand-alone generation schemes still play an essential role in contributing to the three pillars of energy policy: decarbonisation, security of supply, and affordability, because of their critical ability to generate, from a renewable source, zero-marginal carbon electricity – which is something that storage, on its own, cannot do.

6.11.35 The size of the import connection secured by connection agreement with NESO at the point of connection is an important input into the maximum power capacity of the BESS proposed at a facility. Other physical parameters may limit specific elements of the scheme, including parameters which will have the effect of capping the energy capacity of the proposed BESS.

6.11.36 Given the need for flexible sources of generation to support the rollout of renewable generation capacities onto the NETS, it follows that where the deployment of storage facilities is acceptable in a planning sense, that the consent process does not impart any conflicting or arbitrary caps on either energy or power capacity of an installed storage facility. Developers may therefore approach consent in such a way that secures flexibility in design (by way of a 'Rochdale envelope' approach) to allow provision in the DCO for technological innovation and improvements that may be realised at the time of procurement and construction.

6.11.37 This will ensure that the scheme may be constructed to incorporate future and as yet unknown innovation, safety improvements, and cost-efficiencies.

BESS provide Flexibility

6.11.38 BESS provide flexibility to the electricity systems because they are able to import power when national supply outstrips demand, and export power when demand outstrips supply. BESS are also able to provide Ancillary (Balancing) Services.

6.11.39 Typically, BESS (as opposed to other forms of storage, e.g. pumped hydro, or in the future hydrogen) are used to balance supply and demand over short time periods (e.g. milliseconds to days). BESS may import energy at times of low demand (e.g. overnight) or high supply (e.g. the middle of a sunny day, or when wind generation is high) and release that energy when demand is high.

6.11.40 In the UK, demand currently tends to be higher in the morning (e.g. 07:00 to 09:00) and in the early evening e.g. 17:00 to 19:00) than it is at other times of the day, although it is conceivable that the daily shape of national demand will trend towards the daily shape of national supply through the implementation of smart meters, time of use tariffs, electric heating and transport needs in domestic and commercial properties.

6.11.41 Ancillary (Balancing) Services are procured by NESO and under these contracts, operators respond to NESO'S requests to import or export power. Ancillary (Balancing) services are important because supply of and demand for electricity must be matched at all times, and the electricity system needs to be kept in balance and within statutory control parameters. Ancillary (Balancing) Services are used by NESO to do this and the need for Ancillary (Balancing) Services is projected to increase as the capacity of intermittent renewable generation on the UK's electricity system increases.,

6.11.42 **Table 6-1** describes the potential contributions made by a storage asset as part of the Proposed Development to the GB electricity market. This includes the role of the storage asset in supporting the operation of the solar asset by directing energy from times when generation is in abundance to times when it is needed. The storage asset would also able to provide ancillary services which support the operation of the solar asset as part of a decarbonised GB electricity system and help to mitigate the impact arising from an increasing portion of the UK's electricity being supplied from intermittent renewable sources. Further explanation of the associated nature of the storage development is included in **Planning Statement [EN010159/APP/5.5]**.

6.11.43 **Table 6-1** describes on each row, the different types of service, or commercial application, available to BESS. The second column provides an explanation of the service. The third column addresses the applicability of each service to either solar, storage or both (whether co-located or not).

6.11.44 The fourth column describes whether the service is an Ancillary Service, procured by NGESO for the proper functioning of the electricity system or has other purposes which help 'keep the lights on' but are not those services specifically described by the NIC as those which "support renewables and maintain the security of the electricity system" [69](p6).

6.11.45 The fifth column describes whether in providing each Ancillary Service (as categorised in the fourth column), a co-located solar + BESS would import, export, or both, power from/to the NETS.

6.11.46 BESS are needed to provide these services, because the assets which currently provide these services, being thermal (coal or CCGT plant), are either closing to reduce emissions associated with electricity generation to achieve net zero, or are expected to run less and less in the future as renewable energy grows, and the majority of these services can only be delivered by plant which are already operating.

"Rapid progress will need to be made to ensure that the electricity system can be operated securely and cost effectively using zero carbon ancillary services.

NESO will continue developing short and medium-term balancing service markets, in order to help deliver a cost-efficient system: NESO's Roadmap outlines measures to enhance utilisation of batteries in providing flexibility services" [1](p89).

6.11.47 Under an Ancillary (Balancing) Services contract, thermal plant would provide positive regulation (i.e. are ready to increase their output) by operating at a low level of power which can then be increased in very short order following instruction from NESO. Thermal assets which are already operating at higher levels of power are able to provide negative regulation (i.e. are ready to decrease their output) in a similar way by turning their output down following instruction from NESO.

6.11.48 BESS will be able to provide both upward and downward regulation by ensuring that they are entering their contracted period with a 50% State of Charge. This allows the BESS to import energy under instruction and store it until it is full (i.e. SoC reaches 100%), or export energy until it is empty (i.e. SoC reaches 0%).

6.11.49 **Table 6-1** shows how the provision of many services requires both an import and an export connection, which allows for the upward and downward regulation as previously described.

6.11.50 Not all grid connections have available import capacity, so it follows that where export and import capacity is available at a particular grid connection point, BESS should be considered and assessed. If those available connections are not used, it is possible that storage will not be able to come forward to the capacity and timings required to support the full integration of low carbon power into the UK electricity system because new connection points will be needed to connect the scale of storage foreseen as necessary by NGESO.

6.11.51 A co-located BESS is foreseen to undertake the following five types of operation during its operational life:

- Importing from the co-located solar facility when local solar generation is high but national generation is higher than national demand
- Exporting to the grid when co-located solar generation is low but national demand is higher than national generation
- Importing from the grid when national demand is low but national generation is high
- Exporting to the grid when national generation is low but national demand is high
- Importing or exporting from the grid under an Ancillary (Balancing) Service contract instruction from NGESO

Table 6-1: The potential contributions of a storage asset within the Proposed Development to the GB electricity market, including ancillary service provision
[Author analysis]

<table>
<tr><th>Service</th><th>Explanation</th><th>Applicability</th><th>Service Type</th><th>Connection</th></tr>
<tr><td>Trading</td><td>Forward balancing of anticipated energy supply with energy demand.</td><td>Solar assets generate energy. Storage helps by directing energy from when it is produced to when it is needed. Storage can be co-located with solar assets or developed independently.</td><td>Other</td><td></td></tr>
<tr><td>Balancing Mechanism</td><td>Being available to NGESO to balance supply and demand at delivery.</td><td rowspan="3">Solar will provide downward flexibility, if needed, but at the ‘cost’ of low-carbon energy unless that energy is instead stored. Co-located RES and storage can provide both upward and downward flexibility, and operating storage in support of a RES asset avoids the loss of any low-carbon energy generated by that asset. Stored energy can be dispatched over milliseconds to days, depending on technology and need.</td><td>Other</td><td></td></tr>
<tr><td>Frequency Response / Dynamic Services</td><td>Changing output over seconds / minutes to help maintain national system frequency at the statutory level of 50Hz.</td><td rowspan="2">Ancillary</td><td rowspan="2">Both</td></tr>
<tr><td>Reserve Operation</td><td>Changing output over minutes / hours to re-balance supply and demand following a fault or other event on the electricity system.</td></tr>
<tr><td>Reactive Power</td><td>Locational service which supports the ‘flow’ of power from source to destination.</td><td>A mandatory service for all transmission-connected assets, delivered by solar, other RES and storage assets</td><td>Ancillary</td><td>Export</td></tr>
<tr><td>Inertia</td><td>Helps to slow the rate of change of the electricity system in response to an unforeseen event, stopping faults from escalating.</td><td>Solar inverters are able to provide synthetic inertia. Storage also provides synthetic inertia.</td><td>Ancillary</td><td>Both</td></tr>
<tr><td>Black Start</td><td>A locational service which would help ‘turn back on the lights’ if the national electricity system failed.</td><td>Solar is unlikely to provide Black Start on a stand-alone basis. Stand-alone storage may be capable of providing limited Black Start support. A co-located asset is likely to be able to be more useful.</td><td>Ancillary</td><td>Both</td></tr>
<tr><td>Constraint Management</td><td>Changing output in response to local energy supply, demand and transmission conditions, to ensure locational adequacy at all timescales.</td><td>Solar can provide downward constraint management services. Co-locating solar and storage can allow for the provision of upward and downward constraint services.</td><td>Ancillary</td><td>Both</td></tr>
</table>

Service	Explanation	Applicability	Service Type	Connection
Infrastructure	By connecting generation assets where they are needed and where infrastructure already exists, less new electricity transmission and distribution infrastructure needs to be delivered.	RES and storage can help with reducing new infrastructure requirements, and sharing connection points by co-locating assets means that, ultimately, less connection points will be needed.	Other	

6.11.52 BESS will operate in the electricity market in response to a market need. Market need manifests as a differential in market price at different times, driving the BESS to import or export accordingly. A greater market need will drive a greater price differential. Electricity is bought and sold ahead of time (based on operational forecasts of supply and demand, see following) and also by NGESO much closer to (or at) delivery. Buying or selling ahead of time is called trading and commitments are then delivered through BESS operations, as is illustrated in the following. Any other operation at delivery will be under an Ancillary (Balancing) Services contract arrangement.

BESS Operational Parameters

6.11.53 Two important operational parameters which describe the size of a BESS are its power capacity and its energy capacity. It has already been stated that the size of the import connection secured by connection agreement with NESO at the point of connection is an important input into the maximum power capacity of the BESS proposed at a facility.

6.11.54 The following examples describe how the Operational parameters for the size of the BESS are related to each other, using as an illustration, a 100MW, 200MWh Li-Ion system.

6.11.55 Power capacity is measured in megawatts (MW) and describes the maximum instantaneous level of power export or import achievable by the BESS. This is analogous to the power capacity of a conventional generator.

6.11.56 Energy capacity describes how much energy the BESS can store. Energy equals power multiplied by time. Energy capacity is measured in megawatt hours (MWh) and can be described as MWh, simply hours, or by a C-rate.

6.11.57 For clarity, energy capacity does not relate to how long energy can be stored for (elapsed time between charge and discharge) although different technologies may have different technical or commercial factors which provide a practical limit to that elapsed time.

6.11.58 A BESS with 100MW power capacity would, at any specific moment, be able to import, or export (not both at the same time) up to 100MW of electrical power.

6.11.59 If that BESS was able to store enough energy to export at full capacity for one hour, it would have an energy capacity of 100MWh (100MW x 1h).

6.11.60 A BESS with two hours of energy capacity would be able to store 200MWh (100MW x 2h). This energy could be exported to grid at its maximum power rate (100MW) for two hours.

6.11.61 Once fully depleted (i.e. all stored energy has been exported from the BESS), the BESS would take two hours at full import power rate (also 100MW) to reach a full state of charge. The state of charge (SoC) can be measured as an absolute number (e.g. when full, the state of charge in this example would be 200MWh) or as a percentage of the energy capacity of the BESS (e.g. when full, the state of charge would be 100%).

6.11.62 The battery C-rate describes the ratio of the power capacity and energy capacity, and the C-rate is the inverse of the number of hours required fully to charge the BESS from empty to full. This example describes a 0.5C BESS which takes at least two hours to discharge all of its energy from full (100% SoC) to empty (0% SoC).

6.11.63 In reality, BESS are not normally operated across the full 0% - 100% range of state of charge, instead cycling across 80% to 90% of that range (i.e. from c.10% SoC to c.90% SoC) to preserve battery cell life. Neither are BESS 100% efficient, and a Round Trip Efficiency (RTE) measure describes the percentage of energy which has been imported to the BESS is then available for export. A current typical RTE value is 88%.

6.11.64 **Section 7.9** of this Statement shows how a co-located Solar and BESS scheme may operate and how the BESS may support the solar facility as well as fulfil additional functions to support high-RES electricity system operation in the UK energy market. In the examples given in that section, to simplify the explanation given on how BESS may operate, both round trip efficiency and the operational range of state of charge have been ignored.

6.11.65 **Section 10.2** of this Statement describes the commercial operation of the UK's electricity market and how changing levels of forecast supply and demand may affect electricity price. In summary, if over some future period of time, the national supply of electricity is expected to be higher than the national demand for electricity, then market price will be low. If national demand is forecast to be higher than supply over a different period of time, then market price will be higher.

6.11.66 A BESS which imports during lower price periods and exports that power during higher price periods will therefore help balance supply and demand in both periods.

6.11.67 Once charged, a lithium-ion BESS is able to hold its charge without significant depletion (charge leakage) for a period of at least days, meaning that BESS are able to import energy one day and export it the next.

6.11.68 In practice however, lithium-ion BESS are anticipated to provide short term balancing and electricity market operations and the long-term storage of imported energy in the BESS is not currently foreseen as a normal mode of operation for any lithium-ion BESS co-located with a solar facility.

6.11.69 Evidence on possible modes of operation of a co-located solar and BESS scheme are included at **Section 7.9**.

6.12 Conclusions on clean electricity supplies

6.12.1 This Statement of Need aligns with NPS EN-1 and concludes that many low-carbon generating technologies are urgently needed to meet the government's energy objectives by:

> Providing security of supply

> Providing an affordable, reliable system (through the deployment of technologies with complementary characteristics)

> Ensuring the system is net zero consistent

6.12.2 Government's Clean Power 2030 Action Plan sets out capacity ranges for key technologies for 2030 and 2035. The capacity ranges create a framework to help increase the pace of delivery of schemes which are more ready to be developed and can be connected to the grid in those timeframes. However, the capacity ranges do not constitute a government pathway [1](Connections Reform Annex, p5) and therefore should not be interpreted as a cap or ceiling on the requirement for low carbon electricity generation capacity.

6.12.3 This Statement of Need describes progress made in the development of as yet unproven, unconsented, or unfunded schemes or schemes with long or uncertain development timelines.

6.12.4 Yet, to address the ongoing climate emergency, it is critical that the UK urgently develops a large capacity of low carbon generation.

6.12.5 The evidence shows that there are many significant uncertainties associated with the development of such schemes, particularly in relation to the timeframes in which material contributions to decarbonisation and security of supply must be made. Put plainly, such schemes cannot yet be relied upon to contribute to the delivery of net zero and many simply will not be ready to contribute in a meaningful way to decarbonisation before the 2030s. Achieving meaningful progress in decarbonisation during the 2020s is of critical importance in the fight against climate change.

6.12.6 The evidence therefore points to the development of proven technologies such as large scale solar as necessary to mitigate against the potential for non-delivery of other technologies. Such schemes should be brought forwards with urgency to make tangible and essential advances in decarbonisation in the near term.

6.12.7 The government's current policy of developing market-led frameworks to support the development of low-carbon generation from diverse sources of energy remains important. Such schemes have the potential to complement the UK's growing renewable generation capacity to bring decarbonisation and security of supply benefits forwards before 2030 and beyond into the next decade.

6.12.8 Solar power generation has global momentum, and large-scale schemes are already being developed in GB. Solar is a proven technology. It is already delivering as part of the UK's electricity system and will continue to deliver further critical benefits to consumers through the urgent and continued decarbonisation, security of supply, and affordability.

6.12.9 The IPCC has stressed the importance of urgent action to decarbonise electricity generation, and the CCC have reported that the UK needs to commission more low-carbon generation, and more quickly, to meet its net zero obligations.

6.12.10 The prompt development and deployment of proven technologies, such as solar, is a lower-risk pathway for delivering low-carbon generation both now and for the longer term, than waiting for technologies which may not deliver.

6.12.11 This is consistent with the approach described in NPS EN-1 which articulates the prudence of planning infrastructure development on a conservative basis, including for scenarios in which the future use of hydrogen is limited. [2](Para 3.3.10).

6.12.12 Solar generation is needed in the UK to keep the country on course in its fight against climate change because it is a beneficial, fundable, and deliverable technology.

6.12.13 Flexibility of supply is also necessary to maximise the use of renewables when there is an abundance of generation, and to fill the supply gaps in periods of shortfall. Storage capacity is needed to increase to support renewable electricity generation capacity growth. The Proposed Development seeks to bring forwards co-located storage facilities as associated development to the main (renewable generation) development.

6.12.14 The Proposed Development should therefore be recognised for the critical contribution it will make to the UK's journey to a net zero and secure energy system. Consenting the Proposed Development, such that it will be able to be constructed and operated as intended, will bring the UK closer to its required track through to meet its legally binding carbon emissions reduction targets. The delivery timing associated with current forward nuclear and CCUS projections strengthen this conclusion.

6.12.15 It is vital that the development of low-carbon generation capacity occurs urgently in the near-term and also on an ongoing basis to facilitate wider necessary decarbonisation actions. It is important that schemes with long development timescales continue progressing their plans to achieve or sustain carbon reductions in decades to come.

6.12.16 Developments with the proven ability to achieve carbon savings comfortably within in the next decade are essential to keep the UK on its legally binding carbon reduction path.

6.12.17 An actual, potential, or aspirational pipeline for longer term low-carbon generation schemes presents additional opportunity for future decarbonisation. However, the presence of such a pipeline cannot legitimately be used as an argument against the consent and development of a scheme proposing to use proven technology and short development timescales, thereby delivering dependable decarbonisation benefits.

6.12.18 The Proposed Development is a viable proposal, which currently is planned to deliver in the late 2020s. It will achieve significant carbon reduction benefits through the deployment of a proven, low-cost technology at a very suitable grid connection. As such, the Proposed Development possesses exactly those attributes identified as being required to make material carbon reductions in the UK electricity sector.

7. Technical considerations for UK solar schemes

7.1 Chapter summary

7.1.1 This chapter provides an overview of the characteristics of solar power and the delivery of large-scale projects.

7.2 Large-scale and small-scale generators

7.2.1 Generation assets can be 'centralised' (connecting to the NETS) or 'decentralised' (connecting to the distribution networks or 'behind the meter' in consumer premises).

7.2.2 Electricity transmission networks operate at high voltages. High voltage operation reduces transmission losses and makes the bulk flow of energy over longer distances more efficient. Distribution networks operate at a lower voltage than the transmission networks, and are located closer to points of final demand. A lower voltage connection means that Generators which connect to distribution systems must be of a smaller capacity than those which connect to the NETS. Therefore, to connect the same total capacity of generators, more connections would be required at the distribution network level (at a potentially greater overall cost to consumers) than would be required directly into the NETS.

7.2.3 The NETS was designed to allow for the connection of large generating assets, but distribution networks were originally designed to transmit power to consumers. Distribution networks were not designed to connect significant capacities of electricity generation. Connecting generation assets of any meaningful size to distribution systems is becoming more difficult and more expensive (ultimately to the bill-payer). The Connections Action Plan includes an example of how distribution network constraints cause a significant delay to the installation of rooftop solar for an industrial consumer [17](p79). It is therefore not the case that the connection of renewable generation to the distribution networks is either quick, or cheap.

7.2.4 By virtue of their role in transferring power from the bulk NETS to businesses, built facilities and houses, many distribution networks are in built up areas, away from areas of large natural resource potential. Geographical and technical constraints may therefore arise as generators continue to be connected to these networks, applying upward pressure to the costs and durations required to grant a connection agreement. This may materialise as significant cost, timing, and complexity considerations both for asset developers as well as for consumers who ultimately pay for the developments and the operation of the complex distribution systems which result.

7.2.5 However, in 2023 31% of all generation capacity was connected to the distribution networks. FES net zero pathways project that the proportion may decrease up to 2030, but may increase in some net zero pathways by 2050, up to 35% [29](2024, Figure ES.07).

7.2.6 The proportion of generation capacity in 2050 connected to the distribution networks in the 2020s has decreased year-on-year in NGESO's analyses since the UK's commitment to net zero by 2050 was made.

7.2.7 This reflects the increased and urgent need for renewable generation capacity to come forwards, but with increasing complexity associated with connecting generation to distribution networks. An ongoing programme of work is seeking to increase the capacity of the NETS in as affordable a way as possible [70].

7.2.8 In their election manifesto, the government stated that "Local power generation is an essential part of the energy mix and reduces pressures on the transmission grid" [16](p54). Although the total capacity of generators connected to distribution systems is expected to grow, the total capacity of generators connected to transmission systems is also expected to grow.

7.2.9 Government states that "Wherever renewables can connect to the distribution network, this should be encouraged for reasons of speed and efficiency" [1](p63) but also that "Much of the generation capacity that will be deployed by 2030 is likely to come from large-scale, commercial energy infrastructure" [1](p78).

7.2.10 FES 2024 net zero pathways triple the capacity of generation connected to the transmission network (2050 vs. 2023 capacity) to a total of 238.5 – 247.5GW. The capacity of generation connected to distribution networks is projected to increase by a factor of approximately 3.3 (2050 vs. 2023 capacity) but to a smaller total of 95.1 – 131.4GW [29](2024, Figure ES.07).

7.2.11 A wholesale decentralisation of the UK's electricity system is not expected to occur in the next 30+ years, and even in the most consumer-led scenario, the share of generation capacity connected to distribution networks is anticipated to rise to only 35%.

7.2.12 Decentralisation is not in itself a strategy or a requirement of the energy system but is a trend which will go some way to delivering a flexible, low-carbon, and affordable energy system. Distributed generation will contribute to meeting carbon emissions targets and improving energy security.

7.2.13 While it is right to encourage local generation capacity growth, local generation alone will not replace the need for new large-scale electricity infrastructure to meet UK energy objectives [2](Para 3.3.12).

7.2.14 Operating a mainly national electricity system (as current) will likely be more affordable than operating multiple distribution systems, connected by a 'light' transmission system.

7.2.15 By connecting more decentralised assets to distribution networks, less power will flow on the NETS and its unit cost of operation, which must be passed to consumers, will increase.

7.2.16 However, to ensure local as well as national adequacy of supply, the connection of more assets to distribution systems would also require either investment in power transfer capability between each separate distribution system and the NETS, or a greater capacity of local low-carbon generation on each distribution system to manage local peak power security of supply.

7.2.17 In contrast, a system with a high proportion of transmission-connected assets would offer "a number of economic and other benefits, such as more efficient bulk transfer of power and enabling surplus generation capacity in one area to be used to cover shortfalls elsewhere." [2](Para 3.3.12).

7.2.18 Further, to accommodate more decentralised generation capacity, more investment will be required to reinforce distribution networks and provide more connection capacity.

7.2.19 Operating a primarily decentralised electricity system in the UK would also likely be significantly more complex than operating today's primarily centralised system.

7.2.20 Electricity consumers, either directly or indirectly, through their energy bills, pay for all costs related to both transmission and distribution systems, including market inefficiencies, economic decision making, asset investments, balancing actions, and transmission and distribution system enhancements. Energy bills will rise if existing assets are underutilised and/or reinforcements are required on other systems.

7.2.21 The NETS remains an important measure to maintain interregional connectedness, support the meeting of national peak demand "reliably in all areas" from geographically disparate sources whatever the weather [31](p182), and keep power flowing to consumers with the high levels of reliability consumers have come to expect and require.

7.2.22 The Applicant has accepted a Connection Offer from NESO to connect the Proposed Development to the NETS at High Marnham. This substation is connected to an existing part of the NETS with sufficient capacity to transmit the energy the Proposed Development will generate to consumers in the Midlands and beyond. See also **Paragraph 3.7.16** of this Statement.

