Norwell Solar Farm Steering Group

Application by Elements Green Trent Limited for an Order Granting Development Consent for the Great North Road Solar and Biodiversity Park (GNR Project)– project ref. EN010162
Unique Number [redacted](Our ref NSG/1)

Deadline 1 Lifecycle Greenhouse Gas Evaluation

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Executive Summary

The publication of Chapter 15 Climate Change as part of the ES is accompanied by a Technical Appendix which attempts to calculate the greenhouse gas emissions (GHG) associated with the development. Just as with the PEIR, the Group reviewed the Applicant's methodology and calculations.

The Applicant finally provided an equation for quantifying annual power from the arrays. However, it was based on a theoretical figure and in DC. Their formula failed to include any location factor The Group applied the industry standard AC formula for these calculations, and in so doing, arrived at a much lower generation figure. This also had a knock on effect for the BESS discharge totals which also reduced.The applicant’s assumption that the project can power 400,000 homes is unsupported; recalculations show only about 272,000 homes could be supplied

The Applicant relied upon an assumption on data which by their own admission was unlikely. This was not compliant with the Rochdale Envelope principles and National Planning Statement EN-3 (2023) which requires assessment of likely worst-case environmental effects.The Group recalculated all generation data and found that there were substantial generation reductions in the 3 scenarios predicted. The Applicant's, which was highly unlikely, one the Group presented as more likely and the third based on modelling by the Department for Energy Security and Net Zero (DESNZ).

The Group scrutinised all the calculations for materials in the Technical Appendix. It found numerous omissions, wrong assumptions, incorrect factors and mathematical errors. The Group also revised some of the replacement material figures as the Applicant's assumptions seemed over optimistic and not in line with similar developments. In total, the corrections actually led to a increase in associated carbon emissions of 320,606tCO_2e, over and above the Applicant's total.

The new emission savings and production emissions were then consolidated. The results were that the project was likely to lead to a net increase in GHG over 40 years in the three scenarios- the first by 1,099,611tCO_2e and in the more realistic scenario, 2,241,532tCO_2e. Using DESNZ modelling, the third would be 2,719,012tCO_2e. In other words, the project would actually add significantly to global warming compared to no construction.

An analysis was completed of the expected generation from the original design which showed that too much land had initially been included for panels in order to efficiently achieve 800MW. The latest design probably still has too much panel acreage to efficiently achieve that power.

1 Introduction.

1.1 This report, the first in a suite of three, will focus chiefly on the analysis in TA A15.1 – Lifecycle Greenhouse Gas Evaluation (APP-285)- the 'Appendix'. This process is more usually referred to as Life Cycle Assessment (LCA) and is becoming more utilised to evaluate the net costs/gains of a renewable energy proposal. The development proposed, if ordered, will lead to the generation of renewable energy. The Applicant also acknowledges that there are significant CO_2 emissions associated with the construction, operation and decommissioning of the plant. They acknowledge that the project will have some negative impacts. The question to be answered here is whether those negative impacts are outweighed by any positive impact the project will have in reducing climate change.

1.2 Reference will also be made to ES Chapter 15 Climate Change (APP-058). The Steering Group submitted a Statutory Consultation response in February 2025. That response scrutinised the PEIR version of the lifecycle greenhouse gas findings. The Group's submission was also adopted by Norwell and Norwell Woodhouse Parish Council as their statutory consultee response. Some extracts from that submission on this subject appear in Chapter 15 and they can be read as being points made also by the Steering Group.

1.3 The Group recognise the complexity of this type of evaluation. Credit should be given to the Applicant for attempting a thorough analysis, to a degree not replicated in many other NSIP applications. There are limitations to the requisite evidential sources. Two principal databases - "Inventory of Carbon and Energy (ICE) Version 4"(ICEv4) and Department for Business, Energy & Industrial Strategy, "Greenhouse Gas Reporting: Conversion Factors, 2024" (GHG Factors) provide significant scientific data which assists with most of the calculations regarding greenhouse gasses. The Group also recognise that the Applicant, when faced with an absence of certain data in either of the above databases, has sought that information in published scientific papers. This has been instructive and helpful. Throughout this document, there are hyperlinks, but only to gov.uk sites as per Planning Inspectorate guidance.Where a third party website is a source, there will be an asterisk and the URL is in Appendix D.

2 Background.

2.1 It has always been (and still is) the Applicant's position that once fully operational, this development will produce enough clean energy to meet the electricity needs of 400,000 homes. There has been strong marketing to that effect. This was because the planned solar generation was to be 800 MW AC and that supposedly could power that number of homes.

2.2 The Group had very early doubts about this claim. On 28th November 2024, senior representatives from the Applicant were asked by a member of this Group how they arrived at the 400,000 figure. They were asked for the details of the formula used to arrive at this conclusion. They were not able to answer but later promised an email reply. There was however early agreement that the average annual figure to be used for domestic electricity use should be 2.7MWh AC, this being the figure previously published by OfGem.

2.3 No email arrived in the following two weeks so the Applicant was again asked for the details by email. The Applicant correctly states in Chapter 15 page 8 that they did respond then (though it was on the 9th December, not 12th as stated on page 8 of Chapter 15). Unfortunately, again no formula was forthcoming. Regarding the number of houses, the email said that *"The Figure is based on annual project generation estimates of 1,125,600MWh".*

2.4 It was hoped that PEIR would inform on this subject, especially as by then, they knew the question was being asked. Unfortunately, the PEIR also did not include the workings behind this assumption.

2.5 With the continued absence of the full workings behind these assertions, the Group posed the question again in its Stage 2 response"

> *"In Year 4, it states the 800MW solar panels will produce 1,107698MWh in that year. The Group would wish to know how an 800MW array in Nottinghamshire (excluding a BESS top-up) can produce that much energy when the Council's own figures suggest annual output would at best be nearer 770,880MWh"*

2.6 At the PEIR stage, there were also differences between the Group and the Applicant in the findings for the embodied carbon associated with the development. Sometimes these were down to the Applicant using Version 3 of the Inventory, whereas the Group used Version 4. The Applicant explains that when the calculations were made , Version 4 had not been released. To gain access to the Inventory, one must register and by so doing, one gets notifications of any updates. The email update announcing Version 4 came well before the PEIR release. However, it is possible that the Applicant did not have time to update and correct errors arising out of using the earlier version. In Chapter 15, the Applicant does accept the majority of errors and gaps in their calculations, identified by the Group.