7.3 Large-scale, brownfield and rooftop solar

7.3.1 Decentralised solar may be installed on domestic or commercial rooftops or on brownfield land. In relation to brownfield locations, some may be suitable for solar deployment, but others will not.

7.3.2 Many decentralised sites may be unable to source a cost-effective and timely grid connection to support a stand-alone solar site. Distribution networks, which by 2023 were already straining with 36GW of distributed generation [29](2024, Table ES.07), may also not be able to distribute the energy generated from new generators, even if connection points are found close to potential sites.

7.3.3 Many sites may simply not be suitable. They may be in areas of low solar irradiation, have unfavourable topography or be too small to develop in a cost-effective manner. Others may have remediation issues which render sites unavailable for solar development given potential costs or liabilities associated with cleaning up after prior activities.

7.3.4 In relation to roof space, larger commercial structures or buildings with shared roof space may have contractual issues relating to ownership, occupation, and upkeep which must be resolved prior to any solar development, or may not be resolvable in a timely and efficient way. Any roof space sloping to the north will be unsuitable for solar panels. Smaller buildings, listed buildings or those with period features are also unlikely to be suitable.

7.3.5 Other locations may be suitable from an engineering perspective but may be overshadowed by nearby taller structures or natural features which could significantly impact irradiation and output, and therefore yield and benefit. Shaded homes in built up areas may be a prime example.

7.3.6 Other roof space may need to be reinforced to accommodate the additional loading associated with solar infrastructure, all of which will add to installation costs for homes and businesses.

7.3.7 **Section 10.3** provides more information on the economics of solar power, and demonstrates that it is already among the cheapest forms of generation over its lifetime. However, the installation costs of small scale solar are significantly higher than that of large-scale solar on a £/kW (installed capacity) basis.

7.3.8 Very small installations, such as those on domestic roof spaces, may not be large enough to make solar installation viable once the ‘fixed’ costs of installation (e.g. design, scaffolding, cabling, and commissioning) have been accounted for. This is important because it is for bill payers to pay for the installation of small-scale generation at their properties, and installation costs for small-scale solar have increased both on an absolute scale and in relation to governmental estimates for the installation costs of large scale solar.

7.3.9 Figure 7-1 shows cost information relating to the installation of domestic solar panels from the government's Microgeneration Certification Scheme (MCS) [71], benchmarked against the capital cost range for small scale (domestic) solar PV and large-sale solar from the government's Cost of Electricity Generation report [72](2023). Capital cost includes development, construction, and infrastructure costs where appropriate.

7.3.10 The data shows that small scale solar (red area) to be two to four times more expensive to install than large scale solar (green area). During the period 2019 to 2021 inclusive, MCS data shows that actual installation costs were comfortably within the governmental estimated range. However, in mid-2022 installation costs rose to above the top of that range.

7.3.11 The reported installation cost for small schemes started to reduce again from a high in early 2023, back towards government's range, but it remains significantly higher than the governmental range for large-scale solar.

7.3.12 Many home or business owners may not have the capital reserves to pay for the installation of solar panels on their roof areas and others may not want them. Since the wind-down of the Feed in Tariff scheme, which was introduced on 1st April 2010 but closed to new applicants from 1st April 2019, previous governments have been silent on measures to support domestic and small commercial solar installations, other than the removal of VAT from installation costs.

7.3.13 The implication of these factors is that the real potential for decentralised solar in the UK is likely to be much lower than any gross potential identified when the suitability, availability, practicality, and economics of such developments are taken into account.

7.3.14 Further, the installation of many thousands of separate systems is likely to take longer than the installation of a smaller number of ground-mount systems to achieve the same capacity. This is an important point in relation to the required urgency for solar generation.

7.3.15 Data from the government's MCS scheme shows that the rate of small-scale installations increased near the end of 2022. The average installation rate from October 2022 to December 2024 inclusive, was 77MW per month. The average installation rate from January 2019 to September 2022 was just 23MW per month [71], [Author Analysis].

7.3.16 To achieve the top end of the government's capacity range of 45 to 69GW of operational solar by 2035 [1](Connections Reform Annex, Table 1) through microgeneration schemes alone, installation rates would need to increase by a factor of more than six, from their already record current level. This increase would need to start immediately and be maintained throughout the next 11 years.

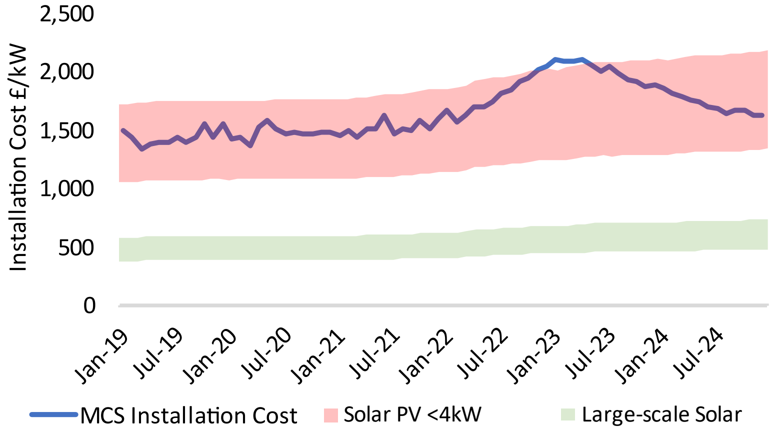


Figure 7-1: Reported and estimated small-scale and large-scale solar capital costs
(£/kW)
[71], [72]

7.3.17 Installation rates would need to reach and sustain an even higher level to meet the top of government's capacity range of 45 to 47GW of solar by 2030 [1](Connections Reform Annex, Table 1) from microgeneration alone.

7.3.18 It is the Applicant's view that this is not a credible projection and therefore large-scale solar schemes are also required in the fight against net zero.

7.3.19 Decentralised generation has an important role to play in decarbonisation, however on its own, smaller scale solar, including rooftop solar, is not likely to deliver a sufficient total capacity at the required pace and at an affordable cost to meet the government's targets.

7.3.20 This information shows that smaller scale solar, including rooftop solar, must be considered as additional to, as opposed to instead of, the need for large-scale solar.

7.3.21 Government has clarified that its capacity ranges for solar do not seek to prioritise or constrain rooftop solar deployment and are applicable to schemes of over 1MW in England and Wales. The threshold in Scotland is lower. [1](Connections Reform Annex, p5 & Table 1, Footnote 10).

7.4 Site selection for large scale solar

7.4.1 Site selection is a critical step in the delivery of projects with aims of meeting the UK national need for sufficient low-carbon, low-cost energy supplies to support legal decarbonisation targets and national energy security requirements. This section sets out, in generic terms, the assessment process for sites for large-scale solar generation in the UK. Further detail on site selection related to the Proposed Development specifically is set out in the **Planning Statement**

Appendix 1: Site Selection Report [EN010159/APP/5.5] and the **ES Volume 1: Chapter 4: Alternatives and Design Evolution [EN010159/APP/6.4]**.

7.4.2 Suitable sites will be:

- Capable of delivering to the required scale (in relation to the need for the scheme)
- Technically and environmentally feasible within the stated timeframes
- Commercially attractive to the developer

7.4.3 Site selection utilises a screening approach which considers possible alternative sites, taking into account the three requirements listed above. In addition, the screening approach recognises the required urgency of low-carbon development in the UK and therefore, in an approach which is consistent with guidance contained in NPS EN-1, applies a principle of proportionality to options which are vague or immature, [2](Para 4.3.28), especially where those considerations are critical for the viability of the project, on the grounds that they are not important and relevant to the Secretary of State's decision. The screening process will prioritise options which are more likely to be able to meet the intended aims of the project, over options which are less likely to proceed due to technical, commercial, or other reasons.

7.4.4 Solar developments require three fundamental technical attributes, and these therefore drive the initial screening process. These attributes (which are consistent with NPS EN-3 [3](Paras 2.10.18-48)) are:

- The existence and availability of sufficient land to deliver to the project to meet the scale set out in the scheme's aims
- The availability of a suitably placed point of connection to the NETS and/or local Distribution Network
- Solar irradiation levels which support the potential for the development to produce an energy yield which is both useful and economic

7.4.5 Other attributes will also apply later into the screening process, for example those environmental attributes described in NPS EN-3 Paras 2.10.27 to 2.10.48 and the potential for environmental impacts as described in NPS EN-3 Paras 2.10.73 to 1.10.126. However, a site which does not possess all three fundamental attributes is less likely to be a suitable location for large-scale solar generation than a site which does possess these attributes.

7.4.6 Further information on site selection for the Proposed Development can be found in the **Planning Statement Appendix 1: Site Selection Report [EN010159/APP/5.5]** and the **ES Volume 1, Chapter 4 Alternatives and Design Evolution [EN010159/APP/6.4]**.

7.4.7 The UK's approach to the energy sector provides that "It is for industry to propose new energy infrastructure projects that they assess to be viable within the strategic framework set by government" [2](Para 3.2.3). It is important therefore to acknowledge that an individual developer's approach to screening may not be rigid and inflexible but instead may be sensitive to local variability and indeed developer approach. Developers may therefore weigh the importance of one or more criteria in their screening approach differently for different schemes to accommodate and incorporate the needs and benefits of different geographies and local characteristics.

7.4.8 The site selection process also considers other factors which will not be a simple pass/fail for taking forward a site for development, but sites which are environmentally, technically, operationally, and commercially suitable will likely score favourably on a majority of important characteristics.

7.4.9 For example, adjoining land parcels may be both suitable and available for development, resulting in an increased density of solar deployment and an environmental footprint over a more focussed area of the countryside. Other proposals may consider separate land parcels which do not border each other but instead combine to an integrated scheme which is more dispersed within a countryside setting.

7.4.10 Further, the connection of separate parcels of suitable land together into a single scheme may, subject to analysis, enable those parcels of land to connect economically to the electricity system, whereas if developed as stand-alone schemes they may not be able to carry the associated costs of connection and therefore may never be developed.

7.4.11 Large-scale solar schemes, because of their scale and the area of land required for their development, are more likely to be sited in more rural areas of the country. In order to enhance the energy delivered from the installed capacity, schemes are also more likely to be sited in areas of higher solar irradiation levels.

7.4.12 **Figure 7-2** is a map of PV power potential in the UK. Areas of higher irradiance are identified by colours towards the red end of the spectrum, while areas of lower irradiance are towards the blue end of the colour spectrum.

7.4.13 The government's Digest of UK Energy Statistics (DUKES) [28](Table 6.2) shows that the installed capacity of solar generation in the UK rose above 10GW in 2016. Further, the average load factor of UK solar generation since that time has been 10.4% (min 9.9% in 2021, max 11.1% in 2018). A 10.4% load factor is equivalent to 910 kWh/Yr/kW(p), a value which corresponds to the boundary between the yellow to the right of 876kWh/Yr/kWp, and the darker yellow to the left of 949kWh/Yr/kWp on the scale shown in **Figure 7-2**.

7.4.14 Early experience in panel efficiency, system efficiency, site layout, and scale effects may mean that the load factor of existing solar in the UK is not as high as it would be if all existing solar facilities were re-powered with panels of a current specification and technical performance. However, from **Figure 7-2** it can be seen that any solar facility developed to the east of a line between Aberdeen to Manchester, and south of Manchester, could be expected to experience a higher load factor than the current UK average.

7.4.15 However, there may be reasons that developers bring forward schemes for consent which lie to the north and the west of those lines as they may also be beneficial to decarbonisation and energy security aims.

7.4.16 The approximate location of the Proposed Development, High Marnham, is shown in **Figure 7-2** by the green circle, where the solar resource is shown to be higher than the UK average.

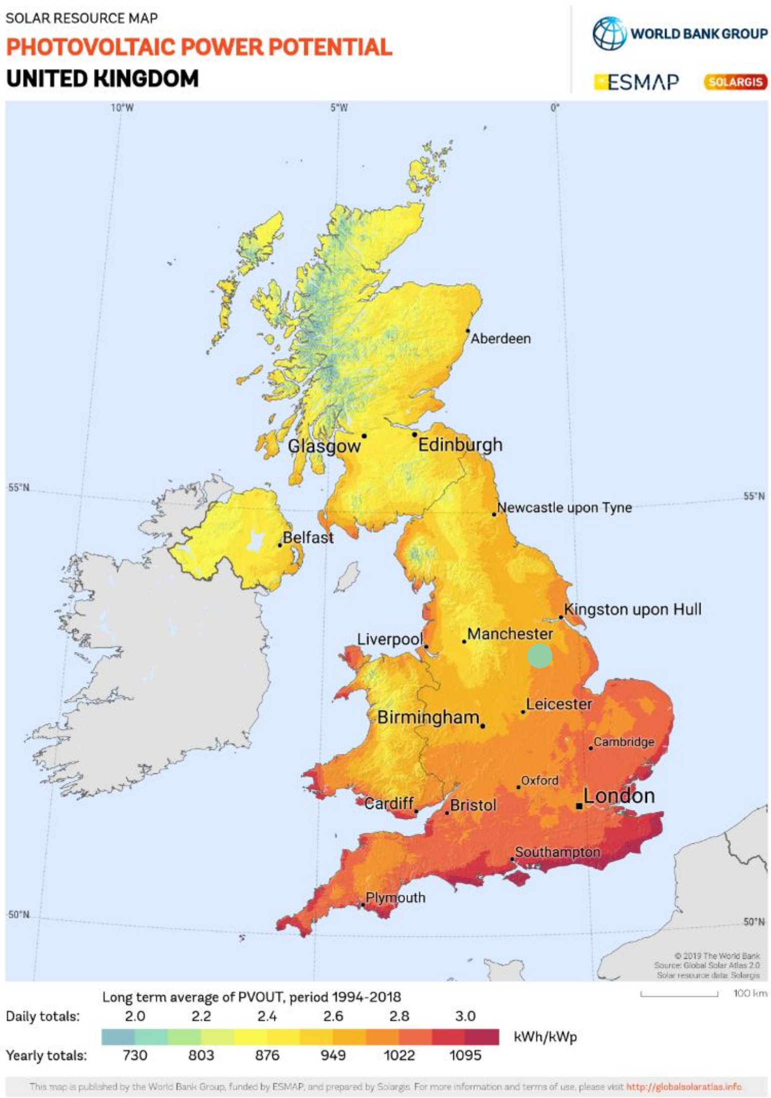


Figure 7-2: United Kingdom solar irradiation
[73]

7.4.17 Large-scale solar schemes are expected to connect to the NETS. The NETS is an existing national infrastructure asset which is designed specifically for the bulk transmission of energy from its point of generation to nationwide consumers.

7.4.18 NPS EN-3 states that:

"The capacity of the local grid network to accept the likely output from a proposed solar farm is critical to the technical and commercial feasibility of a development proposal." [3](Para 2.10.22).

"Larger developments may seek connection to the transmission network if there is available network capacity and/or supportive infrastructure" [3](Para 2.10.23).

"To maximise existing grid infrastructure, minimise disruption to existing local community infrastructure or biodiversity and reduce overall costs applicants may choose a site based on nearby available grid export capacity." [3](Para 2.10.25).

7.4.19 To enhance the overall benefit of the scheme in terms of environmental impact, efficiency, and timeframes for connection, schemes may elect to make use of existing and available points of connection to the NETS insofar as such connection points exist, in preference to building new connections or increasing the available connection capacity at existing locations.

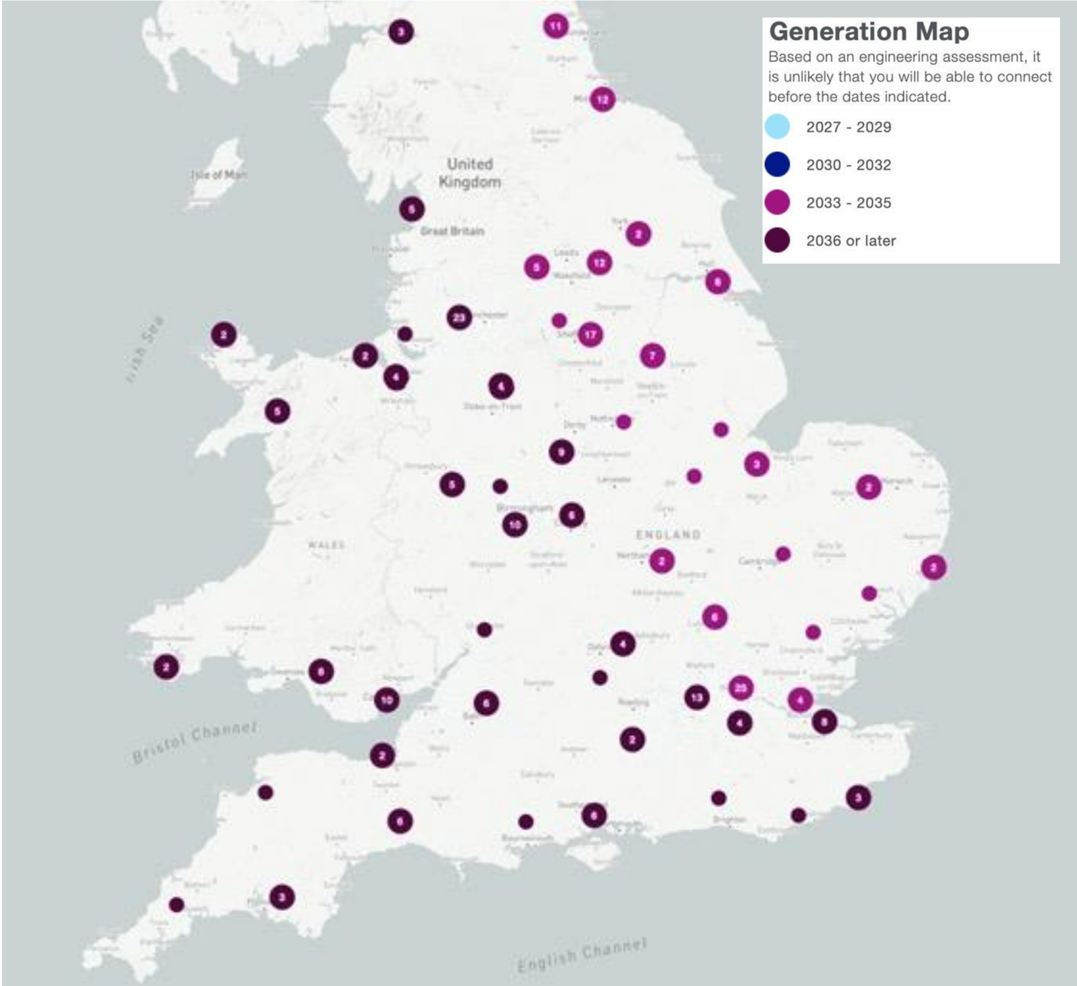
7.4.20 However, this is not always possible and new substations will be needed to facilitate the connection of schemes which are not located near existing substations. This is a similar development to that which has already occurred for offshore wind.

7.4.21 This substation is connected to an existing part of the NETS with sufficient capacity to transmit the energy the Proposed Development will generate to consumers in the Midlands and beyond. See also **Paragraph 3.7.16** of this Statement.

7.4.22 **Figure 7-3** following shows data from NGET's online ConnectNow Research Assistant [74]. The tool is a useful but sombre reflection of the challenge faced by the UK to bring new large-scale generation developments online in timelines which will support the urgent need for decarbonisation and energy security in the UK.

7.4.23 Each numbered circle on the map shows the number of connection points in that broad geography, and the colour represents NGET's view (current at the time of download of the map) of when a new connection might be achieved at each of those locations. The map shows that connecting any new assets (i.e. those which have not already secured a connection agreement with NGESO) to the NETS before 2032, is not currently possible.

7.4.24 It is important to recognise therefore, and as evidenced by the data shown in



7.4.25 **Figure** 7-3, that connection to the electricity network, which is an essential element of project development, is currently a constraint to many schemes which are coming forwards.

7.4.26 This issue has also been acknowledged by Ofgem who in May 2023 issued an open letter launching a policy review on reforming the electricity connections system [75] by NGESO, who are now working with the industry to undertake a review of the connections queue [76], and by the then government which published, in November 2023, a Connections Action Plan which explains these sets of actions and how together they will work towards delivering quicker connections for low-carbon generation assets [17].

7.4.27 The UK will therefore need largely to look to those schemes which already have connection agreements to deliver the low-carbon capacity required to support the delivery of net zero and energy security aims until the mid-2030s. Indeed, NESO paused connection applications received after 29th January 2025 to “enable resources to be dedicated to delivery of connections reforms at pace across 2025” [77].

7.4.28 Existing substations and existing transmission cables with spare transmission capacity, provide the opportunity to repurpose existing, therefore largely sunk-cost, infrastructure to connect new schemes to the NETS earlier than would be possible at entirely new connections.

7.4.29 The utilisation of existing and available infrastructure to meet the urgent need for new large-scale solar generation is an important factor in the site selection for the Proposed Development. The Proposed Development is to connect to an existing part of the NETS at High Marnham with sufficient capacity to transmit the energy the Proposed Development will generate to consumers in the Midlands and beyond. See also **Paragraph 3.7.16** of this Statement.

7.4.30 Further, in light of the urgent need to decarbonise the electricity system and the current lack of available connection points for low-carbon generation assets, developers may make use of different ways of maximising the generation potential from available and accessible land resource through any limited yet available grid connection capacity the project has secured.

7.4.31 Great Britain's energy transition to date has been characterised by the decommissioning of (primarily) coal fired power stations and the development of new renewable power plants. When power stations decommission, they leave behind the infrastructure used to connect them to the grid.

7.4.32 In light of the grid connection constraints identified above, the re-purposing of existing but unused infrastructure is an incredibly important strategy to help bring renewable power online in the timeframes required to support decarbonisation and security of supply.

7.4.33 Making best use of connections which are being upgraded for other reasons, as is proposed at High Marnham, also represents an efficient use of infrastructure.

7.4.34 Large scale solar schemes must connect to the grid via high voltage electrical cables. Locating solar schemes close to grid connection points will reduce electrical losses (which rise in proportion to cable length) and may also result in a scheme with a lower environmental footprint than a scheme located further away from the point of connection, which would have longer cable routes.

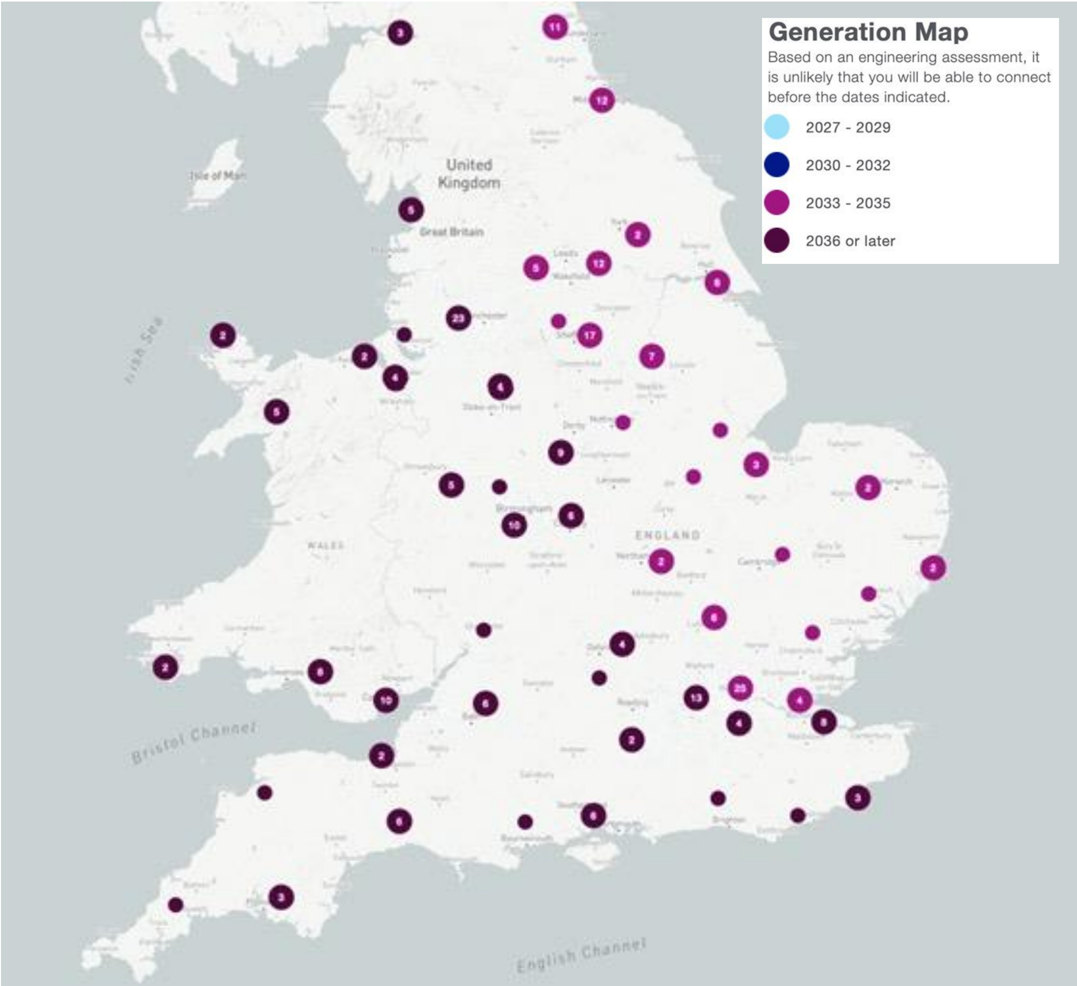


Figure 7-3: Transmission system connection points and potential connection dates
[74]

7.4.35 The location and capacity of an available point of grid connection is therefore a firm driver for site selection for large-scale solar schemes. However, due to the finite number of existing substations – and the smaller number of those substations with available capacity, it is also anticipated that:

- New grid substations may be needed to connect the anticipated capacity of solar required to meet net zero
- Sites may be located at greater distances from existing grid substations than previous developments

7.4.36 The number of locations in the UK which satisfy all three core site selection requirements (land availability and suitability, feasible irradiation levels, and grid connection availability) is limited. For example, high population density and a large extent of designated land limits opportunities for large-scale solar development in the south east of England (where **Figure 7-2** shows that irradiation is highest), and the need for proximity to existing and available grid connection capacity limits opportunities in the South West and East Anglia (where **Figure 7-2** shows that irradiation is also high).

7.4.37 It should therefore not be expected that large-scale solar is located only where irradiation is highest in GB, nor only where suitable land is available, nor only in close proximity to existing grid substations with available capacity. Developments will be proposed in locations with the blend of characteristics which is assessed as suitable for each scheme, and each scheme may have unique features which are particular to its proposed location.

7.4.38 Further evidence supporting the suitability of the location of the Proposed Development is included in **Chapter 8**.

7.5 Technology selection / orientation

7.5.1 NPS EN-3 provides guidance that, along with associated infrastructure, a solar farm requires between 2 to 4 acres for each MW of output [3](Para 2.10.17).

7.5.2 There are currently three main configurations of solar panel used in the UK, each has different physical and operational characteristics:

> Fixed South Facing (FSF) panels are installed in rows stretching from east to west, with the receiver side of the panel facing south. The panels will be fixed on frames at an angle to the ground (dependent on latitude and ground slope) which will have been optimised prior to installation

> Single Axis Trackers (SAT) are installed in rows stretching from north to south. A single table of panels rotates about the north-south axis so that the panel is perpendicular to the incident irradiation from the sun for as long as possible

> East-West (E-W) panels are installed in rows stretching from north to south, with panels facing both east and west and an apex between them. As with FSF, the panels will be fixed on frames at a set (immovable) angle to the ground

7.5.3 Panels may be orientated vertically (portrait) or horizontally (landscape) and may be mounted with one or more above (or next to) the first.

7.5.4 Different configurations have different benefits and disbenefits, and some configurations may be better suited to some locations than others.

7.5.5 As the sun tracks through the sky, both throughout each day and throughout the year, the inbound irradiation on the panels will vary and frames, axes and panels will be oriented to best optimise irradiation at that location, for that configuration, across the year.

7.5.6 A characteristic which is common to all three configurations is the potential for there to be a shadowing effect of one panel on another panel from time to time. Site designers will seek to optimise output given the specific location, the available land, and a known grid connection capacity and this will include reducing panel-on-panel shadowing effects where possible.

7.5.7 For example, latitude will impact on the effects of shadowing and site-specific mitigations for all layouts, but especially so for FSF schemes. At higher latitudes, rows of FSF panels on flat land may be spaced further apart to reduce shadowing effects, while at lower latitudes spacing on flat land may not be as large. This is because the sun tracks lower in the sky when seen from higher latitude locations, casting longer shadows.

7.5.8 Spacing FSF panels further apart increases the ratio of acres / MW for the installation, but also increases the expected generation from each of the panels and therefore has the potential to increase the ratio of energy generated over capacity installed (MWh / MW(p) / Year) for the scheme.

7.5.9 A similar analysis can be carried out for SAT and E-W configurations, however it should be noted that generally:

> SAT requires more land per MW(p) but has the potential to generate more MWh/MW(p) than FSF

> FSF requires more land per MW(p) but has the potential to generation more MWh/MW(p) than E-W

7.5.10 Other local characteristics such as location and land topography may determine which configuration or combination of configurations delivers the greatest benefit in terms of annual MWh generation from a proposed development while considering the land area used, cost of installation and ongoing cost of operation and maintenance of specific developments.

7.5.11 The Applicant’s **ES Volume 1: Chapter 5: Description of the Proposed Development [EN010159/APP/6.5]** describes that the Applicant is bringing forward a scheme which optimises use of the available grid connection capacity through the installation of panels in a FSF orientation.

7.6 Overplanting

7.6.1 This section describes key aspects of overplanting. The Applicant has included an illustrative layout for the Proposed Development as part of this submission in the **Illustrative Masterplan [EN010159/APP/2.7]**. Although overplanting is not achievable on all schemes, this illustrative layout indicates that the Proposed Development is coming forward with overplanting.

7.6.2 Overplanting has been proposed to increase utilisation of the available grid connection capacity vs. the case that no overplanting was considered. The ratio of overplanting considered at this scheme lies within the ranges described in this section and the impacts of the Proposed Development have been assessed including the overplanted capacity.

What is overplanting?

7.6.3 NPS EN-3 describes 'overplanting' as:

"The situation in which the installed generating capacity or nameplate capacity of the facility is larger than the generator's grid connection" [3](Para 2.10.55, Footnote 92).

7.6.4 NPS EN-3 also sets out that reasonable overplanting at a scheme should be considered as acceptable in a planning context as long as it can be justified and its impacts have been assessed through the planning process on the basis of the full extent of the scheme including any overplanting [3](Para 2.10.55, Footnote 92).

7.6.5 By selecting sites with the right blend of characteristics, developers will bring to commercial operation, solar schemes which deliver decarbonisation, security of supply, and affordability benefits.

7.6.6 An important consideration for developers is maximising the utilisation of the available grid connection capacity through the life of the scheme because schemes with greater lifetime outputs deliver greater decarbonisation and security of supply benefits and should also be more affordable. Location-specific commercial and environmental constraints also need to be respected in order for schemes to be consentable and financially rational.

7.6.7 Solar panels degrade as they age, and as they do they may produce less energy year-on-year for the same irradiation levels. Degradation is caused by physical processes relating to weather effects including the effects of light on the panels over time. Overplanting provides an opportunity to increase the quantity of valuable low-carbon, zero-marginal cost MWh of electricity transmitted from a solar scheme to the grid over its lifetime.

7.6.8 Overplanting is dependent on sufficient suitable land area to be available to the scheme for installing solar panels. Overplanting is commercially rational on all types of schemes subject to the availability and suitability of a sufficient area of land for overplanting the Proposed Development.

7.6.9 Similarly, locations with sufficient local, available, and suitable land but a capped grid connection capacity may seek to use that land by overplanting the scheme, thereby exporting more MWh to the grid over the life of the scheme.

7.6.10 However, there may also be rational reasons why a particular developer, at a particular location, does not pursue an overplanting strategy for that scheme.

7.6.11 Further, overplanting is commercially rational for both stand-alone schemes and schemes which include co-located storage facilities, although the optimum extent of overplanting at each type of scheme (including those with or without co-located storage) is likely to be different.

7.6.12 Indeed (and further subject to the availability of land and co-located storage technology chosen) different schemes may take different overplanting strategies.

7.6.13 It is possible that, at the application stage, applicants may not be sufficiently informed to lock in a preferred overplanting strategy for their scheme. In these circumstances, at the detailed design phase (i.e. post consent) the developer must judge the appropriate trade-offs to make to optimise a scheme at a specific location, subject to any conditions set out in the DCO. Some constraints may require judgement rather than pure quantitative analysis to resolve, and for that reason applicants often seek flexibility in DCO applications.

The benefits of overplanting

7.6.14 Overplanting increases the generation potential of a scheme through a fixed capacity network connection, especially when the effects of panel degradation are considered. But a balance is necessary. Overplanting implies that when irradiation is high and panels have not yet degraded, sites may be forced to self-curtail because, at those times, they will be generating more power than they are able to export. At these times, inverters will limit the amount of energy exported to the grid, and excess energy is lost. This is sometimes called clipping.

7.6.15 However, when irradiation is lower, such that panels are not generating to their maximum potential, it is clear that an overplanted scheme will generate more than a scheme which is not overplanted. This is because at those times output will not be limited by the grid connection capacity. This is illustrated in **Figure 7-4**.

7.6.16 The royal blue line in **Figure 7-4** shows output (against the dark blue connection capacity line) of a unitary solar scheme on an average irradiation day (left hand graph) and a high irradiation day (right hand graph). Note that the term ‘unitary’ is here intended to describe any scheme where the total capacity of the panels installed (MW(p), in DC) equals the export capacity of the scheme (MW, in AC). The grey line on each graph shows the output of a solar scheme which is identical to the representative scheme, except that it has been overplanted (i.e. it has more panels, but no more grid capacity, than the unitary scheme).

7.6.17 On an average irradiation day, more energy is exported from the overplanted scheme than the unitary scheme and no energy is clipped.

7.6.18 However, on a high-irradiation day, more energy is exported each hour from the overplanted scheme until the grid capacity limit is reached. At this time, the overplanted scheme experiences clipping. The output from the overplanted scheme therefore ‘flatlines’ until lower incident irradiation causes the overall output of the scheme to reduce below the grid export limit again, and more energy is exported each hour from the overplanted scheme until the sun sets.

7.6.19 As solar panels degrade, clipped energy volumes will reduce. This is because the peak output from a degraded scheme is lower than the peak output from a scheme which has not yet degraded. Therefore, under the same irradiation conditions, the maximum generation from the degraded scheme would be lower than the maximum generation from the scheme before degradation occurred.

7.6.20 In time, the maximum achievable generation from the scheme may fall below the grid export limit. This case is illustrated by the light blue lines in **Figure 7-4** which show overplanted schemes exporting more energy than unitary schemes and not incurring any clipping.

7.6.21 Schemes which are overplanted therefore generate more low-carbon electricity than unitary schemes. Overplanted schemes increase the utilisation of the available grid connection capacity throughout a scheme's operational life. This is a key driver of enabling the transmission of as many MWh of energy onto the grid through the (limited) available grid connection resource as is possible, noting that, nationally, grid connection capacity is currently constrained and is projected to remain constrained over the coming decade.

7.6.22 Degradation of solar panels may mean that panels need to be replaced through the operational life of the scheme. Other than in instances of the premature failure of individual panels (which would likely be replaced under a warranted maintenance arrangement) panel replacement is likely to be guided by data gathered through monitoring panel performance throughout the life of the project. This may be carried out on a rolling or programmed basis subject to any parameters which defined the assessment of the scheme's impacts on the environment.

7.6.23 The opportunity to overplant is driven by scheme-specific characteristics, such as available land area, cable access routes, grid connection capacity, panel orientation, and local irradiation levels. Overplanting (or the level to which overplanting is proposed) also has commercial drivers and these may differ from scheme to scheme and between developers.

7.6.24 It is therefore expected that solar schemes will overplant where possible while balancing commercial, geographical, and environmental considerations.

7.6.25 Developments which seek to make best use of available grid connection capacity will present as highly viable schemes and therefore will help to ensure that the need for large-scale solar generation can be fulfilled. This is an important and relevant factor in the decision-making process.

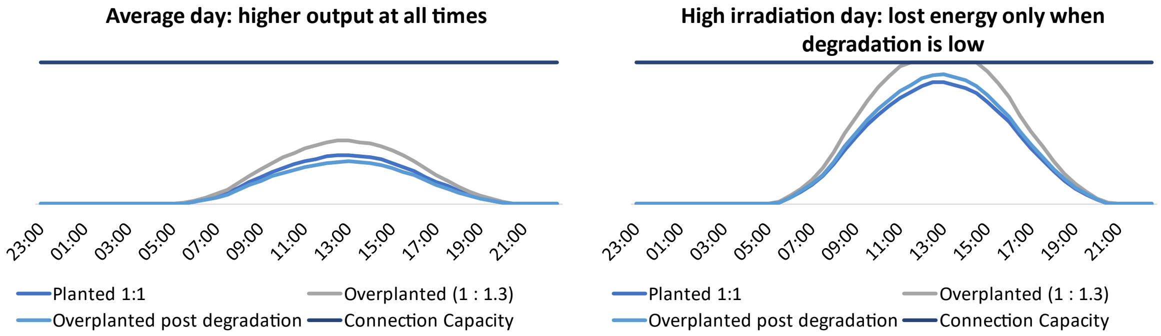


Figure 7-4: Illustrating clipped generation vs. optimised generation on overplanted solar schemes vs. unitary schemes
[Author Analysis]

7.6.26 Given the constrained nature of available connections to the NETS, developers of solar schemes typically look for suitable locations close to existing and available grid connection points.

7.6.27 Further, schemes which maximise the generation and transmission of energy through the available connection will deliver a greater quantum of national climate change and energy security benefit through their operation, than schemes which deliver less energy to the grid.

7.6.28 Developers are therefore likely to aim to make greatest use of the existing and available grid connection at their contracted substation, by which it is meant to design a scheme which will export to the grid, the greatest volume of low-carbon energy over the lifetime of the scheme.

7.6.29 Overplanting supports developers in achieving this aim, but there are limits to the benefits of overplanting.

Limits to the net benefits of overplanting

7.6.30 **Figure 7-5** and **Figure 7-6** show the results of an analysis of the average annual output of a solar scheme per MW installed (y-axis) as a function of the overplanting ratio (x-axis), for a Fixed South Facing (FSF) scheme.

7.6.31 These figures have been derived from inputs which are appropriate for UK-based solar schemes generally and therefore the conclusions following are also applicable across all schemes, excluding the impacts of location-specific parameters.

7.6.32 As the overplanting ratio of a scheme increases, clipped solar generation at times of high irradiation and early in the scheme's operational life increases. Those losses may be compensated for by greater output in times of lower irradiation and more generally later in operational life, as illustrated previously. The level of overplanting determines the overall balance between clipped generation during times of high irradiation, and incremental generation at times of lower irradiation.

7.6.33 **Figure 7-5** below illustrates the average annual output of a scheme through a Grid Utilisation metric (%) over the first 40 years of its operation.

7.6.34 Grid Utilisation is calculated as the total MWh exported through the grid connection during the life of the project, divided by the maximum MWh export possible through the connection during the life of the project, i.e. [grid connection capacity (MW)] x [project life (years)] x 8760 (hours/year).

7.6.35 The points on **Figure 7-5** show the lifetime Grid Utilisation for schemes with an overplanting ratio of between 1.0 and 2.2, at regular increments under a FSF layout. Clearly an underplanted scheme (i.e. one in which the MW peak installed solar generation capacity is lower than the grid connection capacity), would deliver a lower 40-year average grid utilisation factor than that of a scheme which is planted at unity, or one which is overplanted. Underplanted schemes therefore do not make the greatest use of the available connection capacity. Because connection capacity is nationally constrained, it is of vital importance that schemes which come forwards make the most of that contracted capacity.

7.6.36 The blue dotted line is the best fit straight through each ‘curve’ of points. This is for visual aid only, as it helps the reader to assess the gradient of the curve which passes through each point, and where that gradient changes.

7.6.37 As the overplanting ratio increases, so too does Grid Utilisation. However, beyond an overplanting ratio of approximately 1.6 (where the blue points are furthest above the straight trend line), the incremental benefit of overplanting on grid utilisation reduces (the points start to return back towards the straight line, and ultimately fall below it).

7.6.38 **Figure 7-6** following shows that the average annual output of a scheme over the first 40 years of its operation on a MW(p) basis (installed panel capacity) decreases only when the overplanting ratio increases above a certain level.

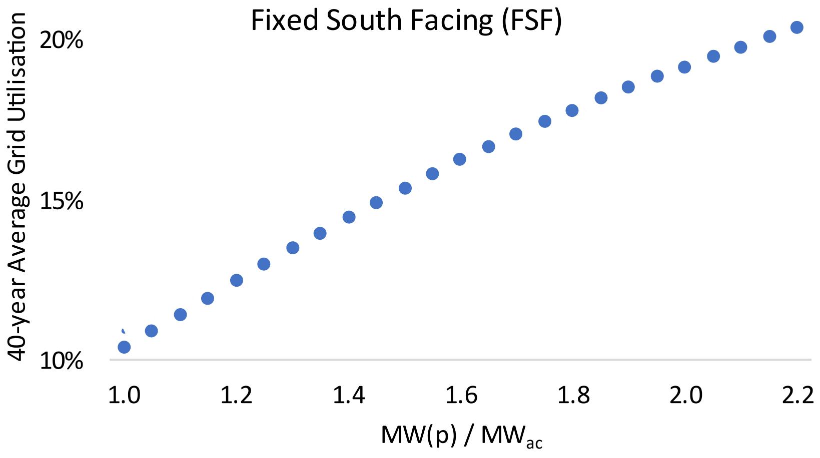


Figure 7-5: Grid Utilisation increases as overplanting increases, but gains are incrementally smaller above a ratio of c.1.6.
[Author Analysis]

7.6.39 Any scheme which has an installed capacity which is lower than its grid connection capacity would generate less energy than a scheme which is overplanted, and would therefore deliver a lower quantum of overall benefit to energy security and decarbonisation than that delivered by an overplanted scheme. Scale is therefore important.

7.6.40 Beyond an overplanting ratio of c.1.3, the curve between the points starts to turn downwards more steeply than it did for a lower overplanting ratio, implying an increasing inefficiency as overplanting ratio increases beyond c.1.3.

7.6.41 This analysis does not seek to establish 'hard and fast' rules around overplanting, but together **Figure 7-5** and **Figure 7-6** do provide quantifiable evidence that an overplanting ratio of between 1.3 and 1.6 is rational for this FSF scheme.

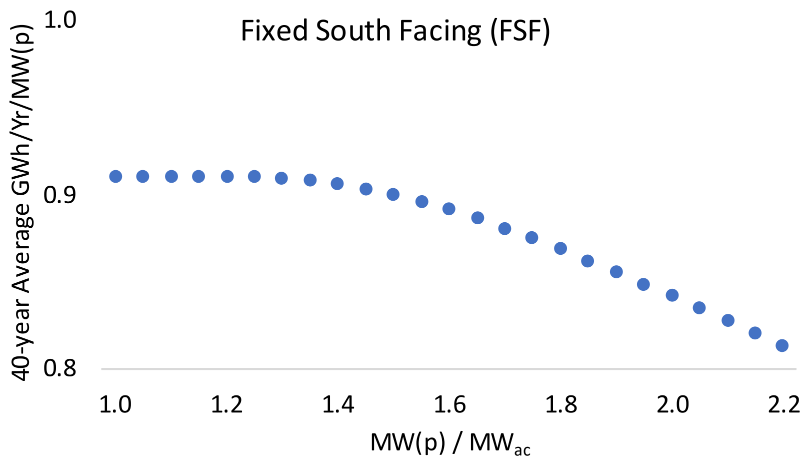


Figure 7-6: GWh/Yr/MW decreases as overplanting increases, and losses are incrementally larger above a ratio of c.1.3.
[Author Analysis]

7.6.42 The extent to which a proposed location can be overplanted cannot be determined in isolation, however. There is an intrinsic relationship between latitude, orientation, acreage, and overplanting which must be considered in the design of all developments in relation to optimising the benefits of the scheme, while respecting the planning balance. Further, local characteristics of a site, such as topography, archaeology, land, and other environmental factors which may influence the scope for overplanting.

7.6.43 The output from any illustrative design may be based on different ways in which the site may be laid out within the parameters which define the extent of the scheme, and which make use of an effective overplanting ratio. The final design and layout will reflect the available technology (and overplanting ratio) arranged in accordance with the assessed parameters.

Overplanting and co-located BESS

7.6.44 At proposals for co-located solar and storage facilities, the power and energy capacity of any co-located BESS facility will, alongside environmental factors, also be important in determining the level of overplanting which can be accommodated.

7.6.45 Generally, BESS facilities may be connected to generators through Alternating Current (AC) or Direct Current (DC) coupling. AC and DC coupled schemes provide different energy system benefits and different environmental effects.

7.6.46 There is no ‘one size fits all’ approach to optimising co-located facilities, however the co-location of BESS at solar schemes provides an opportunity for clipped generation to be stored and released when generation levels are lower.

7.6.47 AC-coupled BESS facilities are grouped in one or a small number of locations on site which may be in close proximity to the substation or may have very low LVIA impacts. DC coupled systems are placed in very many small groups, dispersed among the solar arrays.

7.6.48 Being located close to the grid substation means that line losses associated with power flows between the BESS and the grid are lower for AC-coupled BESS, while line-losses between the panels and the BESS can be lower for DC-coupled BESS.

7.6.49 Maintenance access must be available to all BESS groups through the operational life of the scheme, and some locations may render this unachievable for operational or commercial reasons. Schemes may therefore be better suited to one technology over the other from an environmental impact perspective.