2.7 The position of both parties at the end of Statutory Consultation was that the Applicant concluded that the project would deliver savings of 1,594,744tCO_2e, whereas the Group's calculations arrived at 905,762tCO_2e. The Applicant's new ES worst case figure is now 789,292tCO_2e, below half of what was originally forecast. This submission will later test the validity of this latest figure.

3. Rochdale Envelope

3.1 The following helpful explanation (with our emphasis) is drawn from a footnote on page 14 of National Policy Statement for Renewable Energy Infrastructure EN-3:-

> *"10 Case law, beginning with R v Rochdale MBC Ex p. Tew [2000] Env.L.R.1 establishes that while it is not necessary or possible in every case to specify the precise details of development,* ***the information contained in the ES should be sufficient to fully assess the project's impact on the environment and establish clearly defined worst case parameters*** *for the assessment. This is sometimes known as 'the Rochdale Envelope."*

3.2 In terms of embodied carbon calculations in the ES by the Applicant, there are examples where this approach has been rightly adopted. Steel and aluminium sourcing and the choice of mineral oil for the transformers are examples.

3.3 In one of the 2 cases which gave rise to Envelope, Judge (Sullivan J) stated in R. v Rochdale MBC ex parte Milne (Queens Bench Division) that the level of information required should be *"sufficient information to enable 'the main,' or the '****likely significant'*** *effects on the environment to be assessed".*And also...

> *"It will be for the authority responsible for issuing the*

development consent to decide whether it is satisfied, given the nature of the project in question, that it has 'full knowledge' of ***its likely significant effects on the environment****."*

3.4 The Planning Inspectorate has helpfully issued guidance (principally aimed at applicants) in version 3 of their advice note "Nationally Significant Infrastructure Projects - Advice Note Nine: Rochdale Envelope". The Examining Authority will be aware that contained within that is:

> *"2.4.....the clearly defined parameters established for the Proposed Development must be sufficiently detailed to enable a proper assessment of the* ***likely significant environmental effects ..."***

3.5 In all the emphases, the word 'likely' figures with Mr Justice Sullivan requiring that the worst case parameters be adopted where uncertainty exists. In the GNR application, there are a number of potential environmental effects. However, it is argued that the two main ones are embedded in the project's raison d'etre – one is that the project will produce low carbon energy and in so doing it will produce a net reduction in CO_2 emissions. The second involves energy security.

3.6 Applying the likely significant effects requirement to this project has to mean that the data presented with regard to MWh produced should ideally have a high likelihood of taking place, and where there is doubt over the data, the worst case scenarios are adopted.

3.7 Whereas predictions of energy generation could be estimated with a degree of confidence (if the right formula is used), estimates of carbon avoidance are more difficult to quantify. In such cases, it is argued that assessment of highly unlikely predictions has no place in the calculations. Instead, if Mr Justice Sullivan's ruling is to be followed, and in the absence of certainty, then the worst case scenarios should be used to assess the project's impact on the environment. Completely unlikely environmental impacts or effects should be not be included.

3.8 The worst case assessment requirement is not just based in case law, it is also a requirement in the Overarching National Policy Statement for Energy (EN-1) 2023. At paragraph 4.2.12, it states:

> *"Where some details are still to be finalised, the ES should, to the best of the applicant's knowledge, assess the likely worst-case environmental, social and economic effects of the proposed development to ensure that the impacts of the project as it may be constructed have been properly assessed."*

3.9 The Applicant has provided 2 projections for CO_2 avoidance due to renewable generation from the solar panels. In line with the Envelope, the Applicant states at paragraph 32 of Chapter 15:

> *"A worst-case approach is taken in this chapter when assessing the carbon avoidance from Solar PV generation. The level of carbon savings depends predominantly on the embodied carbon of the grid electricity that is displaced by the electricity generated by the Development."*

3.1 And at paragraph 34 (with our emphasis)...

> *"In order to assess a worst-case scenario, **the predicted, and rapidly decreasing, levels of carbon intensity** in the grid have been applied to our assessment, resulting in a carbon avoidance which is lower than might be expected."*

3.11 The predicted carbon intensity data used by the Applicant appears to be sourced from DESNZ modelling, contained within its 2023 publication "Valuation of energy use and greenhouse gas emissions. This modelling provides guidance on the predicted levels. This data is consistent with data the Group have. To name these intensity figures as worst case may be misleading – according to the Applicant, these are the predictions. It is appreciated that from the Applicant's point of view they are bad news as they show a predicted ever decreasing grid carbon avoidance attributable to the panels. But they represent the effects over time on the environment from the development, given its design, location and size.

3.12 This is best represented by the Applicant for the year 2034 when they state in paragraph 33 of Chapter 15 that the carbon intensity "*is predicted to be 0.0295 kgCO2e/kWh."* The entry for that year in Table A15.1.19 (page 39 Technical Appendix A15.1) indeed shows 0.0295kgCO2e/kWh in the calculations.

3.13 It is accepted that the further in the future one predicts, the more challenging it becomes to be certain of accuracy. However, if one is to evaluate the lifetime benefits of this development, then one has to start somewhere.

3.14 Page 42 of the above Appendix presents a second table – Table A15.1.20 where the grid carbon intensity is pegged at the 2024 figure, for the working life of the development. The Applicant is open in that this would represent "*a scenario where all or most low carbon electricity proposals do not proceed.*" The latest TEC Register at the time of writing show 3.6GW of green energy projects under construction or about to be commissioned. The sheer number of green energy projects at various stages of planning of course makes the above quoted scenario virtually impossible. And it ignores the likely grid connection in 2030 of the Hinkley Point C nuclear power station with its 3.2GW capacity, amongst numerous other NSIP and TCPA projects proceeding to construction.

3.15 Given that this scenario is totally unrealistic and highly unlikely, it is not clear what purpose it serves. It may be that the author of Chapter 15 and the Group are of a similar mindset on this point. Paragraph 35 states about this exercise:-

> *"...arguably this approach does not reflect the expected continued decarbonisation of the electricity grid as an evolving baseline."*

3.16 The only slight difference in the Group's point of view is on the need to include the word 'arguably'. Given the complete unlikelihood of this scenario and therefore the irrelevance of the table data, this approach cannot be consistent with the requirements of the Rochdale Envelope which emphasises the need to evaluate likely effects, not highly unlikely ones.