7.6.50 These considerations may be significant when assessed over the anticipated operational life of the scheme. AC-coupled systems are currently more established in the UK market. The Proposed Development includes AC-coupled BESS which is considered by the Applicant to be more suitable than DC-coupled BESS at this location, for practical and operational reasons, including the consideration of suitable parcels of land within the red line boundary upon which BESS can be accommodated.

7.6.51 **Section 7.9** of this Statement provides further detail on the benefits arising from co-location of storage with solar schemes.

7.7 Land use associated with large-scale solar

7.7.1 NPS EN-3 indicates that along with associated infrastructure, a solar farm typically requires between 2 to 4 acres for each MW output [3](Para 2.10.17). Different configurations have different performance characteristics in terms of acres/MW(p), but MW(p) is not the only metric for the decarbonisation benefit brought forwards by solar schemes.

7.7.2 Lifetime average annual generation is the key metric which, if maximised for a scheme, provides the greatest decarbonisation and energy security benefit from the scheme. For a given scheme, lifetime average annual generation depends upon the overplanting ratio while taking into account the potential shading effects of panels on each other.

7.7.3 In extremis, it is possible for two panels to be located sufficiently far away from each other for neither to ever be in the shade of the other. In contrast, moving one of those panels to be directly in front of the other, would not change the total installed capacity (two panels) but would halve the annual output because the second panel would always be shaded by the first. The in-extremis example would however use significantly more land area than the contrasting example.

7.7.4 In reality, optimising lifetime average annual output across a large array of solar panels while respecting a finite land area and a finite grid connection capacity requires iteration and judgement and is a non-trivial task.

7.7.5 The inclusion of co-located storage as part of a scheme may also change the scheme's land take ratios.

7.7.6 Large-scale solar schemes are also efficient in comparison to other technologies in terms of the energy they generate over their lifetime on a per unit area basis.

7.7.7 Solar technology can also generate more energy per hectare of land than other electricity generation technologies, for example by growing crops for energy. By following good design principles, solar schemes can generate a similar amount of energy per hectare of land as onshore wind.

7.7.8 For example, a Guardian article [78] reported that 450Ha of crop is required to provide fuel for a 1MW biogas plant, implying that a biogas plant may generate 20 MWh per year per hectare of land used. A biogas plant which is fully available may therefore produce 2 GWh/Yr/km2 of clean energy.

7.7.9 An academic study published in 2020 [79] indicates that the installed capacity density of onshore wind farms in Europe is 19.8 (6.2–46.9) MW/km2, which is equivalent to 0.2 (0.06-0.47) MW/ha.

7.7.10 Guidance on industry norms for onshore wind farm developments in the UK suggests that turbine towers should be placed between six and ten rotor diameters apart from each other in order to optimise the output of each turbine. This separation is sufficient to ensure that no turbine lies within the 'wind shadow' of any other turbine. It is the Author's experience however that in practice, turbine towers on UK wind farms tend to be spaced between three and five rotor diameters apart, consistent with the findings of the academic study [79].

7.7.11 By assuming an annual load factor of 35% for onshore wind it is possible to calculate that onshore wind may generate 61 (18–144) GWh/Yr/km2, a factor of thirty more useful low-carbon energy than from biofuels.

7.7.12 NPS EN-3 states that UK solar typically uses between 0.8 (High density) and 1.6Ha (Low density) of land per MW of installed capacity [3](Para 2.10.17) which is equivalent to 62.5–125 MW/km2 and the illustrative design for the Proposed Development lies within that range.

7.7.13 By assuming a conservative annual load factor of 10% for solar [Author research], see also

7.7.15 **Table** 9-1, solar may generate 54–108 GWh/Yr/km2. At the midpoint of EN-3’s typical capacity range, large-scale solar may generate 72 GWh/Yr/km2 which is higher than the average reported in the academic study [79].

7.7.16 Biogas will generate just a small percentage of the levels of the two renewable technologies from the same area of land, while for efficient designs, the expected annual generation output per hectare of land for solar and onshore wind will be of a similar magnitude.

7.7.17 This analysis demonstrates that large-scale ground-mount solar schemes, including those that are developed with a configuration which maximises annual output, are likely to produce a greater quantity of low-carbon electricity per acre than the output from a crop-to-biogas application.

7.7.18 When compared to onshore wind, the energy production from land under solar is of a similar order of magnitude while the environmental effects of solar schemes may be significantly lower.

7.8 Solar cell efficiency

7.8.1 It is important to differentiate between the efficiency of solar technology (which is a measure of how much of the energy contained in the sunlight incident on the panel is converted into electrical energy) and the load factor, as described in **Section 7.7.18**. Both influence the output of a scheme.

7.8.2 The load factor of a scheme is influenced by the proposed location, the installed capacity of panels and their orientation and layout. The efficiency of a scheme is influenced by panel selection, the physical properties of those panels, the properties of other electrical components which make up a scheme, and the electrical design of that scheme. In summary, the efficiency of a scheme is intrinsic to its design, whereas the load factor is dependent on location, incident sunlight, and panel orientation as well as the efficiency of the scheme.

7.8.3 Solar panels and electrical infrastructure have become larger and more efficient, as shown in **Figure 7-7**, meaning that more electricity can now be generated from the same area of panel, and the same area of land than was previously possible. As a consequence, solar is now, and is expected to remain, a leading low-cost generation technology.

7.8.4 While they do not represent an independently sourced update to **Figure 7-7**, panel supplier product specification sheets can be used to assess the efficiency of currently available solar panels.

7.8.5 **Figure 7-7** shows that the efficiency of solar cell technology has increased over the last 40 years and that Crystalline-Si, Multi-Function, and Thin-Film technology cell efficiencies have increased broadly linearly.

7.8.6 A review by the author of 500W + solar panels commonly available on the open market in September 2024 found that they were advertised as being between 21% and 23% efficient and converted incident irradiation at a rate of 210 – 220W/m2 [Author Research].

7.8.7 For context only, over the period 2019 to 2022, coal generation in the UK achieved an average efficiency of 35.1% and the UK's CCGT achieved 48.6%. Both technologies emit CO_2 as a by-product of electricity generation [28](Table 5.6), [Author Research].

7.8.8 The same data reports nuclear efficiency of 39.9%, Hinkley Point C is expected to achieve 36-37%. Smaller gas-fired reciprocating engines achieve similar levels, but they too emit CO_2 when they generate. Wind turbines are 20 – 40% efficient at converting wind energy into electricity [Author Research].

7.8.9 The efficiency of solar generation is towards the lower end of the scale of efficiencies for technologies commonly used to generate electricity in the UK, but solar cell efficiency continues to improve.

7.8.10 It is important to recognise however that sunlight, the input energy source for solar generation, is abundant, predictable, renewable, low-carbon, and free. Wind is similar but can be more difficult to predict. Solar generation produces no marginal carbon emissions and no long-term radioactive waste. Therefore, the lower efficiency exhibited by solar technology versus other generation sources should not be considered as a material objection to its future use. FSF solar generation also benefits from free input fuel (sunlight), no moving parts, low height in comparison to other technologies, and zero-carbon operation.

7.8.11 Solar panel output increases as a product of panel size (area) and panel efficiency. Panel size has been and remains the key driver of panel power in newly released products, although efficiency increases have been achieved as a result of ongoing research and development.

7.8.12 Any increase in panel output due to increasing the size of each panel will not materially affect their coverage across a proposed parcel of land because the total area of panels which can be placed in the parcel will be broadly the same.

7.8.13 It is difficult to predict what the future capacity of a PV module will be, but manufacturers are constantly improving the technology. For example, one panel which became available in Q4 2020 was advertised at 21.3% efficiency, while a panel from a different manufacturer, which became available in Q1 2023, was advertised at 23% efficiency [Author Research].

7.8.14 It seems reasonable therefore to anticipate that panel efficiency will continue to increase at best linearly over the 2020s.

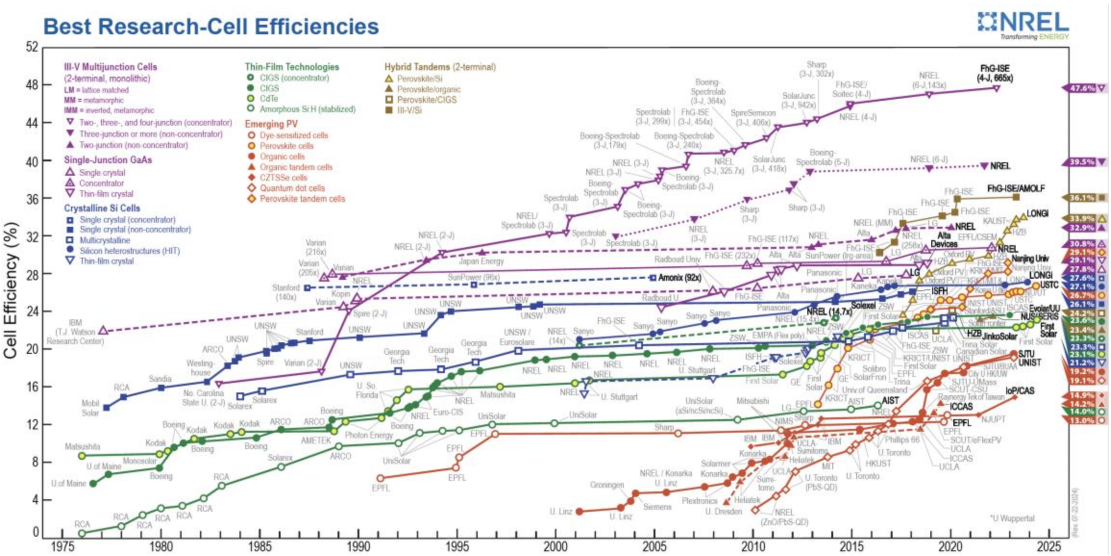


Figure 7-7: Evolution in solar cell efficiency 1975 - 2024
[80]

7.8.15 By installing more efficient panels, a facility may install less panels but the total coverage across a site is not expected to change significantly, and it is not a given that the installation of higher efficiency panels will result in reduced land take. Opportunities to enhance the overall efficiency of the scheme may materialise at the detailed design stage, for example by procuring more advanced (efficient) panels and spacing them out more (increasing the pitch) within land parcels to reduce shadowing effects or removing inefficient corners of fields that reduce infrastructure requirements.

7.8.16 Proposed designs can only incorporate products which are already available in the market. Similarly, detailed designs, which will be carried out post consent for a scheme, will only incorporate those panels which are available at the time.

7.8.17 At the detailed design stage, opportunities will be investigated to increase the lifetime generation output of the scheme and the benefits arising from its development, within the envelope of development secured at consent.

7.9 Co-location

7.9.1 NPS EN-3 states that:

“Government is supportive of solar that is co-located with other functions (for example, agriculture, onshore wind generation, or storage) to maximise the efficiency of land use”. [3](Para 2.10.10).

7.9.2 **Section 6.11** describes the role of BESS within a net zero energy system. BESS provide services which support the operation of renewable energy generation schemes and the efficient and secure operation of the UK’s electricity system provided that they are able to both import energy from and export energy to the electricity system.

7.9.3 BESS may be proposed as part of solar projects as a resource to hold energy generated by the solar farm during times of low demand and release it through the scheme's grid connection at times of high demand. If a scheme is to connect to the electricity system at a location where the scheme is also able to import electricity from the grid, a co-located BESS could allow energy to be imported from the grid at times of low demand and exported back to the grid at times of high demand.

7.9.4 At some locations, the former can be achieved without upgrades being required to existing grid connection substations, but at other locations, significant upgrades to transmission system infrastructure may be required to allow BESS to contribute fully to the electricity system.

7.9.5 Such upgrades may be time consuming and/or expensive. Waiting for grid upgrades to deliver before developing a scheme may delay the scheme's commissioning date, thus delaying the delivery of much needed renewable energy as a critical and urgent contribution to meeting net zero. Delays and increased costs may also increase the commercial risk associated with the scheme above the level at which investment may be secured, risking the deliverability of the scheme as a whole.

7.9.6 Developers may propose to install storage at sites which do not have a grid import connection, however current commercial, technical, and system operation considerations would suggest that storage is more beneficial to the electricity system, and more likely therefore to be developed, if it is able to both import energy from and export energy to the NETS, as well as store energy generated from the co-located solar panels.

7.9.7 The following Figures illustrate how co-located solar and BESS may work together under a number of different well-defined and distinct market scenarios. The reality of electricity market operation is that BESS and solar operations are unlikely to be so clearly defined and actual operations may vary significantly on a day-to-day basis.

7.9.8 For simplicity, **Figure 7-8** to **Figure 7-12** illustrate a 500MW solar array co-located with a 500MW, 1 hour (therefore 500MWh energy storage capacity) BESS, but the illustrations are applicable to larger arrays and co-located schemes with different energy storage capacity.

7.9.9 In each of **Figure 7-8** to **Figure 7-12**, the yellow bell-shape areas in sub-figures (a) and (b) represent solar generation which is transmitted to the grid through the day. The green areas represent energy imports to the BESS, and the red areas represent energy exports from the BESS through the day. In sub-figures (c) the blue area represents the energy stored in the BESS through the day.

7.9.10 The import of energy from the co-located solar facility is illustrated by a green area overlapping a yellow area. The import of energy from the electricity network is illustrated by a green area which does not overlap a yellow area.

7.9.11 For example, in **Figure 7-8** to **Figure 7-12**, the BESS is shown moving from 0% to 100% State of Charge and back again on each operation. In reality this may not be the case, and the BESS may instead undertake many more partial, rather than full, import/export operations.

7.9.12 Local solar generation is usually highest in the middle of the day, and national demand is currently highest in the evening (around approximately 17:00 in winters, 19:00 in summers).

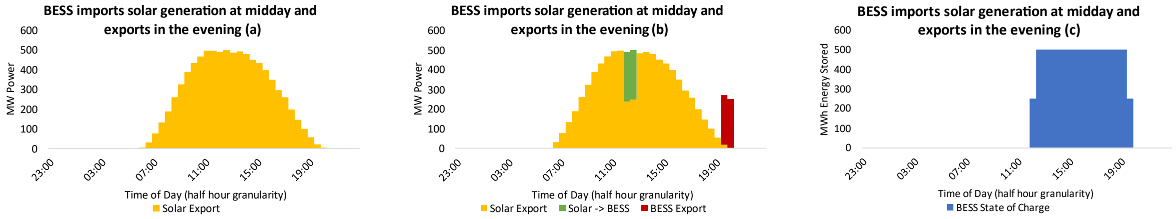


Figure 7-8: BESS imports solar generation at midday and exports in the evening
[Author Analysis]

7.9.13 **Figure 7-8(a)** represents solar generation at the facility over the course of one sunny day. If the asset operator's forward view was that energy may be in surplus in the middle of the day but would be needed in the evening, the operator could schedule the BESS to import from the solar generation during the middle of the day (**Figure 7-8(b)**, green area) and to export that energy later when it was needed more (**Figure 7-8(b)**, red area). **Figure 7-8(c)** shows the State of Charge of the BESS on that day.

7.9.14 The BESS may be configured to import and export at a lower rate than its maximum power output, this will allow it to import over a longer period and export as shown in **Figure 7-9**. Critically, the amount of energy the BESS can store is the same as in **Figure 7-8**. Operators would determine their rate of import and export according to market needs.

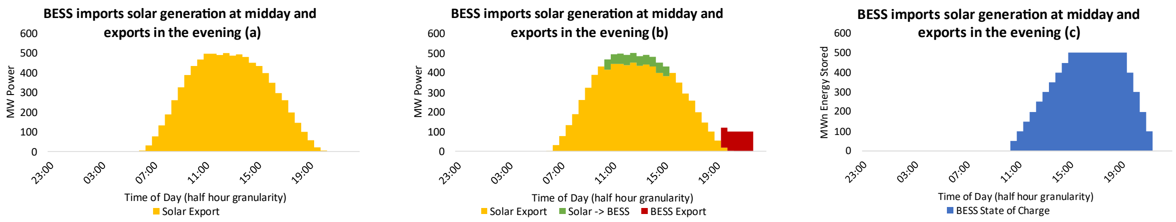


Figure 7-9: BESS imports solar generation at midday and exports in the evening – lower import / export rates
[Author Analysis]

7.9.15 National UK electricity demand varies through the day, and can also be different from day to day, for example weekdays versus weekends, or summer versus winter days. Additionally, solar is not the only variable renewable generation on the UK electricity system.

7.9.16 This means that at times when the BESS is not supporting the operation of the principal solar site, it may be useful for the BESS to support the national supply and demand balance by importing directly from the grid rather than from the co-located solar, as was shown in **Figure 7-8** and **Figure 7-9**. A good example of when the BESS might import from the grid in response to national supply / demand balance, might be when wind generation is high.

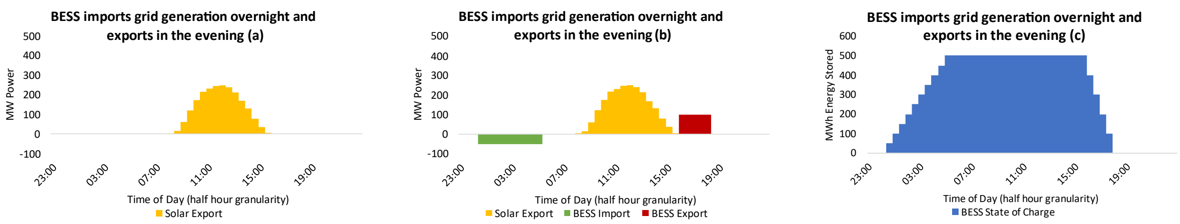


Figure 7-10: BESS imports grid generation overnight and exports in the evening
[Author Analysis]

7.9.17 **Figure 7-10** shows how the BESS may import overnight, store its charge through the day, and export in the evening peak. **Figure 7-10** uses a solar output profile which may be more typical of a winter's day, but the type of operation shown is not foreseen to be restricted only to the winter.

7.9.18 On some days, operators may foresee the market need for the BESS to operate more than one import/export cycle over a 24-hour period, and **Figure 7-11** shows how this might work. In practice, the BESS operational parameters will limit how the BESS is able to respond to market need.

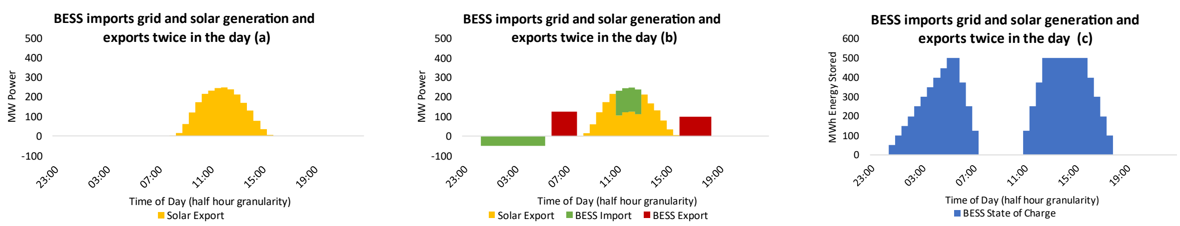


Figure 7-11: BESS imports grid and solar generation and exports twice a day
[Author Analysis]

7.9.19 Ancillary (Balancing) Services are contracted at relatively short notice (e.g. contracted 'today' for delivery 'tomorrow') and service time windows tend to be contracted in 4-hour windows, commencing 23:00, 03:00, 07:00, 11:00, 15:00, and 19:00 daily.

7.9.20 Subject to certain technical characteristics, BESS are also able to store clipped generation and export it to the grid when solar irradiation falls such that generation from the scheme is lower than the grid export capacity. **Figure 7-12** shows how this might work in practice.

7.9.21 **Figure 7-12** assumes an overplanted scheme (e.g. 600MW) connected to a capped (e.g. 500MW) grid connection. **Figure 7-12(a)** shows generation on a sunny day might exceed the grid connection cap for multiple hours and that generation is ‘clipped’. However, a co-located BESS may be able to store this energy, shown by the green area in **Figure 7-12(b)**, so that it can be exported when grid capacity is available as indicated by the red area in **Figure 7-12(b)**.

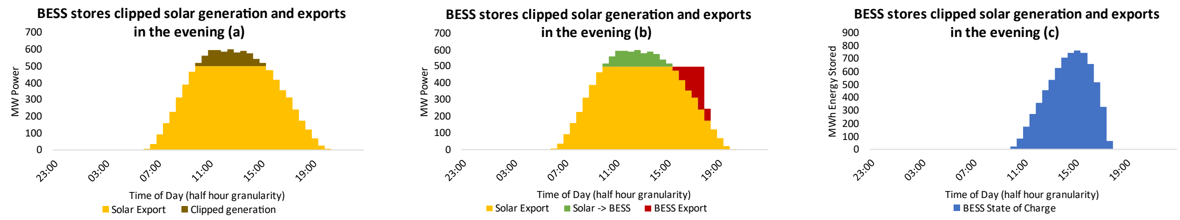


Figure 7-12: BESS stores clipped solar generation and exports in the evening
[Author Analysis]

7.9.22 Abundant generation can be stored in either AC- or DC- coupled energy storage facilities. Storage facilities which are DC-coupled to solar facilities use less equipment than AC-coupled facilities and therefore may provide a more efficient solution for storing abundant co-located generation, however, they require different physical layouts and therefore may not be appropriate for all schemes. The Proposed Development is coming forward as a co-located FSF solar scheme with AC-coupled batteries.

7.9.23 Ancillary (Balancing) Services help to keep the UK electricity system operating safely and securely. Some Ancillary (Balancing) Service contracts require BESS to provide upward regulation (export of energy to the UK’s electricity network) and others require downward regulation (import of energy from the UK’s electricity network). Some require both and providing both from the same facility is often a more economic option for both operators and NESO. To provide services, BESS would need to ensure that their State of Charge before they start a service window is appropriate for the service they are contracted to provide. This means that a BESS may therefore need to import or export to achieve an appropriate State of Charge immediately prior to a contracted period for Ancillary (Balancing) Service provision.

7.9.24 The UK’s electricity system operates at a nominal frequency of 50Hz and NESO procure services over very short timescales (sub-second response services) out to minutes or hours for reserve services to keep frequency always at or close to 50Hz.

7.9.25 BESS operation under reserve service contracts will be similar to the BESS operation shown in **Figure 7-8** to **Figure 7-12**, i.e. consistent importing or exporting over periods of minutes or hours at pre-agreed levels. BESS operation under response service contracts will however be different.

7.9.26 Response contracts require the immediate import or export of energy to the grid based on whether the instantaneous frequency of the grid is higher or lower than the statutory 50Hz. Importing energy into the BESS has the effect of reducing grid frequency (so import actions are instructed when frequency is high). Exporting energy from the BESS has the effect of increasing grid frequency (so export actions are instructed when frequency is low).

7.9.27 Under normal operating conditions, the frequency of the grid varies by small amounts from the statutory 50Hz level. Short duration injections (or exports) of energy to the grid nudge frequency back to the statutory level. **Figure 7-13** following shows how grid frequency changed second-by-second over a 30-minute period of operation in July 2023, and how a BESS operating under a Frequency Response contract may respond to those normal changes in grid frequency.

7.9.28 **Figure 7-13** seeks to illustrate that if frequency is moving away from the nominal 50Hz line, BESS will respond to bring frequency back towards 50Hz. The size of the green (import) and red (export) columns is intended to signify the magnitude of the BESS response, which would be driven by a combination of the rate of change of frequency (quicker changes require a larger response) and the magnitude of the variation of grid frequency from its nominal 50Hz at the time of the instruction.

7.9.29 In reality, BESS imports/exports may be much more frequent than those illustrated in **Figure 7-13**. In normal operational conditions, under Frequency Response, a BESS may import roughly the same amount of energy as it exports, leaving its State of Charge broadly unchanged over the contracted period. However, it is important that the contracted State of Charge is known before the contracted period starts such that in fault conditions, the BESS can be relied upon to deliver the extent of the services it has contracted with NGESO.

7.9.30 Co-located BESS with both an import and export capability will allow the BESS to charge from the co-located solar and from the grid whenever UK system supply was greater than UK system demand. This type of operation provides much needed flexibility to the UK power system and therefore will provide benefits to the UK system and decarbonisation generally.

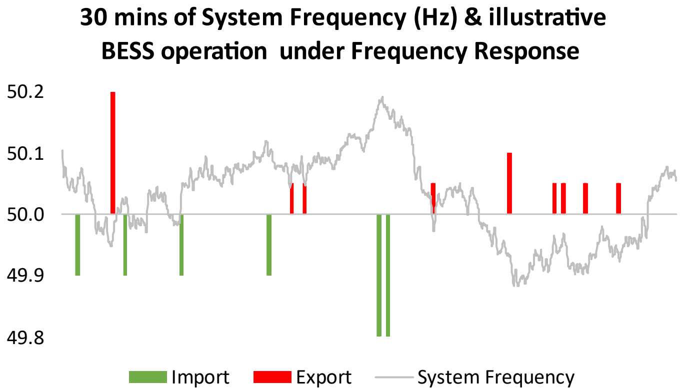


Figure 7-13: Illustrative BESS operation under Frequency Response type operation
[Author Analysis]

7.9.31 Being able to regulate power flows both to and from the grid would allow the BESS to provide many kinds of system-wide ancillary services which will support a further reduction in the UK's reliance on fossil fuels. **Table 6-1** provides more information.

7.10 Conclusions on technical considerations

7.10.1 Large-scale solar is a highly beneficial technology within the UK's electricity system.

7.10.2 Solar developments require locations to possess three fundamental attributes of sufficient available land, a point of connection to the electricity system, and sufficient solar irradiation levels.

7.10.3 Large-scale schemes which connect to the NETS allow for a "more efficient bulk transfer of power" for national consumption [2](Para 3.3.12) than smaller schemes which connect to distribution systems.

7.10.4 Connections to both transmission and distribution systems in the UK are in short supply. The use of existing and available connections is therefore necessary to support the delivery of low-carbon generation in the next decade to meet the previous government's aims for a zero-carbon electricity system by 2035, and the government's aim to deliver 'Clean Power by 2030'.

7.10.5 The development of new points of connection are also foreseen as necessary but are likely to have longer development timeframes than connection points which already exist, therefore the prioritisation of existing and available connections goes towards meeting the urgent need to decarbonise the electricity system.

7.10.6 Solar schemes represent an efficient use of land for energy generation purposes.

7.10.7 The efficiency of solar generation is towards the lower end of the scale of efficiencies for technologies commonly used to generate electricity in the UK, but solar cell efficiency continues to improve. Sunlight, the input energy source is abundant, predictable, renewable, low-carbon, and free. Solar's lower efficiency than other generation sources should not therefore be considered as detrimental to its future use.

7.10.8 Overplanting and panel layout optimisation can both increase the likely annual generation of schemes through their grid connection points. This goes towards best meeting the urgent need for solar generation within the context of a constrained grid connection queue. The Proposed Development's illustrative layout would deliver a commercially rational overplanting ratio.

7.10.9 Any optimisation of layout at a detailed design stage would be unlikely to identify any useful areas of land because any such areas identified would be likely to be around the edges of field margins and disconnected from other useful areas and therefore would have little or no agricultural value.

7.10.10 The connection of very many small-scale (including rooftop) systems to the aggregate capacity targeted by government under its mission to deliver 'Clean Power by 2030' will not, in isolation, meet the urgent need for solar. The installation cost of small-scale schemes, which would be met by individual households, is much higher than the cost of large-scale schemes on a per unit basis.

7.10.11 The inclusion of a BESS as associated development to the main solar scheme will support the operation of the main solar scheme and will be able to store energy generated by the main solar scheme and export it to the NETS when it is needed.

7.10.12 The Proposed Development includes an appropriate level of overplanting given the land area, grid connection capacity, and preferred FSF panel orientation. The AC-coupled BESS also included in the Proposed Development will support the operation of the main solar scheme and will be able to store any abundant generation and export it when it is needed. The characteristics of the Proposed Development seek to optimise the annual average generation over its operational life at its specified location.

8. Suitability of the proposed location for large-scale solar

8.1 Chapter summary

8.1.1 This chapter provides an overview of the evidence provided to support the suitability of the proposed location of the Proposed Development for large-scale solar plus storage.

8.2 Local Demand / decarbonisation requirements

8.2.1 The Proposed Development is to connect to an existing part of the NETS at High Marnham which has sufficient capacity to transmit the energy the Proposed Development will generate to consumers in the Midlands and beyond. See also **Paragraph 3.7.16** of this Statement. The Connection Offer provides for the export of up to 740MW of power, connecting in October 2029.

8.2.2 High Marnham is located close to an existing part of the NETS between West Burton and Keadby to the north and Staythorpe to the south. The NETS is well-connected and resilient in this part of the country. The Proposed Development is located near to National Grid's High Marnham substation.

8.2.3 Government's Clean Power 2030 Action Plan sets a regional capacity breakdown for the Midlands area (which includes High Marnham) of 4GW for transmission connected solar required for 2030, rising to 5.2GW for 2035. The capacity of consented transmission connected solar sites in the Midlands area is lower than the regional capacity breakdown for that area. This means that there is currently room for more transmission connected solar, such as the Proposed Development, in the Midlands, in NESO's prioritised connection capacity queue.

8.2.4 NESO's TEC Register lists eight schemes, including the Proposed Development, comprising 2.3GW of capacity with agreement to connect at High Marnham. These schemes are listed in **Table 8-1** of this Statement.

8.2.5 Although the Proposed Development proposes to connect to the NETS, it is located in the area covered by National Grid Electricity Distribution's East Midlands distribution network.

8.2.6 Grid substations and Grid Supply Points (GSPs) are where the generators connect to the NETS and/or the NETS connects to local distribution systems. At these points, voltage is reduced from the NETS high-voltage cables to lower voltages for more local transmission via Bulk and Primary substations, then on to consumers.

Table 8-1: NESO TEC Register entries for connection at High Marnham
[41]

Technology	Capacity (MW)	Effective from date
CHP + Solar PV	30	Sep-19
Proposed Development	740	2029
Solar PV + BESS	57	October 2029
Solar PV	100	October 2031
BESS	249	March 2033
Solar PV + BESS	400	October 2033
BESS	500	October 2034
Solar PV + BESS	240	October 2037

8.2.7 The East Midlands distribution area contains Bulk and Primary substations. These substations, and the distribution cables between them, are not of a sufficient capacity to facilitate connection of the Proposed Development.

8.2.8 However, these substations ensure that although the energy generated at the Proposed Development may be transmitted to consumers nationally without constraint, there is a network pathway from the Proposed Development to the local Bulk substations which service local consumers.

8.2.9 This does not mean that the energy generated at the Proposed Development will necessarily or solely service either local or national consumption, but it does mean that connecting the Proposed Development at High Marnham will enable the unconstrained flow of energy to either local or national consumers, whenever it is needed.

8.2.10 **Figure 8-1** shows that the East Midlands has a significant annual energy demand [12]. In 2022 18.8TWh of electricity was consumed, equivalent to around 7.3% of national electricity consumption. Transport needs in the region consumed 42.7TWh, and a further 54TWh (non-electricity demand) was sourced from other fuels such as coal, gas, oils, and biomass.

8.2.11 Total energy consumption in the East Midlands reduced by 13.9% over the period 2005 to 2022. Electricity consumption decreased by 21.5% and non-electricity consumption including transport decreased by 22.4%.

8.2.12 Transport increased by 5.2% over the period 2005-2022.

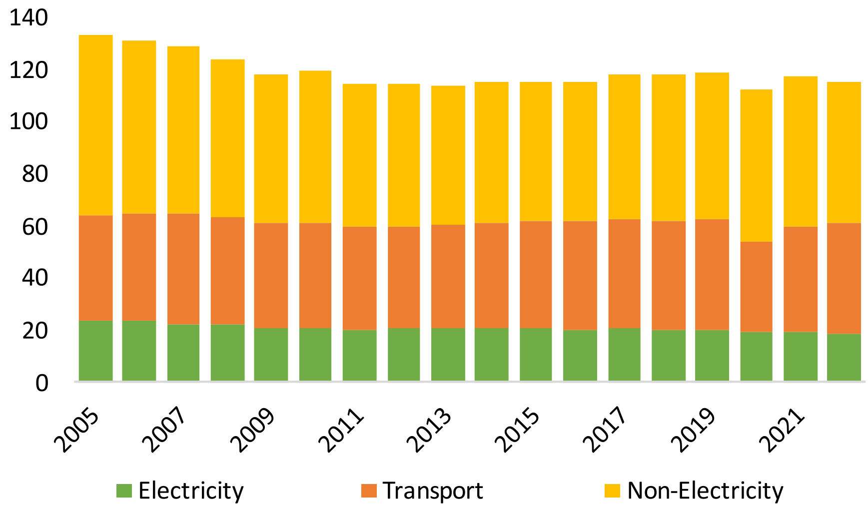


Figure 8-1: Energy consumption in East Midlands
(TWh/Yr)
[12], [Author Analysis]

8.2.13 The data shows that non-electricity consumption (including transport) in East Midlands, is four to five times greater than electricity consumption. A significant increase in electricity as a share of total energy consumption will be required in the future to meet net zero locally. These trends are broadly consistent with the national trend as described in **Chapter 5** of this report.

8.3 Local Supply

8.3.1 As part of its 2022 FES, NESO published a map of regional generation carbon intensity on two types of day (a higher wind day and a lower wind day) [29](2022, p32). The map is reproduced in **Figure 8-2**.

8.3.2 In 2023, the average national carbon intensity of generation was reported as 171 g/kWh [28](Table 5.14), i.e. at the 'high' end of the 'low' range shown in **Figure 8-2**.

8.3.3 The map on the left of **Figure 8-2** shows the carbon intensity of generation by region during a higher wind day, and the map on the right shows the same but for a lower wind day. The values indicate the installed wind capacity in each region at the time of publishing the map (therefore current capacities may be higher).

8.3.4 As expected, during windy days, the carbon intensity of generation is on average lower than the annual average figure. On days with lower wind, carbon emissions from electricity supply in Scotland and the north of England remains below the annual average, but from Yorkshire and North Wales and further south, the carbon intensity of generation is at best moderate, and may approach double the annual average figure.

8.3.5 Measures must be implemented to reduce the carbon intensity of generation outside of Scotland and the north of England during low-wind days. Solar generation is well suited to support a such a reduction.

8.3.6 Further, **Figure 8-2** suggests that there is carbon emitting plant located in the south of the country which currently generates when wind output is low. This can be inferred because at times of low wind, the carbon intensity of generation in the south of the country is high. During periods of low wind, NESO's analysis shows that the East Midlands area has the highest carbon intensity of generation of any of the other distribution areas in the country. The Proposed Development will, if consented, reduce the carbon intensity of generation in the East Midlands area in both 'low' and 'normal' wind conditions. The inclusion of BESS as part of the Proposed Development means that it will be able to store low-carbon energy when generation is in abundance and release it when demand for energy is higher.

8.3.7 As **Section 6.2** describes, solar and other renewable generation displaces carbon emitting generation from the grid and therefore has a decarbonising effect on the electricity system. The placement of any solar farms in these areas means that when the sun is shining their generation will be flowing through parts of the transmission system where otherwise the energy generated by carbon emitting plant would flow. It is unlikely therefore that the installation of solar schemes would cause any significant network constraints by connecting in these areas. Further information on the benefits of a multi-technology energy system can be found in **Chapter 9**.

8.3.8 **Figure 7-2** shows that the Proposed Development is located in an area with solar irradiation levels above average for the UK, and initial studies suggest that an average annual load factor before degradation at the site is sufficiently high to support the development of a large-scale ground mounted solar facility at the proposed location. The region is well positioned to use its natural resources and existing infrastructure to support the UK's energy needs through the development of the proposed large-scale solar scheme to generate clean electricity to power homes, locally and nationally, cars, offices, shops and factories.

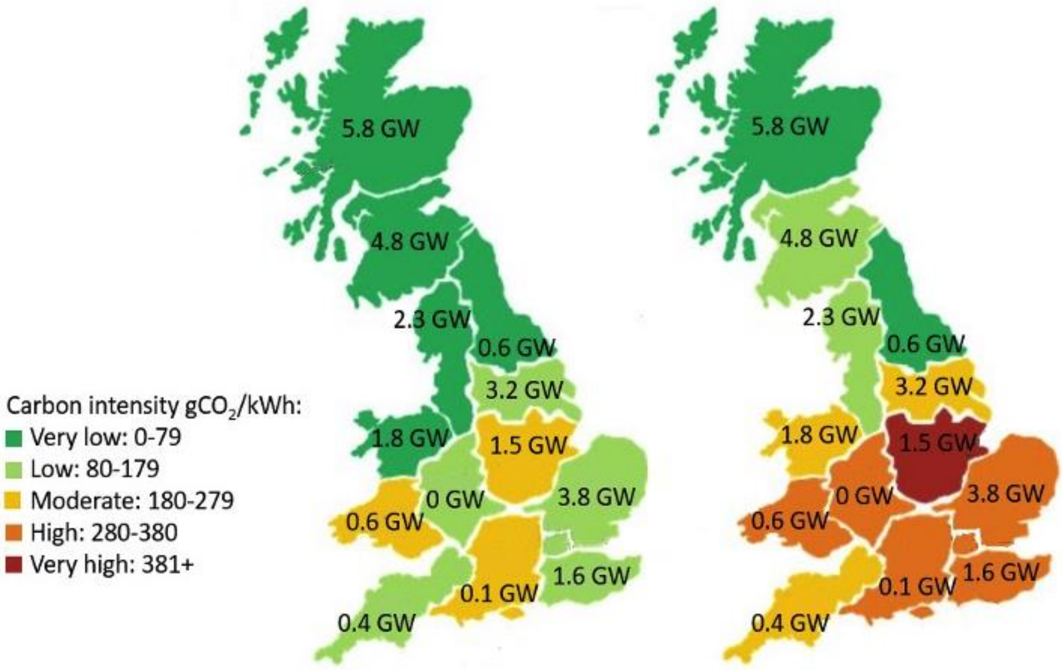


Figure 8-2: NGESO Regional generation carbon intensity analysis
(Left: a higher wind day, Right: a lower wind day. Numbers = installed wind capacity in 2022) [29](2022)

8.4 Grid suitability

8.4.1 Annually, NGESO perform an analysis of the NETS from a security and quality of supply (SQSS) and power flow capability perspective. Their analysis is published as part of their Electricity Ten Year Statements (ETYS) [81]. Options to improve power flow capability can be found in their Network Options Assessment (NOA) [70].

8.4.2 NGESO subdivides its network into operational areas by means of system boundaries. These boundaries are not hard, nor physical, but differentiate areas within which NGESO characterise power flows.

8.4.3 The ETYS looks at whether the current network allows GB national demand to be met through two lenses.

8.4.4 The first is the Security Criteria. This validates that the capability of each boundary is sufficient to allow the expected maximum flow across that boundary required to ensure security of supplies across the network. In other words, the maximum boundary transfer capability must be greater than that required to maintain, under reasonable ‘worst case’ conditions, security of supply at all locations on one side of the boundary with supplies from the other side.

“The boundary transfer requirements needed to satisfy demand without relying on intermittent generators or imports from interconnectors” [81].

8.4.5 The second is the Economy Criteria. This validates that the capability of each boundary is sufficient to allow the expected flow of power across the network such that a national merit order of operation is maintained. In other words, this criteria balances the need for cheap power to flow unconstrained across the network (therefore lowering prices and costs for consumers), against the enabling cost of upgrading the network:

"The boundary transfer requirements when demand is met with high output from intermittent and low carbon generators and imports from interconnectors. This ensures capacity is adequate to transmit power from highly variable generation without any network constraint" [81].

8.4.6 The NOA then identifies, assesses, and recommends (where appropriate) specific upgrade projects which meet the future needs as anticipated in the ETYS.

8.4.7 The Proposed Development proposes to connect a major existing 400kV transmission circuit which provides a connection through Keadby in the north to demand centres in the south and London.

8.4.8 Many of the main transmission circuits running south from High Marnham and the East Midlands area are double transmission lines, providing defence in depth. In the event that one line of a double circuit section of the NETS faults, power can still flow on the other line. Double circuits also deliver high power flow capability [81](Appendix A).

8.4.9 The East Midlands area is home to critical infrastructure connecting generators and consumers across the country. The strength and capacity of connections within these areas contribute to the transfer capacities available across nearby system boundaries.

8.4.10 High Marnham is located in NESO's North Midlands and North Wales transmission zone. This zone is connected to the surrounding NETS as shown in **Figure 8-4**. It is located between NESO's B8 and B9 boundaries.

8.4.11 B8 (North of England to Midlands) is one of the wider boundaries intersecting the centre of GB and separates the northern generation zones including Scotland, Northern England and North Wales from the Midlands and southern demand centres. B9 (Midlands to South of England) separates the northern generation zones and the southern demand centres.

8.4.12 **Figure 8-3** shows the current and projected level of boundary transfer capacity (thick solid red line) across the B8 (left) and B9 (right) boundaries. The fine solid red line shows the Economy Criteria and the dashed red line shows the Security Criteria for each year to 2042.

8.4.13 The transfer capability of Boundary B9 is currently 1.8GW higher than the transfer capability of Boundary B8. Both are expected to increase over the coming twenty years. Boundary B8 is expected to increase to 21.5GW by 2033 to accommodate power flows into the area from the north. Boundary B9 is expected to increase to 16.4GW as flows further to the south are anticipated to continue over the study period.

8.4.14 Decarbonisation of industry and demand located between the boundaries will increase electricity demand in the area, and the development of generation assets further south will also work to meet southern demand.

8.4.15 The boundary capacities are both expected to be above the range bounded by the Security Criteria through the study period and boundary capacities are projected to need to increase only from the late 2020s in response to the economy criteria level increasing as more renewable generation connects to the system. Therefore, connecting a large-scale renewable generator between the B8 and B9 boundaries is not likely to cause any incremental constraints under either the economy or security criteria.

8.4.16 The flow of energy from the Proposed Development will therefore be capable of displacing more expensive and more carbon intensive power generated south of the B8 and B9 boundaries. The displacement of carbon intensive power generation will be to the benefit of electricity system decarbonisation and consumer cost nationally.

8.4.17 The inclusion of BESS as part of the Proposed Development provides opportunities for NGESO to manage any potential power flow constraints on the NETS in the vicinity of the Proposed Development over its operational life. This may, for example, include any constraints which occur as a result of high wind or other causes, and minimising these in a cost-effective way would be to the commercial benefit of consumers.

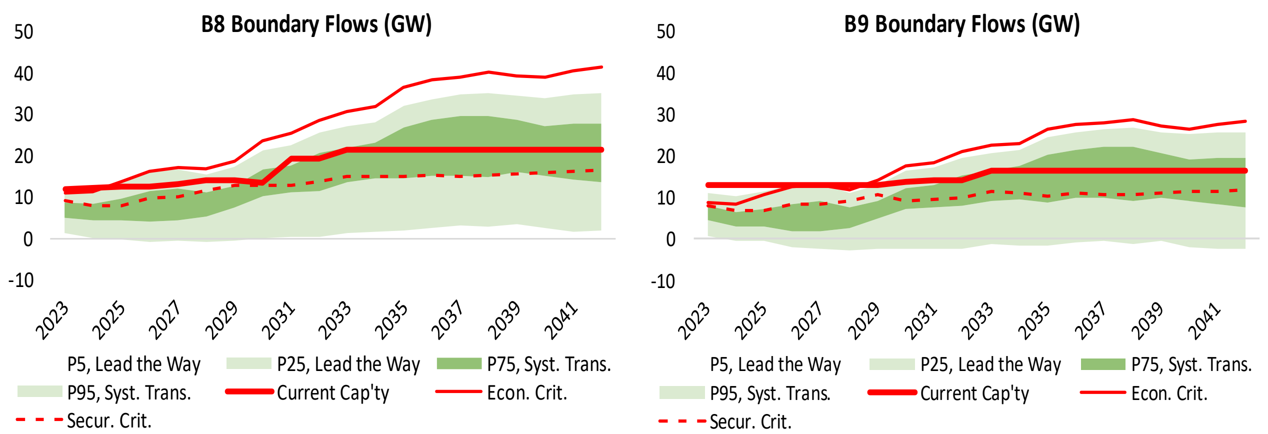


Figure 8-3: B8 and B9 Boundary flows under most extreme scenarios
[81](Boundary Data workbook)

8.5 Connection points / history

8.5.1 The East Midlands area is home to critical infrastructure connecting generators and consumers across the country. The strength and capacity of connections within this area contributes to the transfer capacities available across nearby system boundaries.