3.17 The Applicant, it seems somewhat reluctantly, includes Table

A15.1.20 with the justification (Chapter 15 paragraph 35) that the Planning Inspectorate have previously approved applications which included highly unlikely scenarios as compliant with the Rochdale authorities. The Group are not aware of these applications so it is requested in the response to this deadline that these are named. One wonders whether these applications were approved despite this statistically dubious exercise.

3.18 The importance of this point is that for the overall scheme benefit, it presents both findings in the Technical Appendix A15.1 as if they have similar weight and value. Firstly, the overall effect on the environment in the highly unlikely scenario and secondly, based on predicted data.

3.19 For the purposes of future calculations in this document, the Group will use as the starting point Table A15.1.5. It is the nearest to comply with the directions of Mr Justice Sullivan.

Table A15.1.4 - Summary of Net Emissions (with 2024 grid carbon intensity baseline for solar PV)

Total Emissions	**Total Emissions ($teCO_2e$)**
Total Emissions Produced	3,194,264
Total Emissions Saved	(-) 9,794,671
Net Emissions	**(-) 6,600,408**

Table A15.1.5 – Summary of Net Emissions (Worst-Case Scenario)

Total Emissions	**Total Emissions ($teCO_2e$)**
Total Emissions Produced	3,194,264
Total Emissions Saved	(-) 3,983,556
Net Emissions	**(-) 789,292**

4 Load factors

4.1 In order to address the next question- how much electricity will this development produce?- it will be helpful to explain the relevance of load factors.

4.2 In their submission to the Inspectorate in June 2024, Enso Energy provided a clear and helpful explanation of load factors (Helios Project, PINS Document Number EN010140/APP/6.3.12.3):-

> *"Capacity factor, or load factor, is a term often used to consider the performance of solar farms, and other generation sources. The capacity factor is how much electricity a site generates a year compared to how much electricity could theoretically have been generated if it were producing at maximum output continuously. In this case a capacity factor of 10.6% has been used in line with the latest figures released by the Department for Business, Energy & Industrial Strategy for UK solar photovoltaic projects"*

4.3 The Government figures referred to in the extract show the average load factors for UK solar farms since 2018 :-

	UK	Spain
2018	11.2%	18.58%
2019	10.7%	12.08%
2020	10.5%	14.95%
2021	9.9%	15.67%
2022	10.4%	16.62%
2023	10.2%	17.29%

(Source Dukes 6.3) (Source* Wemake Renewable Energy Consulting, Pamplona Spain 2025(accessed 25/07/25)

4.4 Load factors for solar farms vary within a country and of course internationally as they are critically linked to location and the annual solar irradiance there. As an example, the corresponding figures for Spain are shown above.

4.5 In our Group's PEIR response recalculations, a generous load factor of 11% was adopted. Upon reflection , this was not consistent with Rochdale Envelope principles. It is documented that the Examining Authority for the Mallard Pass NSIP enquiry eventually accepted a 10% load factor as a prediction for that development. The Applicant's for the Dean Moor Solar Farm PINs ref EN010155 App -161 assumed a load factor 10.2%. Having revisited this matter, our recalculations will assume an average load factor 0f 10.5%.

5 MWp

5.1 The final background information needed before addressing the Applicant's calculations is the difference between MW AC and MWp. The Applicant's objective is for the project to deliver 800MW AC. That will be the power arriving at the Staythorpe Power Station sub-station in its best years and consequently being delivered to the grid.

5.2* The MWp figure is a theoretical figure, measuring DC power output as it leaves the panels. Grid scale solar panels are rated by their theoretical peak DC output (Wp). This output from each panel design is measured using Standard Test Conditions (STC). To compare like for like, the STC is defined by the International Electrotechnical Commission. The standard test parameters are 1000Wm3 of solar irradiance, module temperature at 25°C, an Air Mass of 1.5 and zero wind speed. Such tests are completed in laboratory conditions. These conditions correspond to the irradiance and spectrum of sunlight incidence on a clear day upon a sun-facing 37°-tilted surface with the sun at an angle of 41.81° above the horizon. They approximately represents solar noon near the spring and autumn equinoxes in the continental United States, with the surface of the cell aimed directly at the sun. Lower irradiance, different panel tilt and sun azimuth angles, or lower/higher temperatures would reduce the output just as would dust, pollutants or minor possibly non visible manufacturing defects.

6 Recalculation of Solar Panel output

6.1 The Applicant has finally provided their formula to calculate annual MWh production from the development (page 41 of the TA A15.1). In 5.1.11 Section 42 Applicant Response Table (APP-314), the Applicant states that the theoretical maximum for the solar generation is 1120MWp and 800MW AC.

6.2 The formula that has been used by the Applicant is

1120MWp x yield (1005kWh/kWp/annum x annual degradation.

For Year 4 this comes out as 1,107698 MWh.

6.3 Addressing the yield issue first, the Applicant appears to be saying that for each kWp, 1.005kWh will in practice be delivered to the grid. Bearing in mind section 5 above, one cannot use the laboratory STC rating to calculate real world generation to the grid. It is a theoretical maximum measured at panel outlet in a laboratory. It is extremely unlikely to ever be remotely experienced in Nottinghamshire. This is actually stated by the Applicant as such in paragraph 10 of "Technical Guide for Solar Power Generation, Storage,Maintenance and Decommissioning" APP-330:

> *"A 1MWp solar PV system operating under ideal conditions would generate approximately 1,000MWh of electricity per year. However, the actual amount of electricity generated will depend on the environmental conditions within which any particular solar PV system is operating i.e. sunlight levels, ambient temperature and geographic location."*

6.4 Secondly, the STC kWp is measured in DC watts, not AC. The power delivered to the final grid substation is designed to be 400kv AC. This now explains the misdirection behind the claim that 400,000 homes can be powered. The Applicant has divided 1120MWp DC by 2.7MW AC. That is not a valid real world calculation and is not factoring like for like. As an aside,the Gate Burton NSIP solar station (PINs reference EN010131) is predicted to power 160,000 homes from its 500MW generation. The Great North Road generating capacity is 60% greater but according to the Applicant, is capable of powering 150% more homes than Gate Burton. The larger Botley West NSIP (840MW) is projected to supply enough electricity for 330,000 homes (PINs reference EN010147)

6.5 The third important error is that one will notice there is no geo-location influence on the calculations. By removing all reference to a UK load factor, this just becomes a theoretical equation for panel efficiency. To best illustrate this, if the Applicant was to build another identical project, but located in the Sahara, according to this formula, both would produce the same amount of annual power. Lastly, the load factor recognises that it gets dark at night, and sometimes it is cloudy. The above equation does not.