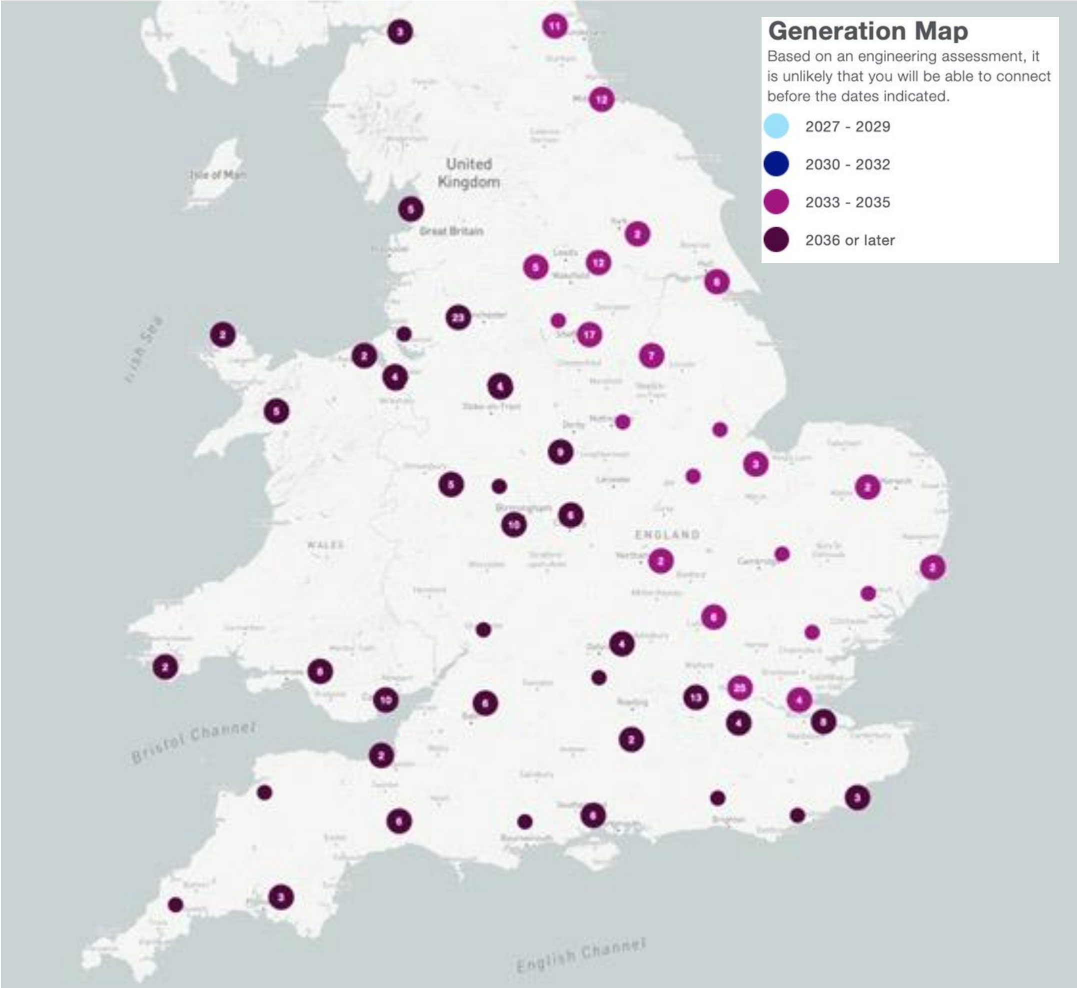
8.5.2 **Figure 8-4** shows a map of the NETS, with a 50km radius drawn in red and centred at High Marnham. High Marnham coal-fired power station closed in 2003, leaving the connection largely unused for over two decades.

8.5.3 Of the ten other 400kV National Grid substations located within 50km of High Marnham, four are already connection points for operational thermal generators. Two of these (Cottam and West Burton) and two others (Ratcliffe and Thorpe Marsh), like High Marnham, are connections formerly used by now decommissioned coal-fired power stations. Many of these connections and similar connection points further afield are being, or are proposed to be, re-purposed to connect new low-carbon generators to the NETS. This is an efficient and rational re-use of existing and available infrastructure.

8.5.4 However, **Figure 7-2** shows that solar irradiation near High Marnham is above the UK average.

8.5.5 Given that the opportunities to bring large-scale solar schemes located in this area to grid are limited, it is clear that the development of a scheme which makes use of existing and available infrastructure is rational when considered against the urgent need for significant new renewable generation capacities to connect in the next decade to support the drive towards net zero.

8.5.6 Using this connection and the available capacity in the transmission line to which it connects is critical to support the urgent deployment of low-carbon generation assets required to decarbonise the UK's electricity system.

8.5.7 

8.5.8 **Figure** 7-3 confirms that no new schemes (i.e. schemes which are not already listed on the TEC Register) are able to connect to any of those substations within 50km of High Marnham substation before 2032.

8.5.9 The Proposed Development will be an important part of the future generation mix connecting in the East Midlands, especially if any of the other schemes proposing to connect at High Marnham and other substations in the East Midlands are either delayed or cancelled. Existing and new grid connection infrastructure must be used to the greatest possible extent, to connect new low-carbon generation in timescales which meet the government's plans (and those of the previous government) to reduce national carbon emissions.

8.5.10 If existing and available grid connection points, including former coal connections, are not used to connect low-carbon generation at the earliest available opportunity, the deployment of low-carbon generation will be significantly slower and potentially a lower overall level of installed capacity than would be achieved if connections at former coal sites are used.

8.5.11 The Applicant's **ES Volume 1: Chapter 4: Alternatives and Design Evolution [EN010159/APP/6.4]** provides additional information on the Applicant's site selection process. See also **Paragraph 3.7.16** of this Statement.

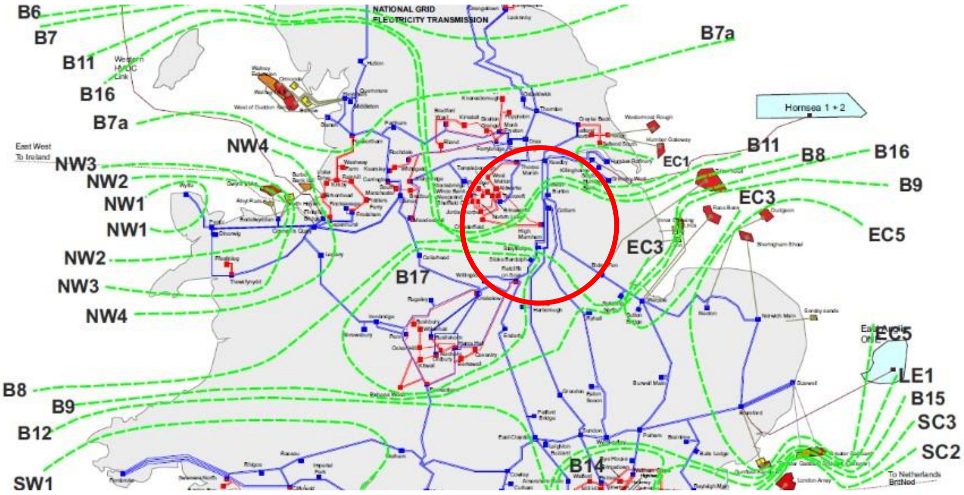


Figure 8-4: Transmission system within 50km of High Marnham
[81](Appendix A)

8.6 Conclusions on locational suitability

8.6.1 The East Midlands has a history of using its available natural resources to power the UK, firstly through coal and then through natural gas, piped from the UK Continental Shelf for local industrial and power generation use. This analysis, when considered in combination with **Figure 7-2** and **Figure 8-4** shows that the region is well positioned to use its natural resources and existing infrastructure to support the UK's energy needs for a third time, through the development of the proposed large-scale solar and storage scheme to generate, store, and release clean electricity to power homes, locally and nationally, as well as cars, offices, shops, and factories.

8.6.2 This Statement of Need demonstrates that the proposed connection point is suitable and no adverse operability effects are anticipated as a result of connecting at this location.

8.6.3 The Proposed Development has a Grid Connection Agreement with NESO. National Grid. As part of National Grid's connection reforms, "Energy generators that are not progressing [with project development] and will not meet their connection date will either be able to choose to move backwards or leave the [connection] queue, in order to make way for projects that want to connect and are delivering on their milestones" [76].

8.6.4 Subject to obtaining the necessary consents, the Applicant aims to construct the Proposed Development ready for connection to the NETS in line with the timeframes set out in the Proposed Development's Grid Connection Agreement.

8.6.5 Therefore, if consented, the Proposed Development would contribute to continuing the UK's decarbonisation and security of supply efforts prior to increases in electricity demand from non-traditional sectors in the 2030s.

8.6.6 If the DCO is not granted, then a critical opportunity will be missed to deliver a significant capacity of low-carbon solar generation capacity onto the NETS in the timeframes indicated. This would increase the risk of non-delivery of the UK's legal obligations because:

- The benefits which would have been brought forward by the scheme would need to be delivered by as yet undefined, unconsented schemes
- The criticality and scale of schemes required to deliver in later timeframes to make up for those benefits would both increase
- The pace and cost of delivery of such schemes would also likely be higher than in the case that the Proposed Development was consented

8.6.7 NPS EN-1 is clear on the point of need:

"The Secretary of State should assess all applications for development consent for the types of infrastructure covered by this NPS on the basis that the government has demonstrated that there is a need for those types of infrastructure which is urgent" [2](Para 3.2.6).

8.6.8 NPS EN-1 further states that "the Secretary of State has determined that substantial weight should be given to this need when considering applications for development consent under the Planning Act 2008" [2](Para 3.2.7) and that the "Secretary of State is not required to consider the specific contribution of any individual project to satisfying the need established within the NPS" [2](Para 3.2.8).

8.6.9 The need for the Proposed Development is urgent and substantial weight should be given to that need. The proposed location is a highly suitable location for large-scale solar because of the existence of a grid connection with the capacity available to connect the Scheme in the timeframes indicated, with sufficient solar irradiation, and suitable secured land at the site.

8.6.10 Further, the development of a large-scale solar development connecting at High Marnham provides the potential to help decarbonise local electricity demand to the benefit of consumers both locally and nationally.

8.6.11 The Applicant's grid connection at High Marnham is suitable and available for the Proposed Development to commission in the 2020s thereby permitting the Proposed Development to contribute to achieving the UK's Sixth Carbon Budget. Connection to the transmission system is of significant importance, enabling an unencumbered and efficient transfer of bulk power across the country, in order to provide electricity wherever it is needed.

8.6.12 The land included in the Proposed Development's proposals will support an optimisation of the available grid connection secured at High Marnham. The Proposed Development has been sized to optimise use of the grid connection from the proposed layout and BESS configuration, while being sympathetic to planning issues and respecting identified constraints.

8.6.13 FSF is currently preferred at the Proposed Development because of its enhanced lifetime MWh generation potential at the proposed location, given appropriate layout parameters and local constraints, including the availability of suitable land. The illustrative layouts would deliver a commercially rational overplanting ratio, and the inclusion of BESS as Associated Development to the Proposed Development will support the main solar site during its operational period.

8.6.14 Lastly, the electricity network local to the Proposed Development has sufficient capacity to accommodate the anticipated generation from the Proposed Development without constraint. By connecting between the B8 and B9 boundaries, the anticipated generation is not expected to exacerbate existing network constraints often associated with periods of high generation in northern wind farms.

9. The contribution of large scale solar to system security

9.1 Chapter summary

9.1.1 This chapter provides an overview of the system security benefits of large-scale solar in the UK.

9.1.2 Decarbonisation is just one of the three pillars of GB energy policy. Low carbon generation of all forms, solar, wind, and nuclear included, brings with it new challenges. Current and future energy policy and related actions must ensure that security of supply is maintained, and that electricity is affordable for all. This chapter demonstrates how solar has contributed, and will continue to contribute, to security of supply in Great Britain. As set out in NPS EN-1:

"[The government] need[s] to ensure that there is sufficient electricity to always meet demand; with a margin to accommodate unexpectedly high demand and to mitigate risks such as unexpected plant closures and extreme weather events" [2](Para 3.3.1).

"The larger the margin, the more resilient the system will be in dealing with unexpected events, and consequently the lower the risk of a supply interruption" [2](Para 3.3.2).

"We need a diverse mix of electricity infrastructure to come forward, so that we can deliver a secure, reliable, affordable and net zero consistent system during the transition to 2050 for a wide range of demand, decarbonisation, and technology sources" [2](Para 3.3.19).

"A secure, reliable, affordable, net zero consistent system in 2050 is likely to be composed predominantly of wind and solar" [2](Para 3.3.20).

9.1.3 'Security of supply' means, essentially, keeping the lights on in people's homes, and has two main components:

- Ensuring that there is enough electricity generation capacity available and operational to meet demand (adequacy)
- Ensuring that the quality of electricity supplied to customers falls within a narrow 'quality' band during all reasonably foreseeable operational circumstances and is resilient during rare excursions from this band

9.1.4 This definition of adequacy includes not only the capacity of generation assets but also the availability of source fuel to those assets so that they are able to generate electricity.

9.2 Power system stability

9.2.1 Power systems connect supply (sources of power, largely generators) to assets which demand power (industrial, commercial, or domestic customers). Power systems are complex; yet they must be designed and operated safely, securely, and economically.

9.2.2 Governments define policy to ensure that adequacy requirements are met, i.e. that there is sufficient generating capacity (i.e. the maximum achievable level of power generation which may be connected to the NETS) available to meet maximum expected demand, with secure and economic supply chains for the fuel they use to generate electricity.

9.2.3 Key power quality characteristics (including frequency, voltage, and power shape) must also be controlled for the electricity system to operate without fault. NGESO define this topic area as system operability, specifically: “the ability to maintain system stability and all of the asset ratings and operational parameters within pre-defined limits safely, economically and sustainably” [82](p5).

9.2.4 Keeping an electricity system from entering fault conditions during operation or returning an electricity system to normal operational conditions post fault, is also important. All large-scale generators must be capable of maintaining their own synchronicity with the system to a high level of reliability.

9.2.5 NGESO also ensure that power demand, or load, and power supply, always remain balanced. Balancing requires the right generating assets to be connected and disconnected to/from the right power levels, and at the right time. This can sometimes be at short notice, in response to emergent (fault) conditions. NGESO call those services which support NETS stability and operability are called Ancillary Services and examples have been listed previously in **Figure 6-8** and **Table 6-1**.

9.2.6 The NIC addressed the topic of system stability by stating that it is "Important that generators are responsible for costs and benefits they impose on the system, such as those related to where they situate" [83](p40).

9.2.7 It is well understood that the activities associated with integrating renewables into the GB electricity system will increase as the capacity of renewables grows. Energy balance must be managed at all times; and as renewable capacity increases, a greater volume and range of Ancillary Services may be required to maintain or regain supply / demand balance and retain system control, particularly when demand is either very high or very low. Balancing actions may also increase.

9.2.8 Technological advances, in particular in the introduction of power electronics into generating assets, is increasing the ancillary services and system stability services available from users of the electricity system, for example, by improving an asset's response speed and capability to system faults, and their ability to withstand periods of system instability without disconnecting.

9.2.9 The installation of power electronics at low-carbon generation assets is an exciting development which will enable them to provide important system stability services as part of their normal daily operational routine. By reprogramming the digital power inverters attached to solar panels, services required by the ESO can be delivered from solar generation facilities. Some solar farms already operating have incorporated state-of-the-art power electronics into their designs, and are providing important stability services to the ESO.

9.3 Power system adequacy

9.3.1 Solar plays an important role in diversifying renewable generation sources to maintain adequacy and minimise curtailment.

9.3.2 The uncontrollable nature of the weather raises a potential challenge to the ability of solar generation to play a significant role in electricity supply. However, the variability of solar generation can be mitigated by:

- Developing larger generation capacities (to maximise output during periods of low irradiation, for example through overplanting)
- Connecting assets to different parts of the NETS
- Developing projects with generation profiles which are complementary to solar (for example wind: see **Section 9.5**)

9.3.3 'Integration technologies' may also be used to respond to the intermittency of renewable generation, including electricity storage, interconnection, hydrogen, and demand side response [2](Para 3.3.6). 'Integration technologies' will help balance supply and demand, improving the efficiency of the electricity system as a whole and potentially reducing the installed generation capacity required to meet peak demand.

9.3.4 NESO state that security of supply "refers to meeting all electricity demand at any given time" and that "Traditionally, risks to meeting electricity security of supply, have been at times of high demand." However, "as we move to higher volumes of weather-dependent renewable energy, we will also face additional challenges around both the oversupply and undersupply of renewable generation" [29](2024, p99).

9.3.5 The Capacity Market, which is one of the UK's primary measures for delivering security of supply, applies a de-rating factor to contracts on a technology-by-technology basis. All technologies attract a de-rating factor, and all de-rating factors are lower than 1. This highlights that no single technology can be relied upon to deliver security of supply at all times (otherwise it would have a de-rating factor of 1).

9.3.6 Critically, the de-rating factor for solar in the Capacity Market has nearly tripled for projects contracting capacity over the period 2021/22 to 2027/28 [84] from 2.34% to 6.35%, demonstrating how quickly the market is moving away from traditional norms of supply risk at winter evening peak times only, and how important a multi-technology mix is to the achievement of security of supply for consumers at all times of the day and year.

9.3.7 The Energy White Paper describes that meeting a possible doubling of electricity demand by 2050 “would require a four-fold increase in clean electricity generation with the decarbonisation of electricity increasingly underpinning the delivery of our Net Zero target” [19](p42).

9.3.8 A significant increase in UK electricity generation capacity is required to meet growing demand and deliver security of supply under different weather conditions. Because the weather is uncontrollable, more capacity is needed to ensure that demand can be met even when renewable output is low. The implication is that when renewable output is high, there is a risk of oversupply. The laws of supply and demand in liquid markets such as electricity, imply that at times of oversupply, the price of the traded commodity i.e. electricity, will decrease.

9.3.9 NGESO state that “There is day-to-day uncertainty due to weather but in general, solar generation is quite predictable over the course of a year and the position of the sun and its expected radiation levels over the year are well known. This means it can be a great asset for meeting annual demand levels, especially [and therefore by extension, not exclusively] when coupled with suitable storage” [29](2023, p132). **Figure 6-9** of this Statement provides further information on the growth of storage facilities in GB.

9.3.10 Solar generation, and its potential abundance at foreseeable times of the day and year, will provide regular market signals which support the growth in demand-side flexibility (shifting demand to times of abundant renewable generation) and storage. As well as providing essential support to the security of supply during daylight hours, growth in solar generation will also encourage a shift in demand away from times of traditional peak needs, and/or store abundant energy which can then be dispatched when it is needed.

9.3.11 The inclusion of a storage facility as associated development to the main solar scheme allows the scheme to support the transition to net zero by providing flexibility to a fully low-carbon electricity system.

9.4 Curtailment

9.4.1 NESO's Future Energy Scenarios also describes and evaluates the potential for curtailment to occur in the UK's future electricity system.

9.4.2 It is important therefore to explain why curtailment currently occurs in the UK electricity system, and the level of the prices currently paid to generators for some curtailment actions.

9.4.3 Currently, the majority of curtailment in the UK occurs on the large-scale wind fleet and mainly due to transmission constraints. Transmission constraints occur when the electricity network linking the point of generation to the major points of consumption, does not have the capacity to transmit all of the generation at certain times, but in particular when generation output is high.

9.4.4 In the 12 months starting 1st July 2023 and ending 30th June 2024, NESO data records that wind generated 67.1TWh. Transmission constraints amounted to 5.6TWh (c.8% of net generation) and constraints due simply to there being 'too much wind energy on the system' totalled c.0.6TWh, or less than 1% of net generation.

9.4.5 Curtailment in the UK is therefore currently more to do with where electricity is generated, than how much electricity is generated, and future curtailment in the UK is anticipated to be associated more with wind generation than with solar generation [29](2024, Table ES1).

9.4.6 Curtailment for network constraints currently results in a compensation to the asset operator for the electricity which would have been generated and sold but for the fact that that energy was not accepted onto the transmission system.

9.4.7 An asset located on a transmission network which is well connected to demand centres, is unlikely to be curtailed for the same reasons as the majority of current curtailment in the UK. However, the possibility of curtailment for non-locational reasons remains.

9.4.8 In such circumstances, curtailment would occur because more energy was being generated than that which could be consumed or stored at that time. **Figure 10-1** of this Statement shows that an excess of supply reduces market price, incentivising price-sensitive demand to increase, or in extremis, incentivising supply to shut down so as to avoid having to pay (rather than be paid) to generate. Critically, neither of these outcomes results in a compensation payment from consumers to the asset operator for the electricity they have not generated.

9.4.9 NGESO's analysis shows that average solar curtailment in the years 2031 – 2040 is anticipated to be 1.5 – 4.2TWh [29](2024, Table ES1), or 3.6 – 6.4% of generation. NGESO anticipate curtailment to get worse before it gets better, as network investment, more storage and higher demand reduce solar curtailment by approximately 50% over the period 2041 – 2050.

9.4.10 **Chapter 8** of this Statement describes that the Proposed Development proposes to connect to a well-connected section of the NETS which has available transmission capacity and is geographically distant from areas of the network which currently are constrained. As such, transmission constraints are unlikely to cause curtailment at the Proposed Development and during its operational life, the Proposed Development is unlikely to receive consumer-funded compensatory curtailment payments.

9.4.11 Further, with energy storage assets proposed as associated development to the main solar scheme, the Proposed Development will be able to provide its own operational flexibility to the electricity system without fully relying on flexibility provision from other electricity system users. Such flexibility could include storing solar energy in the co-located batteries during periods of abundant solar supply, until it is needed.

9.4.12 More generally, a growth in the capacity of flexible assets (including demand-side response, storage, interconnection, and hydrogen) will help to minimise the curtailment of assets in the future UK electricity system arising from the build out of large capacities of renewable generation. But because renewable electricity is variable, the UK may not be able to meet demand at times of low renewable output without the build out of large capacities of renewable generation.

9.4.13 Having insufficient operational renewable generation capacity in the UK may cause one or more of the following to occur:

- Power cuts (contrary to the government’s aim to ensure security of supply)
- Price spikes (contrary to the government’s aim to shield consumers from volatile energy markets)
- Stand-by fossil fuel assets to generate (contrary to the government’s aim to decarbonise the electricity system)

9.4.14 The alternative approach, which is the government’s approach, is the build-out of large capacities of renewable generation. This approach meets the government’s aims and provides opportunities for market approaches to manage curtailment through flexibility, by:

- Using curtailed energy to support security of supply when demand is high
- Keeping consumer costs down by capturing and storing energy when it is abundant (therefore cheap) and releasing it when it is needed

9.4.15 Displacing stand-by fossil assets by using stored energy as a low-carbon “peaking” energy resource, further supporting the government’s ambition to deliver ‘Clean Power by 2030’

9.4.16 A flexibility measure which has already gained traction in the UK, and which has been enabled by the introduction of smart meters into domestic homes, is the introduction of ‘time of use tariffs’ (ToUTs). ToUTs apply different prices to consumption metered at different times of the day or year. ToUTs provide customers with the opportunity to schedule their electricity consumption towards times of low prices and away from times of high prices. Consumers benefit from providing flexibility through lower utility bills.

9.4.17 In summary, future curtailment, if/when it occurs, could be interpreted as a ‘good’ problem for the UK power sector to have when compared to the alternate of under-delivering on the UK’s current decarbonisation and energy security aims. This is because if curtailment occurs, it would be because large capacities of renewable generation have already been built out to deliver low-carbon supplies to meet demand, deliver security of supply, meet carbon reduction targets, and reduce wholesale costs of energy.

9.4.18 Further, the market signals associated with curtailment will drive the development of consumer and/or supply side flexibility to make efficient use of abundant resources and drive further security of supply, decarbonisation, and affordability benefits for consumers across the whole energy system.

9.4.19 The Applicant notes that a key benefit of the Proposed Development being connected to the NETS, is that when it is operational, it will need to adhere to the Grid Code. This means that the operational asset will need to inform NESO of its expected generation output ahead of time and at all times, and be ready to respond to instructions from NESO to adjust its output in the Balancing Mechanism. These arrangements provide NESO with control and response options to help NESO balance supply with demand.

9.4.20 These arrangements do not cover smaller embedded generators, including rooftop schemes, which are significantly less controllable and potentially harder to manage within the UK’s electricity market.

9.5 The system adequacy of solar generation

9.5.1 System adequacy is primarily managed through the GB Capacity Market. On an asset-by-asset basis, intermittent generation capacity, such as wind or solar, can be variable, which means that individual assets are de-rated in the Capacity Market. However, the output from portfolios of intermittent capacity, especially those that consist of different technologies, can be relied upon more fully and are easier to forecast more accurately. This supports the efficient provision of system adequacy and security of supply.

9.5.2 The following analysis demonstrates this by showing that the average aggregate monthly output per unit installed capacity of a multi-technology portfolio of wind and solar assets is less variable than the average monthly output per unit installed capacity of each of the single technology portions of that portfolio.

9.5.3 The data for **Figure 9-1** is sourced from NESO's Demand Data and Actual Metered Generation data. These are operational data files, available to download from NESO's data portal, and are updated on a regular basis. These files are large and as such have not been submitted as a reference to this document, but extracts can be provided to the Examining Authority if required.

9.5.4 The Demand Data files include NESO's estimated output, and capacity, for unmetered wind and unmetered solar generation.

9.5.5 The Actual Generation file includes metered wind generation (but not installed capacity). The workbooks accompanying regular FES publications also include historic installed wind capacity by type (onshore and offshore), connection type (distribution and transmission) and year [29](2024).

9.5.6 Data from 1st January 2022 to 31st December 2023 has been used to derive a series of historical metered wind capacity for onshore and offshore wind.

9.5.7 Using two recent years of data provides a credible representation of national generation and capacity including all micro wind, onshore wind and offshore wind as well as rooftop, commercial, and larger scale ground mounted solar to a total combined portfolio of approximately 30GW of wind and 15GW of solar (estimated at year end 2023). The solar and wind generation facilities included in this portfolio are located throughout the UK.

9.5.8 **Figure 9-1** displays the resulting output per unit of installed capacity at a monthly level for GB wind (green columns) and solar generation (yellow columns). It shows the seasonality of wind load in GB: low in the summer months but higher in the Autumn through Spring. It also shows the seasonality of solar generation in GB: high in the spring and summer months and lower in autumn and winter. The output associated with an illustrative combined portfolio is shown by the red line.

9.5.9 The red line in **Figure 9-1** is the weighted average load factor for the combined national portfolio of wind and solar i.e., (wind generation + solar generation) / (wind capacity + solar capacity). The red line always lies between the extent of the green and yellow columns and is flatter across the timeframe analysed than either of the columns, showing a lower variation from month-to-month through the year.

9.5.10 Taking a multi-technology approach to electricity supply can reduce the effects of weather variability on output. By combining two generation portfolios which are largely independent of each other (meaning, the level of solar generation in the

UK at any time is not mathematically dependent on the level of wind generation in the UK at that time, and vice-versa), the variation of the combined portfolio of (solar + wind), when averaged over a period of time, is lower than the variation of each of the portfolios separately.

9.5.11 Clearly, the identification of a general trend does not imply conformance to that trend on all days and at all times. Future 'actuals' will be dependent on prevailing weather conditions as well as levels of installed wind and solar generation capacity at delivery.

9.5.12 Running the analysis over different time periods by using a different range of historical data derives similar results. The level of certainty which may be ascribed to the general conclusions of the analysis is therefore high, based on historical information. Insofar as solar and wind capacity both increase in the future, in broadly similar proportion to each other as has been experienced historically, then it is reasonable to assume that the conclusions reached will remain valid in the future.

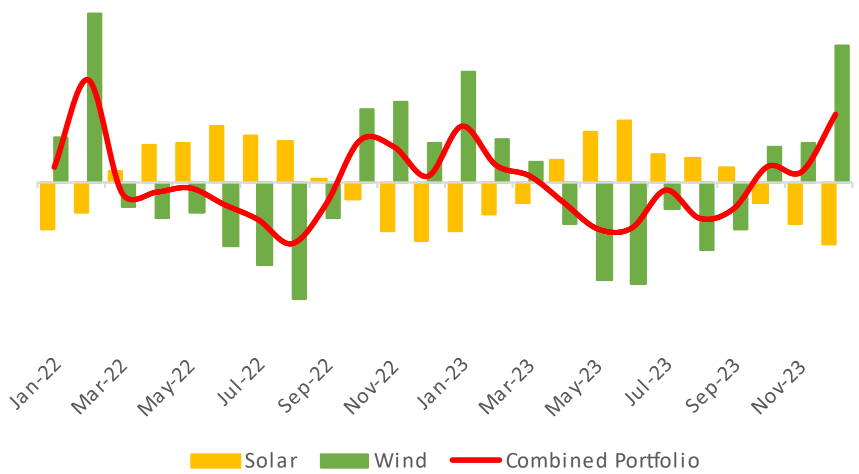


Figure 9-1: Illustrative Generation Dependability for a combined portfolio of solar and wind in GB
[85], [29](2024), [Author analysis]

9.5.13 Forecastable and stable generation output per unit of installed capacity is important because it relates to the reliability of, and therefore NGESO's ability to depend on, forward forecasts of generation outturn. At the macro level, a greater reliability of generation outturn allows for a more efficient and targeted asset development program to be developed; and a lower requirement for (currently fossil fuelled) backup plant, without creating an excess of generation capacity.

9.5.14 A growing portfolio of solar generation would therefore complement the existing and growing GB wind portfolio to deliver a combination of low-carbon generation with improved reliability and predictability than associated with the separate technologies.

9.5.15 A second analytical model has been developed to illustrate the collective capability of solar and wind generation in meeting seasonal demand for electricity in the UK.

9.5.16 The model evaluates the contribution made by different generation classes to overall national demand throughout a year on a month average basis, but does not take into account the requirement to balance supply and demand on a short-term basis.

9.5.17 The data sets model underlying demand, heat demand, transport demand, and different sources of low-carbon supply including solar generation and wind generation, and how each of these change through the year.

9.5.18 The analysis is based on the average within-year shape of demand from 2015 to 2019.

9.5.19 Each data set therefore comprises a month-to-month shape and a future level. The methodology used to derive the shape for each series is as follows:

- 2015 – 2019 national demand data is used to derive a month-average demand expressed as a ratio of annual average demand. The data therefore avoids any one-off within-year impacts associated with outlier weather patterns (because the base data covers multiple years) or due to the COVID-19 pandemic and subsequent cost of living crisis (because data including and after 2020 has not been used)
- The heating demand shape has been derived from the industry rule of thumb that in the UK, gas demand in the winter is up to five times higher than in the summer, and therefore electricity demand for heating (when it displaces gas heating) may follow a similar shape
- The transport demand shape has been estimated as flat through the year

  Demand for electrolysis of water to produce hydrogen has been included in monthly demand estimates for completeness but at only small capacities in the 2030 timeframe, in line with NESO's projections

9.5.20 Total demand is the sum of underlying demand, heat demand, transport demand, and electrolysis demand.

9.5.21 Supply has been modelled with only zero-carbon technology types, to capacities which are consistent with government's Clean Power 2030 capacity ranges. The results are shown in **Figure 9-2**. The technology types are: zero carbon baseload (grey), onshore wind (green), offshore wind (blue), and solar (yellow).

9.5.22 The methodology used to derive the shape for each series is set out below.

> Zero carbon baseload generation represents nuclear energy from the remaining existing UK nuclear fleet, plus one unit at Hinkley Point C, alongside existing biomass, energy from waste and hydro generation. All assets are assumed to have an Unplanned Capability Loss Factor (breakdown rate) of 10% and planned outages are assumed to take place on the nuclear plant in summers rather than winters, leading to a summer baseload low carbon technology monthly availability of 50.6% and a winter month availability rate of 54.1%

> The average monthly load factor for onshore and offshore wind and solar generation has been derived from NESO market data for the entire UK operational wind and solar portfolio for the period 2016 to 2023. The data sources are the same as those used to derive Figure 9-1 but over a wider historical dataset. Historically, both onshore and offshore wind generation in winter months (October through March) has been just below twice the level seen in the low months of the year (June and July), which is almost the inverse solar generation levels

> The data derives a within-year shape (at monthly granularity) which is consistent with NESO Operational Data for the entire UK operational solar estate over the period 2016 – 2020

9.5.23 **Table** 9-1 shows the load factors assumed in the analysis alongside NESO assumptions [29](2024, Data worksheet ES1) and other relevant sources [12](2023), [72](2023).

9.5.24 New offshore wind farms have significantly higher load factors than early wind farms, and the technology is projected to see significant growth from today through to 2030 and beyond. This is predominantly due to:

> Developments being located in areas with higher average wind resource, and larger more efficient turbines now being available on the market. The model assumption (derived from author analysis) matches the FES 2024 assumption

> New onshore wind farms are likely to be more constrained in location and turbine size than new offshore wind farms and growth in load factor is less certain. The model assumption therefore adopts a lower load factor, also derived by the author, for onshore wind than for offshore wind which also matches the FES 2024 assumptions

9.5.25 The FES [29](2024, Table ED1) provides projections for the average levels of demand associated with underlying electricity use, heat, transport, and electrolysis capacities of each technology which may be in operation in 2030.

9.5.26 The analysis assumes annual average load levels for underlying demand of 29.4GW, for heat demand of 3.5GW, for transport demand of 3.1GW, and for Electrolysis of 1.9W.

Table 9-1: Comparison of assumed load factors with independent data sources
[29](2024, Table ES1), [12](2023), [72](2023)

Load Factor (%)	Model Assumption	FES Average	DESNZ Regional Data	DESNZ Cost Assumption
Offshore Wind	45%	45%	37%	65%
Onshore Wind	29%	29%	27%	41%
Solar	10.5%	12%	10%	11%

9.5.27 The model assumes future levels of supply capacity which are consistent with the government's Clean Power 2030 capacity ranges and are listed in **Table 9-2**, alongside the projections of capacity in FES 2024 (average; minimum and maximum installed capacity in 2030 for each technology in the three net zero compliant scenarios.

9.5.28 The model is an illustration based on projections of capacity roll out, electrification of demand, and efficiency / load factor. **Figure 9-2** shows the output of just one projection of a multitude of possible projections. Other outcomes are therefore possible, including those associated with rapid expansions of other zero-carbon generation technologies, should they materialise.

Table 9-2: Comparison of installed capacity assumptions vs. FES 2024
[29](2024, Table ES1), [Author Analysis]

Assumed Capacity (GW)	Model Assumption (for 2030)	FES 2024 Average	FES 2024 Min	FES 2024 Max
Offshore Wind	46.5	43	29	54
Onshore Wind	28	24	20	27
Solar	46	31	22	40
Zero-carbon baseload	9	14	13	15

9.5.29 However, considering the contribution only of proven low-carbon generation technologies to meeting future demand is a prudent approach because:

- **Section 3.3** of this Statement describes the urgency for action to reduce carbon emissions from the UK's electricity system in the critical 2020s, and **Section 6.6** and **Section 6.7** of this report describe that there are as yet no fully funded and consented CCUS, nuclear or hydrogen projects set to deliver in the 2020s beyond the projections already included in the analysis

> **Section 4.2** of this Statement articulates the prudent view that infrastructure development should be planned on a conservative basis, without over-relying on yet-to-be-proven technologies, technologies with long development lead-times, or technologies which have historically experienced funding difficulties

9.5.30 **Figure 9-2** should not be inferred to advocate either for a specific renewables mix, nor for a system without adequate backup or flexible generation, both of which may be required to support decarbonisation of the NETS by managing day-to-day swings in both demand and supply.

9.5.31 The government's mission is to deliver 'Clean Power by 2030' by rapidly expanding the capacity of renewable generation installed in the UK. **Chapter 6** of this Statement describes that although the current pipelines for low-carbon generation are full, it cannot be relied upon that the delivery of those pipelines will be achieved, or that achieving any one of the targets set by the government (to triple solar capacity by 2030, alongside doubling onshore wind and quadrupling offshore wind), will also be achieved.

9.5.32 However, **Figure 9-2** shows that a portfolio of low-carbon generation which includes large capacities solar, onshore and offshore wind, and a low-carbon base, if delivered, is capable of closely matching a future projection of national electricity demand on a month-average level.

9.5.33 **Figure 9-2** uses average load factor data and therefore, for renewable technologies, generation in some months may be higher than the data presented, and in other months generation may be lower.

9.5.34 **Figure 9-2** shows that if the government capacity ranges are delivered across offshore wind, onshore wind and low-carbon baseload technologies, it would be likely that sufficient energy would be generated to meet estimated demand in some winter (October to March) months. The tops of the blue stacked columns (total generation) are near to the red line (total demand) in October, November, and December and are within reach of the red line in January, February, and March.

9.5.35 However, because of the seasonality of wind generation in UK territory, the projected capacities of low-carbon generation would likely be insufficient to meet summer (April to September) demand. The top of the blue stacked column is below the red line in the majority of these months.

9.5.36 Approximately 46GW of solar (an increase of 29GW on late-2024 levels, consistent government's 2030 capacity ranges) would provide additional low-carbon energy to help meet the UK's electricity needs throughout the year, and specifically in the summer months when wind energy yields are lower.

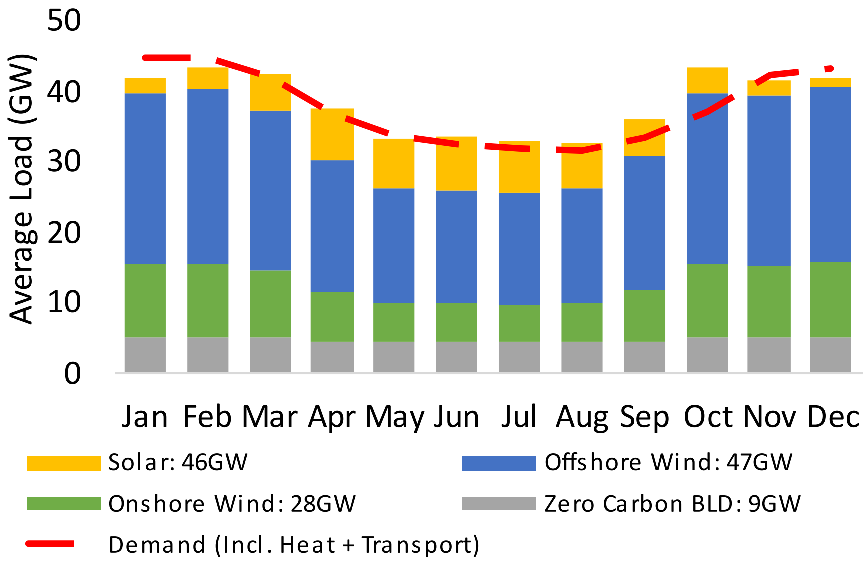


Figure 9-2: Deploying RES to the midpoint of government's 2030 capacity ranges meets anticipated seasonal demand levels
[29](2024, Tables ES1 & ED1), [1](Connections Reform Annex, Table 1), [Author analysis]

9.5.37 However, demand must be met under a wide range of supply scenarios, including when renewable supplies are low. This analysis should not therefore draw the reader to the conclusion that the government does not seek more renewable generation capacity beyond 2030.

9.5.38 To meet 2030 summer levels with a similar level of reliability as shown in this pathway without solar generation, a further c.15GW of offshore wind generation (i.e. a total installed capacity of ~62GW), or an additional c.11GW of low-carbon baseload generation (three new Hinkley Point C equivalent power plants), would be required to be built in the next 10 years.

9.5.39 However, by building out either additional low-carbon baseload or offshore wind generation capacity to the levels indicated to meet summer demand levels without solar, there would be significant over-generation of power in the winter periods of between 8% and 14%. Over-generation may be curtailed (either at a cost to the consumer or by reducing available revenues to asset operators) or stored. If revenues are reduced for asset operators, in some cases assets may not be commercially attractive and therefore may not get built out.

9.5.40 The model supports the conclusion that the deployment of large-scale solar alongside offshore wind, onshore wind, and low-carbon baseload assets provides the opportunity for a lower capital, lower curtailment (therefore lower cost) energy system through diversity of asset type than that provided by scenarios which do not include solar generation.

9.5.41 A high degree of certainty may be attached to this conclusion because of the horizon of data used to inform variable inputs to the model, and consistency of these and other assumptions with those made in government's Clean Power 2030 Action Plan.

9.5.42 As the technical and economic viability of inter-seasonal storage advances, more options will become available for optimising GB's generation mix in relation to balancing capital deployment, development risk, the availability of suitable locations, and ongoing system operations (e.g. curtailment). However, based on current assessments, it is clear that the deployment of large-scale solar alongside that of offshore wind, onshore wind, and low-carbon baseload assets, provides the opportunity for a lower capital, lower curtailment (therefore lower cost) energy system through diversity of asset type than that provided by scenarios which do not include solar generation.

9.6 Conclusions on security of supply

9.6.1 This Statement of Need provides evidence which supports the urgent need for low carbon sources of electricity in the UK. The British Energy Security Strategy provides additional focus on both the scale and the urgency to deliver new low carbon generation capacity, and the Proposed Development is ideally suited to play an essential role in meeting that urgent need.

9.6.2 Although individual renewable assets are variable generators, aggregated generation output from portfolios which consist of different renewable technologies is more stable. The generation profiles of diverse ranges of low-carbon generators combine to meet seasonal average demand levels without requiring significant and unproductive capital investment, seasonal excess generation, or inefficient network / system operating costs.

9.6.3 Many integration measures are already available, or are already in development, which, over short periods, help balance electricity generation from variable generators to meet demand, and to ensure that the best use is made of low-carbon electricity when it is being generated in oversupply. For example, BESS, pumped hydro or interconnectors (see **Section 6.11**).

9.6.4 The contribution made by flexible assets to the short-term balancing of supply and demand are described in **Section 7.9** and **Chapter 8**. However, until inter-seasonal storage is brought forwards at scale and at grid parity costs, the most efficient measures for seasonal balancing of renewable generation include increasing the capacity and geographic diversity of renewable generators, including portfolios of assets with complementary seasonal generation profiles, and managing shorter term intermittency through storage or other measures.

9.6.5 Solar is an asset class which is needed to support a high level of generation adequacy and generation dependability within the GB electricity system.

9.6.6 The Proposed Development, if consented as a leading large-scale solar scheme in GB, represents c. 2% of the new solar generation capacity required in the FES net zero pathways to 2040, [29](2024). In this context, the Proposed Development and many others like it are essential to move the UK towards the future of efficient decarbonisation through the deployment of large-scale, technologically and geographically diverse low-carbon generation assets.

9.6.7 Global expertise in the operation of electricity systems with high proportions of RES is growing. Technologies which help the integration of renewable assets to the grid are already in operation in the UK. However, solar assets are increasingly able to provide important system services themselves, and flexible integration assets are being deployed on a stand-alone and co-located basis to do the same, as well as to manage short-term supply / demand volatility.

9.6.8 Growth in solar capacity, alongside other renewable technologies, is expected to improve the dependability of those assets as a combined portfolio, and this is expected to reduce further any integration costs associated with such growth.

9.6.9 The Proposed Development, if approved, would contribute to an adequate and dependable GB generation mix, through enabling the generation of more low-carbon power from indigenous and renewable resources. Therefore, the approval, construction and operation of the Proposed Development will make a significant contribution to GB's energy security needs, and the decarbonisation needs of the UK.

10. The contribution of large scale solar to the affordability of electricity

10.1 Chapter summary

10.1.1 This chapter provides an overview of the affordability benefits of large-scale solar in the UK.

"Analysis [commissioned by the NIC] suggests that there is no material cost impact, either over the short or long term, of deploying renewables faster. Renewables are now the cheapest form of electricity generation due to dramatic cost reductions in recent years. Cost reductions have been greater than was predicted in 2018 when the Commission made its recommendation on what level of renewable generation the government should be targeting" [69](p9).

10.2 Pricing in the GB electricity market

10.2.1 In the GB power market, generators schedule themselves to generate in response to whether a market price signal for a specific period is above or below their marginal cost of generation. Marginal cost of generation is defined as the cost of generating an additional 1MWh, usually including variable fuel, carbon emissions, and transmission costs.

10.2.2 Each day is subdivided into 48 half-hour Settlement Periods (SPs) and power is traded ahead of delivery for these periods, or continuous groups thereof, from just 90 minutes ahead, up to months or even seasons ahead.

10.2.3 Solar generation has very low or zero marginal costs and therefore solar assets generate as much power as they are able to, when they are available (i.e. whenever there is light) and whenever power prices are positive. Because of the variable, but forecastable nature of solar irradiation, they also tend to trade on near-term power markets, therefore much of the impact of sunny (or overcast) weather on power price is felt in the few days close to delivery.

10.2.4 Thermal and hydro plants have higher marginal costs, relating to the cost of the fuel they are converting into that additional MWh, and any emissions costs associated with the use of that fuel. Thermal and hydro plants will therefore only generate when the market is providing a higher price signal, i.e. when demand is expected to be higher than the supply of low-marginal cost supplies at the time of dispatch. Thermal and hydro plants may also trade power, fuel, and carbon emissions costs into the future to fix their income.

10.2.5 Increases in the cost of source fuels and emissions increase the cost of generation from these assets. Therefore, when they are required to generate electricity, they will do so at a cost which increases the price of electricity for all market consumers for that period.

10.2.6 All generators produce active power (MWs), and at all times, the total national active power generated must meet the total national system load. If solar farms are generating electricity during a settlement period, then less electricity is required from plants with more expensive marginal costs, therefore the price of electricity for that settlement period reduces.

10.2.7 Emissions pricing ensures that carbon-emitting generation is more expensive to dispatch than zero-carbon generation. Therefore, by undercutting carbon emitting assets on marginal cost, zero-carbon assets will displace carbon intensive assets, providing both a carbon emission saving and a cost benefit to consumers.

10.2.8 This market mechanism is illustrated in **Figure 10-1**. The blue line, increasing from left to right along the x-axis, represents the marginal cost of generation in GB at each level of demand. As demand increases, more expensive supply must be scheduled into the market to meet that demand.

10.2.9 The three red vertical lines represent different levels of demand. At a mid-level of demand, the solid vertical red line crosses the blue line (in this illustration: at about £45/MWh) and is the price of electricity for that period.

10.2.10 If demand reduces (e.g. to the left-hand dashed vertical red line), a lower capacity of assets is required to run to meet demand. Therefore, the marginal cost of the most expensive asset required to run to meet demand will be lower than it would otherwise have been, and the price of electricity for that period would also reduce.

10.2.11 Conversely, if demand increases (e.g. to the right-hand dashed vertical red line) assets with higher marginal costs of production are required to run, and they set a higher price of power.

10.2.12 The blue line in **Figure 10-1** will be different for each half hour settlement period because generators may become available or unavailable through the day due to outages or breakdowns. The level of renewable generation will also change through the day. More renewable generation will stretch the blue line within the red ellipse (around a zero marginal cost of power), lowering the price of electricity for that period (the point of intersection between a vertical red line point with any fixed red line), and as a result, the blue line slides to the right for all higher levels of demand.

10.2.13 The marginal cost of production to meet demand over these periods will therefore be lower, and as a result, the traded price of power will be lower.