6.6 They key figure for this project is the 800MW AC. By using overplanting, before the panels start to degrade, this is what may be delivered to the grid, and whatever happens prior to that is to a degree irrelevant to the calculations.

6.7 The Group have previously discussed this with the Applicant but to no positive outcome. It is argued strongly that the correct formula, which is normally used for these calculations, should be (for its least degraded year)-

800MW AC x 24(hours)x 365.25 (taking leap years into account) x 0.105 (UK Load factor) and thereafter reducing 0.4% per annum.

6.8 Using the correct equation, it is possible to calculate the real world predicted solar power generation. Without degradation, the above formula shows that annual real world solar energy generation and transmission to the grid would be 736,344MWh AC- enough power for 272,720 homes.

6.9 All the figures in the last four columns of Table A15.1.19 Page 39 TA A15.1 will need to be amended . To compare like for like, the new table will maintain the same BESS charging percentage. But solar energy to the grid and BESS charging figures will now be in AC as opposed to all the Applicant's figures which are all in DC.

6.10 The Applicant introduced certain assumptions about the life of key materials during the 40 year project life. These have always seemed optimistic. The first was that only 10% of the panels would need replacing during the 40 years. The second is that there will only need to be a 150% replacement of batteries. In other words, some of the batteries would be expected to last around 20 years. Lastly, the Applicant assumes 95% of the transformers will last the full forty years. No evidence has been provided of panels,transformers or batteries expected to last that long.

6.11 The Applicant has stated that it may possible for the batteries to complete one and a half cycles each day. Based on overnight charging each night to discharge in the morning peak demand period, and solar charging during the day to discharge in the evening peak, it would not be unreasonable to estimate the batteries would complete 600 cycles each year. That would be 9,000 cycles over 15 years.

6.12 Comparisons have been sought with other developers of similar projects. The One Earth Solar farm NSIP – EN010159 (in examination at the time of writing) is one example. In their Chapter 14 Carbon and Climate Change APP-043 on page 19, that developer predicts lifespans of 10 years for the batteries and 30 years for the panels and transformers.

6.13 The Botley West solar farm project (PINS reference EN010147) in their Appendix APP-215 anticipates a lifespan of 25 years for their panels.

6.14 The Heckingon Fen Solar Farm project (PINs ref EN010123) helpfully predicts their battery lifespan to be 7,500 cycles. Applied to the Great North Road, this could mean a lifespan of approximately 12 years. For a 40 year project lifespan, there would have to be 3 complete replacements.

6.15 The Oaklands Solar Farm project (PINs ref EN010122) expects their batteries to be full replaced every 8-10 years.

6.16 Figures vary between developer. Clearly, there will perhaps be a subconscious influence for some to be very optimistic about certain lifespans. Currently, major Chinese panel producer Canadian Solar* state:

6.17 *"A high-quality solar panel has a guaranteed lifespan of 25 to 30 years and experience in the field shows that up to 40 years is possible."* (accessed 28/07/25)

6.18 JA Solar* in China predict their panels to last "25 years or longer" (accessed 28/07/25). Another major producer Trina Solar* state;

6.19 *"The NEG9R.25 stands out with its excellent product warranty covering up to 25 years, coupled with an impressive power warranty covering 30 years"* (accessed 28/07/25)

6.20 Considerable time has been spent unsuccessfully attempting to evidence examples where a BESS battery could deliver 600 cycles a year for 16 years. If the replacement rate is to be 150% in total, 16 years would be the estimated lifespan for the Great North Road batteries. That would equate roughly to 9,600 cycles. If the Applicant has examples of manufacturers who state their BESS batteries are capable of this number of cycles, then their figures are accurate, although they are not consistent with other developers.

6.21 Given how new this technology is, there is an absence of empirical evidence. However, it is argued that, unlike Oaklands above and to a lesser extent One Earth, a replacement rate of just 150% is not 'Rochdale compliant'. Instead, it is much more like the best case scenario. The position taken by the Heckingon Fen Solar Farm project may well be a fairer prediction though clearly it is not the worst case scenario. For the purposes of this report a replacement rate of 300% will be adopted.

6.22 The position is similar with the panels. Both Botley West and One Earth predict a 100% replacement. For the purposes of this report, a 50% replacement rate will be assumed as there is some evidence that at least some of the panels may not need replacing.

6.23 A 50% panel replacement rate improves the solar generation capacity of the arrays over the project lifespan. Appendix A shows the calculations when adopting a 50% replacement rate over 5 years around 30 years of operation, with 10% of the panels being replaced each year.

6.24 Once the panel generation total for each year has been established, it is possible to quantify the panel generation direct to grid and by using the Applicant's choice of marginal carbon intensity rates, the emission avoidance for panel direct to the grid total. These workings are shown in Appendix B. **The new total is 454,034tCO_2e**.

7 Recalculated Carbon Savings from the BESS

7.1 With regard to the BESS, the reason why batteries are replaced is that over time they become less efficient at storing and discharging the electricity. As a battery ages, internal resistance grows, leading to greater voltage drop under load. This reduces the effective energy you can get out, especially at higher power demands. Eventually, a battery becomes so inefficient that it is deemed to be at End of Life (EoL).

7.2 The efficiency loss occurs in the following ways.
1. Internal Resistance (Ohmic Losses).As current flows through the battery's internal resistance, some energy is lost as heat. This is especially noticeable at high charging or discharging rates (higher C-rates).

2. Electrochemical Inefficiencies. Not all the lithium ions that move during charging are perfectly recovered during discharge. Side reactions (like electrolyte decomposition or formation of the solid-electrolyte interphase, SEI) consume some of the energy.

3. Self-Discharge. A small portion of energy leaks away internally while the battery sits idle, further lowering usable output.

4.BESS batteries power their own auxiliary systems such as cooling.

7.3 Research has shown that EoL definitions vary. The industry consensus is that it will vary between 70-80% of the original design storage. The PV Magazine *Energy Storage** (accessed 2/8/25) reported earlier this year that Trina Storage, a major supplier of BESS batteries, had quantified the efficiency of its latest 150MWh storage project and had concluded that after one year, 2% of its efficiency had been lost. This is line with the estimated 12 year lifespan for the batteries for Great North Road. Therefore a highly likely EoL for this project will be assumed to be 76%. This needs to be factored into the BESS avoidance calculations.

7.4 Finally, to arrive at what energy arrives as 400kv AC at the substation from the BESS, the Applicant adopts a 4% power loss attributable to the BESS inverters and transformer. The Group do not challenge that figure as it appears to be in line with published electrical engineering reports. The above revised BESS avoidance calculations are shown at Appendix C. **This shows for unlikely 2026 pegged scenario as saving of 1,917,007tCO$_2$e.**

7.5 The Applicant states in paragraph 36 of Chapter 15 the following:

> *"The assessment applies the lowest reported embodied carbon figure for Combined Cycle Gas Turbines (CCGT), 0.365kgCO2e/kWh14. CCGTs are more efficient than single cycle gas turbines, which are most often used at peak times, and therefore, a worst-case approach has been undertaken based on the data available."*

7.6 This is noted and clearly compliant with the Rochdale Envelope principles. However, the Applicant then notes the difficulty obtaining data which would predict future intensity figures, which they rightly state are *"likely to reduce over time, as our reliance on gas fired power stations reduces"* (paragraph 36). The result of this is that the Applicant is still using that 2026 intensity figure for 2060, 10 years after planned net zero. Whilst acknowledging the shortage of reliable prediction data, the Group would argue that some effort needs to be made to demonstrate attempts to show what effects predicted decarbonisation and technological advances in the infrastructure may have on the BESS contribution.

7.7 Few will disagree that maintaining the same carbon intensity figure up to 2065 is highly unlikely to resemble what is likely to happen. It is another example using highly unlikely data to arrive at what is a best case scenario, even when using the CCGT figure. SSE are currently progressing development work for carbon capture and storage (CCS) at four of its gas power stations, including Staythorpe. SSE are doing the same for Keadby 3 power station. There are currently 27 carbon capture and storage projects under licence according to the North Sea Transition Authority (NSTA accessed 5/8/25)*. As the Applicant has hinted at, there is continued large growth in renewable power generation and battery storage. Though it is not possible to accurately predict decarbonisation, a broad brushstroke estimate must surely be more informative than going with no decarbonisation or infrastructure change.

7.8 To that end, the following scenario will be advanced:

- The UK will still rely on high demand top up from gas up to 2035 with no carbon capture.
- After that year, there will be a very gradual reduction in peak demand for gas, as there has been a significant increase in electricity storage and nuclear and wind generation. Additionally, CCS projects start to come online, significantly reducing the carbon avoidance benefits of reducing gas generation.
- the UK misses its net zero target in 2050 but hits it 5 years later.
- By 2055, there is negligible CO_2 emissions from gas generation as the peak demand for gas has been drastically reduced and any gas generation has CO_2 captured and stored. According to the NSTA and the British Geological Survey, there is up to 78 billion tonnes of CO_2 potential storage available, sufficient to meet hundreds of years of UK demand.

7.9 This scenario may not play out. It is more pessimistic about decarbonisation progress than the predictions contained in the Department for Energy Security and Net Zero Green Book and the

2025 Future Energy Scenarios published by NESO. But it is suggested that it is far more likely than assuming no change in peak carbon intensity for the next 40 years. It is not meant as cast in stone prediction but as a more likely indicator as to the carbon avoidance achieved by the BESS over the next 40 years. **Appendix C shows the calculations for BESS emission savings in this scenario to be 775,086tCO_2e.**

7.10 Earlier, it was acknowledged that there was a shortage of predictions for the country's long-run marginal emissions. However, in October 2023, the Department for Energy Security and Net Zero published its "Valuation of energy use and greenhouse gas emissions". Within that document, the Department has modelled *"the impact of power sector decarbonisation on average and marginal emissions factors*" with regard to electricity.

7.11 On page 5 of that document, it states:

> *"Historically, Combined Cycle Gas Turbine (CCGT) plants have been the long-run marginal electricity generators and thus the marginal emissions factor in 2010 reflects that of a typical CCGT plant (0.357 kgCO_2e/kWh before taking into account distribution and transmission losses). However, as the power sector changes to meet the UK's targets for National Determined Contributions (NDC) in 2030, Carbon Budget 6 (CB6) in 2033-37, and net zero in 2050, low carbon generation will increase significantly both as a proportion of total and marginal generation."*

7.12 It is not intended here to describe the methodology employed in this publication. The reader is best visiting pages 5 and 6 of that document. The following table (from page 7) represents the results of their modelling:

Figure 2.1: Generation-Based Marginal Emissions Factors (kgCO2e/kWh)

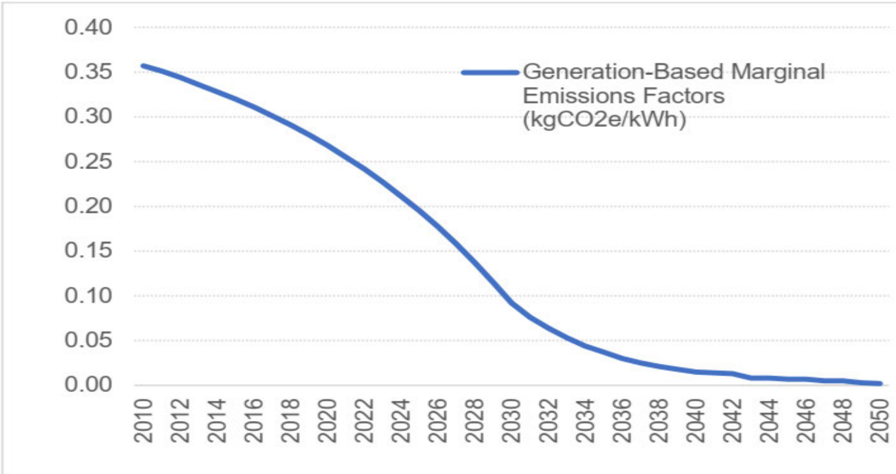

Figure 1

7.13 It appears the above findings were adopted by the Applicant as the emissions factors in Table A15.1.19 in the Appendix. In 2026 (even though it seems unlikely this project will be generating that year at all), an average emissions factor of 0.174kgCO_2e/kWh is adopted, whereas the Applicant's gas peaker evening peak factor for that year is 0.365kgCO_2e/kWh (110% higher). The Group does not challenge the use of that higher figure. Only that it should not apply for every year thereafter.