10.2.14 By running this type of analysis over every settlement period over the future trading horizon, it is possible to derive a view of the price of power for the next week, month, quarter, or season.

10.2.15 The conclusion remains the same. Namely that increasing the capacity of renewable assets in GB reduces the traded price of power.

10.2.16 The GB power pricing mechanism also provides the explanation as to why the British Energy Security Strategy increases the UK's ambition for renewable generation to reduce our dependency on volatile international energy markets.

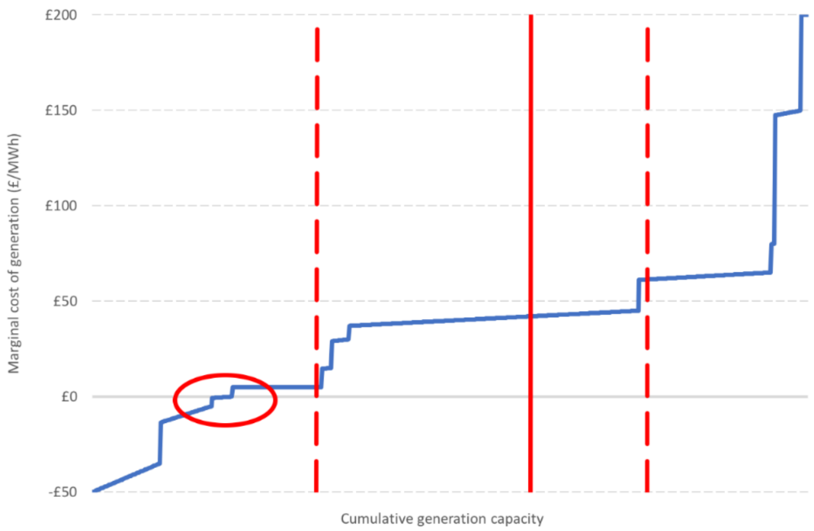


Figure 10-1: Representative marginal cost stack for the GB electricity system
[Author analysis]

10.3 Levelised cost of solar generation

"The International Renewable Energy Agency (IRENA) found that between 2010 and 2019, the cost of solar PV globally dropped by 82% ... In 2019 alone, the cost of electricity from solar fell by 13% to just over five pence per kilowatt-hour. This means that by … [2020] globally, there will be up to 1,200GW of existing coal capacity that will cost more to operate than it would to install new solar PV capacity." [86].

10.3.1 The market mechanisms described in **Section 10.2** only reduce the price of power if solar projects come to market, or if developers believe they are able to make reasonable returns on their investments. The cost of solar generation is an important enabler of its development. Solar panels and electrical infrastructure have become larger and more efficient, as described in **Section 7.7.18**, meaning that more electricity can be generated from the same area of land as was previously possible. As a consequence, solar is now a leading low-cost generation technology (see **Figure 10-2**).

10.3.2 Levelised Cost of Energy (LCOE) is an important metric allowing all forms of generation to be compared with each other on a consistent basis. LCOE is calculated using a discounting methodology and is a measure of the lifetime unit cost of generation from an asset, including capital and operating costs. In-life cap capital and operating expenses, for example the re-powering of sites to manage anticipated degradation, are also anticipated.

10.3.3 **Figure 10-2** shows the results of an analysis of the government's Electricity Generation Costs report [72](2023), with the range of values representative of different complexities of technical solution.

10.3.4 **Figure 10-2** shows a "triple" of columns for each of five generation technologies. Each column within each triple shows the technology's anticipated LCOE for assets commissioning in 2025 (left hand column), 2030 (middle column), and 2035 (right hand column).

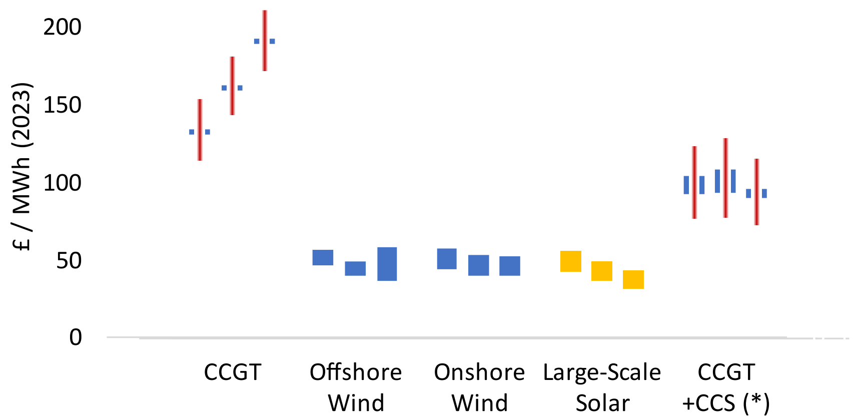


Figure 10-2: Levelised cost of energy comparison
[72], [Author Analysis]

10.3.5 Governmental modelling anticipates different projected operational lifetime, load factors (a measure of the output of the plant per year versus its theoretical maximum if availability is unconstrained), capital and operational costs, and development duration to derive a range of cost projections. The blue bars show that range while the red columns represent the LCOE range under different projections for input fuel costs for those technologies which require a non-zero cost input fuel.

10.3.6 The levelised cost ranges of large-scale solar (the governmental analysis assumes a capacity of 16MW) are highlighted in yellow. **Figure 10-2** shows that renewable generation technologies hold a significant levelised cost benefit when compared to technologies which are reliant on fossil fuels, even when fuel input costs are included at a low level.

10.3.7 The analysis illustrates that the LCOE of solar delivered in 2025 is lower than the LCOE of offshore wind delivered in a similar timeframe, and is comparable to the LCOE of onshore wind. However, predictions are that solar generation delivered in future years is likely to be cheaper than both onshore and offshore wind on an LCOE basis.

10.3.8 A project with a lower LCOE would allow consumers to benefit through market mechanisms. For example, a project with a lower LCOE would be able to bid into a future CfD Allocation Round at a lower strike price than a project with a higher LCOE. If such a project secured an agreement, consumers would also benefit versus the case that it did not.

10.3.9 The government's Cost of Electricity Generation report series [72] also shows that solar LCOE has reduced significantly in the last decade. Solar, already being highly competitive against current conventional and renewable generation costs, is predicted to retain a cost advantage for the decades ahead.

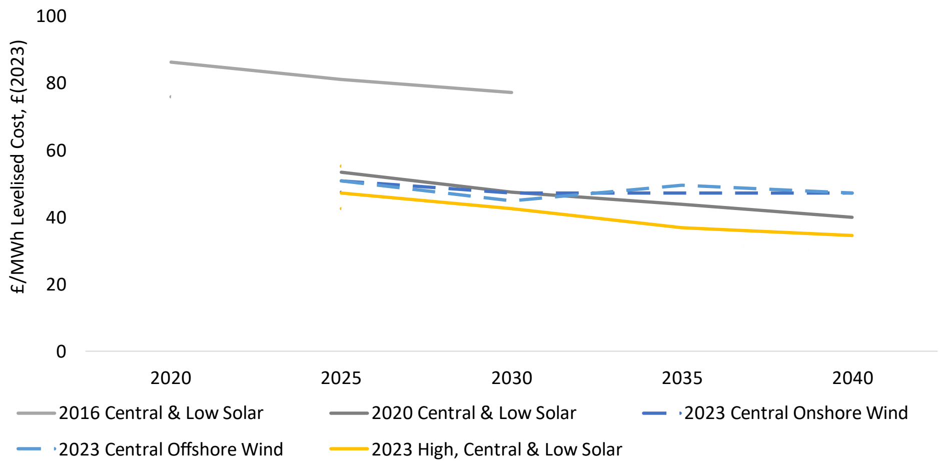


Figure 10-3: Cost of Electricity Generation. An evolution of Levelised Cost forecasts
[72], [Author analysis]

10.3.10 Solar costs have been driven down through the realisation of efficiencies in capital infrastructure, development and integration costs, and lifetime O&M. This includes working to reduce the effects of degradation of solar panels and inverters. Improvements in lifetime cost are likely to continue to be delivered.

10.3.11 Technological advances have also increased the efficiency of solar panels (see **Section 7.7.18** of this Statement) and extended their useable lifetimes. At the same time, economies of scale through the global supply chain have reduced the cost of panels. Development costs have also reduced as efficiencies in the build process have been captured through prior experience.

10.3.12 **Figure 10-3** shows the results of previous and current governmental analysis. The mid grey lines show the 2016 projections of the LCOE of solar commissioning in 2020, 2025, and 2030. The solid line shows the central case projection, and the dotted line shows the low case projection.

10.3.13 The 2013 projections (not shown in **Figure 10-3**) were approximately 70% higher on a consistent 2023 real price basis. Just four years later, the government's

2020 solar LCOE projection (shown in dark grey) was over 30% lower for sites commissioning in 2025 and 2030.

10.3.14 Their projections made in 2023 are shown by the yellow solid line (central cost) and are bounded by the high and low cases shown by the dotted lines. The 2023 solar LCOE estimate is a further 10% lower than the 2020 estimate on a consistent 2023 real price basis.

10.3.15 Industry-sourced data and opinion concurs with the direction of this analysis. For example, a CCC illustration of data from IRENA analysis (2020) shows similar cost reductions in renewable generation technologies, and the competitiveness of those technologies against fossil fuel generation [11](2020, Figure 2.2).

10.3.16 **Figure 10-3** should not however be taken as a justification for delaying the development of renewable projects, in order to capture a lower future installed price. **Section 3.2** of this Statement explains the rationale for urgent action to develop significant capacities of low-carbon generation. Time is a precious commodity.

10.3.17 Further, it is the continuous development of projects which allows learnings to be implemented, technology to advance through practical application, and markets and supply chains to evolve and improve efficiency, to achieve the future cost reductions which have been forecast by previous governments and others.

10.3.18 Solar was included in the 2021/22 CfD Allocation Round (AR4) to help "deliver a diverse generation mix at low cost" and to realise "the rate and scale of new projects needed in the near-term to support decarbonisation of the power sector and meet the net zero commitment" while providing other benefits such as diversity of supply through different resource requirements and a geographical separation from other significant renewable energy sources [87](pp16 & 20).

10.3.19 Many solar projects were successful in CfD AR4, AR5, and AR6 (2024). Auction results indicate that solar is an important and cost-competitive technology within the evolving GB electricity system [88].

- In AR4, over 2.2GW of solar capacity across 66 projects (commencing in 2023/24 or 2024/25) secured CfDs at an initial strike price of £45.99 (2012 indexation, estimated to be equivalent to £64.18 in 2024 money)
- In AR5, over 1.9GW of solar capacity across 56 projects (commencing between 2025 and 2028) secured CfDs at an initial strike price of £47.00 (2012 indexation, estimated to be equivalent to £65.58 in 2024 money)
- In AR6, nearly 3.3GW of solar capacity across 93 projects (commencing in 2026/27 or 2027/28) secured CfDs at an initial strike price of £50.07 (2012 indexation, estimated to be equivalent to £69.87 in 2024 money)

10.4 Whole system costs

10.4.1 The NIC's current view is that RES represent a most likely low-cost solution for GB electricity generation, over large-scale conventional investments:

"More renewables do lead to more money being spent to match supply and demand: a system with 90 per cent renewables is estimated to cost up to £4.5 billion more per year to balance. But cheaper capital costs are estimated to offset this within the costs for the overall system." [83](p39).

10.4.2 Both **Figure 9-1** and **Figure 9-2** provide evidence that the deployment at scale of more than one renewable generation technology will help reduce the capacity of integration technologies needed to manage generation variability across many timeframes, including potentially the long-term storage of excess generation, although it is unlikely to fully remove the need.

10.4.3 An Imperial College expert economic analysis of whole system costs of renewables agrees; they show that the integration costs of RES fall on an absolute basis, as capacity increases from 10GW up to 50GW [89].

10.4.4 The NIC published the results of a whole system cost analysis in 2020. NIC's analysis complements that of the Imperial College team, suggesting that "there is no material cost impact, either over the short or long term, of deploying renewables faster. Renewables are now the cheapest form of electricity generation due to dramatic cost reductions in recent years." [69].

10.4.5 With the development of new schemes, solar technology is proven to be commercially rational over a growing geography. Developing technology, construction risk mitigation, efficient grid connection and efficient financing have all applied downward pressure on solar project costs. As a consequence, utility-scale project costs projected to fall. The global solar market is growing, and the GB solar market is growing as well.

10.5 Conclusions on affordability

10.5.1 Large-scale solar power decarbonises the electricity system and lowers the market price of electricity by generating power so that expensive and more carbon intensive forms of generation do not need to generate as much.

10.5.2 In doing so, solar power delivers national decarbonisation benefits and supports consumer affordability aims, to the benefit of electricity consumers.

10.5.3 Due to technological advances, solar facilities are already among the cheapest form of electricity generation in the UK and government produced forecasts indicate that costs will continue to reduce in the future.

10.5.4 Scale remains important, and maximising the generating capacity of schemes improves their economic efficiency, and so brings electricity generation to the market at a lower cost.

10.5.5 Larger solar schemes deliver more quickly and at a lower unit cost than multiple independent schemes which make up the same total capacity, bringing forward carbon reduction and energy security benefits as well as helping to keep consumer costs in check, in line with government policy, including that of the previous government).

10.5.6 The Proposed Development will be a substantial infrastructure asset, which if consented will deliver large amounts of cheap, secure, and low-carbon electricity which will help the UK achieve its Sixth Carbon Budget commitments and stay on track to achieve net zero by 2050. Maximising the capacity of generation in the proposed location for the Proposed Development represents a significant and commercially rational step forward in the fight against the global climate emergency.

11. Overall conclusions

11.1.1 Decarbonisation is a legally-binding climate change target for the UK and is of global significance. It cannot be allowed to fail, and urgent actions are required in the UK and abroad, to keep decarbonisation on track to limit global warming.

11.1.2 The NPSs establish a critical national priority for the provision of nationally significant low-carbon infrastructure, which includes large-scale solar farms, because a combination of many or all types of such infrastructure is urgently required for both energy security and Net Zero.

11.1.3 NPS EN-1 states that "For projects which qualify as CNP Infrastructure, it is likely that the need case will outweigh the residual effects in all but the most exceptional cases" [2](Para 4.1.7). The Proposed Development is CNP Infrastructure. Therefore it follows that the urgent need for the Proposed Development to achieving the UK's energy objectives, together with the national security, economic, commercial, and net zero benefits will outweigh any other residual impacts not capable of being addressed by application of the mitigation hierarchy [2](Para 3.3.63).

11.1.4 Government's Clean Power 2030 Action Plan [1] reinforces the urgent need for low carbon generation schemes to come forwards to pave the way to decarbonising the wider economy by 2050 as the UK pursues the electrification of heat in buildings, transport, and industry. It also provides a framework for the prioritisation of offers for projects which align with NESO's advice on connections which are deliverable by 2030, and which can demonstrate that they have the means to deliver to those timeframes.

11.1.5 The Proposed Development is required to ensure that the UK remains on track to meet its legally binding carbon emissions reduction targets, including the Sixth Carbon Budget, while enhancing national security of supply, and at a cost which, in relation to other electricity generation infrastructure developments, provides value for money for end-use consumers.

11.1.6 This Statement shows that large-scale solar generation is economically and technically viable in the UK, and that it is an economically and technically preferable source of low-carbon energy for the GB electricity consumer.

11.1.7 The UK has substantial renewable energy resources, including wind and solar, and large areas of the country receive high levels of solar irradiation. These resources must be harnessed to decarbonise our economy and the utilisation of existing and available points of connection supports this endeavour.

11.1.8 The UK policy view is that a low-cost, net zero consistent system is likely to be composed predominantly of wind and solar [19](p43). Flexible assets are also needed to balance supply with demand. National policy is supportive of solar that is co-located with storage to maximise the efficiency of land use.

11.1.9 The Proposed Development will, if consented, bring forwards large-scale ground-mount solar with co-located storage facilities. The Proposed Development therefore goes towards meeting the government's aims.

11.1.10 **Chapter 6** of this report describes the government's aims for many renewable technologies and describes the opportunities and risks associated with their delivery. If solar generation does not meet the decarbonisation and energy security contributions ascribed to it, the challenge faced by the UK in meeting its decarbonisation targets from other technologies will be significantly harder.

11.1.11 Conversely, the continued development of proven low-carbon technologies like large-scale solar is important to protect against the possibility that technologies which are currently in 'prototype' stage do not deliver operational capacity at the pace or scale required.

11.1.12 Other conventional low-carbon generation (e.g. nuclear or conventional generation with CCUS) and new low-carbon dispatchable generation (e.g. hydrogen) will be important contributors to achieving the 2050 net zero obligation, but their contributions in the timeframe in which the Proposed Development will deliver are uncertain.

11.1.13 The Proposed Development would generate power ahead of other potential technologies (which may have longer construction timeframes or have potentially not yet been proven at scale) which will support decarbonisation only in future years and only if they are brought forwards.

11.1.14 The need for solar is especially important given the context of the CCC's identification of the need for urgent action to increase the pace of decarbonisation in the GB electricity sector, and the then government's adoption of their recommendations for the Sixth Carbon Budget (2033 – 2037).

11.1.15 The Proposed Development will, if consented, be capable of supporting the delivery of the Sixth Carbon Budget. Large-scale solar is needed alongside rooftop solar because without increasing capacities of both types of solar generation, the UK will likely fall short of its solar capacity aims and therefore its climate change targets.

11.1.16 Large-scale solar delivery up to and beyond 2030 remains important not only to reduce power-related carbon emissions, but also to provide a timely next step contribution to a future generation portfolio which will support the electrification and therefore decarbonisation of transport, heat and industrial demand.

11.1.17 As part of a diverse generation mix, solar generation improves the stability of capacity utilisations which in turn improves generation dependability. When developed alongside other renewable technologies, large-scale solar will help smooth out seasonal variations in total GB renewable electricity generation, more closely matching anticipated seasonal average levels of demand.

11.1.18 As associated development to the main solar scheme, co-located storage will help the Proposed Development operate flexibly as an essential part of a zero-carbon electricity and energy system.

11.1.19 The Proposed Development would connect to an existing grid connection point on an existing part of the NETS, efficiently optimising the use of an already existing national infrastructure asset. In the event that NESO's upgrade plan for High Marnham proceeds, the Proposed Development will be optimising the use of a new national infrastructure asset.

11.1.20 By being connected to the transmission system, large-scale solar generation can and will play an important role in the resilience of the GB electricity system from an adequacy and system operation perspective. This is because the transmission system is able efficiently to transfer bulk power from where it is generated in abundance to where it is needed. The proposed transmission system connection means that it will be required to play its part in helping NESO manage the national electricity system.

11.1.21 Large-scale solar generation also supports security of supply by helping reduce the national dependency on imported hydrocarbon source fuels. The Proposed Development will therefore also help reduce the UK's exposure to volatile international energy prices.

11.1.22 The low marginal cost and low marginal carbon emissions energy generated at the Proposed Development can be confidently forecast and priced into future contracts for power delivery by all market participants, thus allowing all consumers to benefit from the market price reducing effect of solar generation.

11.1.23 The cost of solar generation is already highly competitive against the cost of other forms of conventional and low-carbon generation, both in GB and more widely.

11.1.24 Internationally, and importantly for GB in this regard, there is the ongoing trend of solar generation assets becoming larger and more affordable, each subsequent project providing a real-life demonstration that solar schemes of similar size and scale as the Proposed Development can and should be developed in GB. The development of such schemes will provide decarbonisation, energy security and commercial benefits to consumers.

11.1.25 If consented, the Proposed Development, along with other solar schemes, will make a critical contribution towards net zero. The government's election manifesto includes its aim to triple solar capacity by 2030. NGESO FES net zero pathways include 33 – 40GW of operational solar capacity in GB by 2030 (for pathways which will achieve net zero), alongside significant increases in the capacity of other technologies, representing an increase of between 16 to 23GW over the next 5 years.

11.1.26 However, the need for new clean power does not stop at 2030. The continued delivery of low-carbon generation facilities beyond 2030 is necessary to meet future electricity demand growth and achieve essential wider societal carbon savings. It is also important to continue to bring forward schemes in the event that 'Clean Power by 2030' is not achieved.

11.1.27 The meaningful and timely contributions offered by the Proposed Development to UK decarbonisation and security of supply, while helping lower bills for consumers throughout its operational life, will be critical on the path to net zero beyond delivery of the government's 'Clean Power by 2030' mission.

11.1.28 Without the Proposed Development, a significant and vital opportunity to develop a large-scale low-carbon generation scheme will have been passed over, increasing materially the risk that future Carbon Budgets and net zero 2050 will not be achieved.

11.1.29 The Proposed Development is a leading GB large-scale solar plus storage scheme. If consented, it would be an essential component of the UK's plan to deliver a future of efficient decarbonisation through the deployment of large-scale, technologically and geographically diverse low-carbon generation schemes and would also deliver flexibility to the UK electricity market.

11.1.30 The Proposed Development is consistent with and addresses all important and relevant aspects of existing and emerging government policy.

12. Author's Qualifications and Experience

12.1.1 This Statement of Need has been authored by Si Gillett, Director at Humbeat Ltd.

12.1.2 Humbeat is an independent electricity consultancy, established in 2016, to support participants in the UK's transition to a low-carbon electricity and energy system. The consultancy supports and advises private individuals and organisations with pre- and post-construction electricity developments by providing commercial and strategic advice in relation to those developments.

12.1.3 Humbeat specialises in assessing, describing, and quantifying the benefits specific technologies and individual developments bring to the overarching and urgent need for decarbonisation in the UK. Humbeat has been commissioned to provide electricity market expertise to over 12,000MW of development-phase renewable generation developments across the UK, including over 3,000MW of ground mount solar, ranging from 10MW sites to large-scale developments.

12.1.4 Mr Gillett authored Statements of Need for seven NSIP solar schemes which received Development Consent between 2020 and 2025, including Cleve Hill Solar Park (May 2020), Longfield Solar Farm (June 2023), Sunnica Energy Farm (July 2024), Mallard Pass Solar Project (July 2024), Gate Burton Energy Park (July 2024), Cottam Solar Project (August 2024) and West Burton Solar Project (January 2025).

12.1.5 Mr Gillett also developed evidence to support IROPI (Imperative Reasons of Overriding Public Interest) justifications for Hornsea 3 and Hornsea 4 Offshore Wind Farms. DCOs were granted in December 2020 and July 2023 respectively.

12.1.6 Humbeat is currently supporting approximately ten other nationally significant electricity generation infrastructure developments by providing electricity market and low-carbon transition expertise to their development teams, as well as multiple engagements on TCPA planning applications for solar and solar + storage developments.

12.1.7 Mr Gillett has 20 years of experience in energy sectors including petroleum and natural gas liquids, and conventional, nuclear, and renewable electricity – on both the generation and sale side. A wide range of energy experience provides a robust basis for a balanced assessment and analysis of the UK energy sector as a whole. This is especially important as the journey to net zero involves more integrated and system-level thinking than has ever previously been required in the electricity sector.

12.1.8 Mr Gillett holds Masters degrees in mathematics and nuclear regulation.

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