7.14 Employing the DESNZ modelling as above but maintaining a constant 110% uplift in emissions year on year would provide a fairer forecast of the BESS emission savings. **Appendix C shows that using this modelling would predict an emissions saving of 297,606tCO_2e.**

7.15 It is now possible to consolidate all the above data for emission savings for the three scenarios.

Table 1. Summary of Emissions Savings (highly unlikely CO_2 gas intensity figures pegged at 2026 levels)

Development Phase	Total Avoided Emissions ($teCO_2e$)
Land Use Change	44,218
Solar PV Generation direct to Grid	454,034
BESS Discharge to Grid	1,917,007
Total	**2,415,259**

Table 2. Summary of Emissions Savings (Possible Future Scenario)

Development Phase	Total Avoided Emissions ($teCO_2e$)
Land Use Change	44,218
Solar PV Generation direct to Grid	454,034
BESS Discharge to Grid	775,086
Total	**1,273,338**

Table 3. Summary of Emissions Savings (DESNZ modelling)

Development Phase	Total Avoided Emissions ($teCO_2e$)
Land Use Change	44,218
Solar PV Generation direct to Grid	454,034
BESS Discharge to Grid	**297,606**
Total	**795,858**

8 CO_2 Emissions and Embodied Carbon for materials and Operations

8.1 BESS Battery cells

8.1.1 The PEIR calculations for this subject were scrutinised in depth by the Group. There is little value in revisiting the former errors. The only relevance now is the Applicant has had the opportunity to revise figures in these calculations, aware of the probability that they will be scrutinised again. Given the past, there has to be value in this Group repeating that level of scrutiny. Where this report does not comment on a particular material, activity or journey calculation, then that should be read that there is general agreement with the Applicant's figures. A slightly different approach will be taken this time in that each item of material will be analysed in the same section of this document for all emission categories.

8.1.2 The first item is Battery (BESS) cells. On page 2 of TA15.1 -the Appendix, (by 'page 2', it is meant the second page 2 as there are 2 page 2's and 2 page 3's in the Appendix) the Applicant estimates they will weigh around 2 tonnes per MWh. This is a copy paste from the PEIR version. This would make the weight to be 1760t. It also states that the project lifetime would be 30 years which is not correct.

8.1.3 If one then checks on page 13 of the Appendix, clearly new research has been completed since the PEIR by the Applicant, referencing the Chinese manufacturer BYD. Referring to a BYD specification sheet, the Applicant changes the total weight of the cells to 7,644t. This is clearly an updated figure and is based on 8.686t per MWh, seemingly drawn from BYD data.

8.1.4 The Applicant estimates for the full 40 years, all cells will need replacing and then a further 50% will again need replacing. Clearly the implication is that a significant proportion will be able to last 20 years, even with daily cycling.

8.1.5 The sea journey distance for the batteries is shown as 19,600km. This is consistent with the use of the container terminal at Shenzhen. This journey distance assessment was completed by the Group as part of its Stage 2 response. The mention of Guandong as the location of manufacturing for the cells is of interest. Even though BYD have their headquarters there, research has shown that they manufacture the vast majority of non electric vehicle batteries elsewhere in the Country. This may well be revisited in a later report. The Group have so far been unable to identify a factory within 30km of the port, that makes these utility scale battery units. In response, to this deadline, the Applicant may wish to clarify this matter.

8.2 PV Panels

8.2.1 Fortunately there are simpler corrections necessary for the panels. Page 14 explains that the panels will leave China through the Port of

Shanghai. However the journey distance used for calculation on page 14 still equates to Shenzhen. Shanghai Port is a further 1437km away. Including the 10% extra replacement panels, this **increases the sea travel emissions by 12,038tCO_2e.**

8.2.2 Moving on to the Decommissioning Waste transport, page 55 puts the embodied carbon for the 64,443t of panels as 15.5tCO_2e. Here the Applicant's multiplication is incorrect. The correct total using the Applicant's own factors is 3,093tCO_2e. This is **an increase of 3077tCO_2e**.

8.2.3 **The total increase for the panels in all phases is 15,115tCO_2e.**

8.3 Inverters

8.3.1 The Applicant's mapping (2.10 Illustrative Design APP-029) shows by the Group's count 198 inverters. This number was arrived at by a visual count and of course may be one of two off. So far, the Group have not found an actual number or specifications for inverters in any document.

8.3.2 Section 5.4.1.4 of Chapter 5 Development Description APP-048 describes the inverters as being central inverters. Paragraph 26 states:

> *"Central inverters are often of similar size and outline to a shipping container,with each serving a large number of PV modules."*

8.3.3 In the Appendix (page 14), the Applicant states the combined weight of the inverters is 444t. That means that each inverter weighs 2.24t. For a central inverter, this seems very low. Possibly the reason why is pictured below. The weight assumption is based " *on Sungros SG250HX 250 kW string inverter"* (page 15 of the Appendix). This is a typo and the make should be Sungrow* (all pages accessed 9/8/25). Below are 2 typical solar farm string inverters, though larger than a *SG250HX.*

Figure 2

8.3.4 According to the manufacturer, the *SG250HX* is 1051 x 660 x 363mm in size and weigh 99kg. Clearly it is nothing like a central inverter. Figure 3 below shows a typical central inverter.

Figure 3

8.3.5 These inverters in the UK usually are enclosed in a steel container as described by the Applicant above. Until more accurate information is provided about the inverters, then the specifications for a similar central inverter will be used here. Sungrow's SG3400 central inverters* are popular and each weigh 6.5t. This is actually quite light for a central inverter. 6.3.5.10 Environmental Statement Figure 5.10

“Illustrative Inverter Transformer Elevations” APP -089 shows an inverter which is 6.05m metres long. This is the same length as the Sungrow SG3425* (which weighs 18 tonnes and can export at 33kV AC). For the purposes of this exercise for now , calculations will be based on the smaller SG3400 (though this may be amended in a subsequent report). It is appreciated that at this early design stage, the Applicant will probably not have decided on an exact model. However, it seems it will be highly unlikely to be the Sungrow SG250HX 250 kW string inverter as per Figure 2 (which cannot export above 920V) and much more likely to resemble Figure 3.

8.3.6 Using the head count of 198, gross inverter weight will be 1287t.

8.3.7 The HGV journeys totalling 689km would cause 213tCO_2e- **an increase of 138tCO_2e**. As for the sea journey, it is the same issue as 8.2.1 above as the Port of Shanghai has been chosen, increasing the journey by 1437km and the carbon emissions to 3520tCO_2e, **an increase of 2390tCO_2e**. This figure is liable to change as and when the Applicant is more specific about inverter choice in line with the Rochdale Envelope principles.

8.3.8 The Applicant estimates a replacement rate of 150% (page 38). The above changes of course apply here too. The replacement inverter transport emissions **increase by 3,792tCO_2e.**

8.3.9 When it comes to decommissioning, the 3217t of inverters (including the replacements) have not been included by the Applicant. The Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, (GHG Factors) show an embodied carbon factor of 6.41kg per tonne of large electrical items. This means that the omitted associated embodied carbon would be 21tCO_2e and adopting the Applicant's transportation methodology, their transport emissions would be 154tCO_2e. Decommissioning adds **an increase of 175tCO_2e.**

8.3.10 The total of all embodied carbon and emissions associated with the inverters for all phases **increases by 6,495tCO_2e**

8.4 Steel Panel framework

8.4.1 At the PEIR stage there were some contradictions in the choice of steel type for the frames. Researching specialist companies who manufacture these frames does not assist as it was apparent one can buy frames in aluminium, galvanised or stainless steel.

8.4.2 Unfortunately that confusion continues in the ES. In the Concept and Design Parameters and Principles APP -329 page 6, the Applicant states the framework will be constructed from *"Galvanised steel, anodised aluminium or Magnelis (zinc, aluminium and magnesium alloy)".* This is the same as in the PEIR documents.

8.4.3 On Page 3 of the Appendix, the relevant section needed amending from the PEIR version as it used an out of date emissions factor. Included in this amendment is the new assumption that the framework will be 100% stainless steel. This amendment was surprising. Firstly, stainless steel is generally more expensive than galvanised. Secondly, the associated embodied carbon for galvanised steel is 36% less than stainless. However, as it appears to be the latest amendment post PEIR, it is taken at face value.

8.4.4 The Applicant's decision to present the worst case scenario for steel production is clearly 'Rochdale compliant'. Their stated intention to, if possible, source steel from Port Talbot new electric arc furnaces when operational is understandable. According to Tata Steel* (accessed 1/11/25), they are due to be operational by the end of 2027. Whether that is soon enough for this project is not clear.

8.4.5 The round trip distance for steel to Newark from Port Talbot is 710km. This journey would be the only significant cause of delivery emissions for this steel. Worst case scenario has to be that the vehicles do not get a return load back to Wales. This would cause 4,487tCO_2e for delivery and 3950tCO_2e for return (source GHG Factors). This means the total transportation emissions would be 8,437tCO_2e for steel. This is to be compared to the Applicant's Chinese sourcing of steel calculations where the transportation would lead to 16,891tCO_2e. This figure differs considerably compared to the Applicant's transportation figures. The reason is explained in 8.24 below and is because of an incorrect choice by the Applicant for the emissions factor for maritime freight. This would be **a reduction of 8,454tCO_2e.**

8.4.6 Should the Applicant be able to source all its stainless steel from Port Talbot's electric arc furnaces, drawing on the *"Seventh global LCI study for steel products" World Steel Association: 2021*(accessed 18/08/25),* the lower embodied carbon factor for the stainless steel produced there would be approximately 2.186tCO_2e (1.42tCO_2e for galvanised steel plus 54% uplift due to chroming). This UK sourcing would reduce the embodied carbon to 107,726tCO_2e as opposed to 205,889tCO_2e. This would be **a reduction of 98,264tCO_2e.**

8.4.7 The best case scenario by replacing China with Port Talbot for the steel supply for all the frames would **reduce emissions by 106,718tCO_2e.**

8.4.8 The steel, according to page 15 of the Appendix, is planned to travel from the Port of Ziamen. Again, the sea journey distance is shown as the same as from Shanghai and Shenzhen. This journey is 546km longer that from Shenzhen. This sea voyage would result in emissions from maritime diesel of 129,063tCO_2e as opposed to the Applicant's figure of 125,565tCO_2e – **an increase of 3498tCO_2e.**

8.4.9 With regard to decommissioning, page 48 of the Appendix states that only 45,390t of steel is to be recycled, when the weight of steel just for the panel supports is 49,280t. Being as there is no figure for steel going to landfill, the embodied carbon for steel decommissioning rises to 48tCO_2e, **a small rise of 4tCO_2e**. However, the effect on decommissioning transport emissions associated with the extra 3890t is far greater, **increasing by 186tCO_2e**. The second point to mention here is that, as the other steel infrastructure is scrutinised below, none of it appears in the decommissioning phase calculations.

8.4.10 With regard to framework steel travelling from China and being fully decommissioned, there is **an increase of 3,688tCO_2e** above the Applicant's calculations.

8.5 Aluminium

8.5.1 The correct ICEv4 factor is now used for this metal from China. There is an assumed 10% replacement factor for the panel frames. This is accounted for in the 'framework' figure in the replacements table.

8.5.2 This time, the port of departure is Qingdao. But the same sea journey distance for Shenzhen is again used. However, Qingdao Port is a further 2686km further away than Shenzhen. This causes **another 8,212tCO_2e** of maritime emissions, if one uses the Applicant's factor.

8.5.3 **Total increase in aluminium emissions is 8,212tCO_2e.**

8.6 BESS Inverters

8.6.1 According to the Appendix, the Port of Shanghai has been chosen for the inverters. Shanghai Port is a further 1437km away than Shenzhen. The corrected journey distance would result in 7,220tCO_2e, **an increase of 493tCO_2e.**

8.6.2 There is a predicted replacement rate of 150%. Assuming the same port of departure for the replacement inverters sea journeys, the replacements would be responsible for 10,830tCO_2e . This is **an increase of 739tCO_2e** over the Applicant's figure.

8.6.3 Again, these inverters have not been included in the Decommissioning calculations. Adopting the 200km decommissioning transportation estimate used for the other electrical items, for the 6,600t of inverters, there should be an additional **317tCO_2e of diesel emissions**.

8.6.4 The GHG Factors show an embodied carbon factor of 6.41kg per tonne for large electrical items. Therefore the embodied carbon for decommissioning these inverters would be **an extra 42tCO_2e**.

8.6.5 The total embodied carbon and emissions associated with these inverters shows **an increase of 1,591tCO_2e.**

8.7 Steel for the Transformers

8.7.1 This steel is to leave China via the port of Ningbo according to page 17 of the Appendix. Again the standard 19,600km figure was used. The journey from Ningbo to the UK is approximately 1386km longer than from Shenzhen. The total emissions increase to 1,391tCO_2e. Taking into account a 5% replacement rate, this would lead to **an increase of 97tCO_2e.**

8.8 Transformer Mineral Oil

8.8.1 This oil has the same port of departure in China as the steel immediately above. There is a slight increase in maritime emissions: **an increase of 45tCO_2e** to 695tCO_2e.

8.8.2 The Applicant estimates a replacement ratio for transformers of 5%. However, there is no replacement planned for the mineral oil. One could safely assume that the minimum replacement ratio would be 5%. However, transformer manufacturers, whilst recommending testing every 1-3 years, suggest that the oil, if high quality, would need replacing every 20-25 years. If the Applicant has in mind a brand of oil which is predicted to last the full 40 years, then perhaps this could be clarified in any response. The Group have failed to find any examples of where the original transformer oil lasted for 40 years. It is not even the worst case scenario to assume there would need to be a 100% replacement quantity. Some transformer manufacturers predict mineral oil change at 10-15 years.

8.8.3 For this reason the Group will adopt the 100% replacement. This would lead to an increase of **357tCO_2e** but assuming UK sourcing at a nominal distance of 100km, an HGV emissions cost of **8tCO_2e.**

8.8.4 There is a mathematical error at the top of page 19 of the Appendix. The Applicant has used the sea journey distance and maritime diesel emissions factor for the UK HGV journeys, wrongly resulting 650tCO_2e of emissions. The correct figure (using the transformer UK HGV distance as a reference) should be 13tCO_2e. This is therefore **a decrease of 637tCO_2e.**

8.8.5 The combination of the changes in this section mean **for mineral oil there is a decrease of 227tCO_2e.**

8.9 Security Fencing

8.9.1 The design of the security fencing must adhere to the National Grid Electricity Distribution's publication 132kV Outdoor Metered Connections - Guidance For Substation Designers (Version 10)* (accessed 5/10/25) which also applies to smaller installations. It contains within it a section on Typical Substation Compound and Fencing Specification. On page 31 in that section it states: 'Install (min. 2.4m high) galvanised steel security palisade fence and gates to BS 1722 Part 12, enhanced to Western Power Distribution specification document EE SPEC 20'

8.9.2 The specifications outlined on page 12 of the Applicant's Concept and Design Parameters and Principles report APP -329 exceed the minimum height requirements of the above, stating that the fence height (AGL) should be between 3m and 4m. However, it gives the option of paladin as oppose to palisade fencing. It should be palisade. It could be possible to use mesh fencing for the BESS compound as per the Applicant's design principles (APP -329). From the Outline Landscape and Ecological Management Plan (APP-031), it is estimated that 2.5 km around the BESS could be paladin fencing.

8.9.2 Unfortunately,in order to arrive at quantity and weight figures for all security fencing, the Applicant has chosen to base all subsequent Appendix calculations on *" First Fence (2025). 1.8m High Stripe Mesh Security Fencing Kit".* This is detailed in footnote 6 on page 5 of the Appendix.

8.9.3 The above quoted fence fails to comply with the National Grid specifications and fails to comply with the Applicant's own minimum specifications. It is not high enough and it is not of palisade construction. It is possible that this inadequate fence was chosen for calculations because it is very light in weight.

8.9.4 First Fence do sell a 3m high palisade fence*(accessed 15/08/25). However, like other major fence suppliers, it is only 2.75m wide. It weighs 89.93kg per bay. It is made from galvanised steel. Each panel requires one 3m post which is made from the same steel and weighs 19.4kg.

8.9.5 The Applicant estimates that 6km of security fencing is required. 3.5km of that will need to be palisade. That will require 1273 bays and the same number of poles. The weight of the bays would therefore be 114 tonnes and the weight of the poles 25 tonnes.

8.9.6 The 139t of galvanised steel would have embodied carbon of 376tCO_2e.

8.9.7 Turning now to the 2.5km of paladin fencing for the BESS,First Fence do supply a security mesh fence 3040mm above ground*. Each bay width is 2518mm. They are made from galvanised steel and are powder coated. Each unit weighs 60.59kg. 992 bays will be required (weighing 60 tonnes) along with 992 19.4kg posts (weight -19t). The embodied carbon for the paladin mesh fencing would be 214tCO_2e. The total for both fence types is 590tCO_2e. **This is an increase of 458tCO_2e.**

8.9.7 When considering transportation of the security fencing, the applicant just provides tonnage for all types of fencing, as opposed to splitting up deer and security fencing. It will not be possible to calculate any difference to the Group's figures until all fencing components have been assessed in this report.

8.9.8 First Fence is based in Swadlincote in Derbyshire, 78km from Averham by road (156km round trip). The diesel emissions to deliver the 218 tonnes of steel for fencing would be 9tCO_2e.

8.9.9 As mentioned above, this steel fencing does not appear in decommissioning. The embodied carbon is less than 1tCO_2e but the decommissioning transportation is **10tCO_2e. This is an increase.**

8.9.10 Excluding delivery emissions, the security fencing's increased emissions and embodied carbon is **468tCO_2e.**

8.10 Security Fence Paint.

8.10.1 The Applicant has based their paint calculation on the inadequate fence, suitable for the BESS in design but not size.. Their 3mx1.8m fence covers an area of 5.4m².But being a mesh design, a lot of the surface area is air as can be seen in Figure 4 below. Coating all sides, the Applicant has estimated that 1.07m² will need coating. That is 31% of the total bay area.

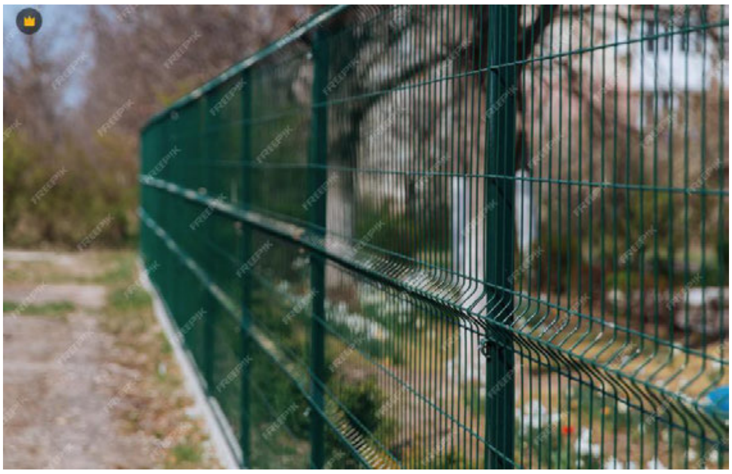

Figure 4

8.10.2 Palisade fencing is far less transparent with smaller air gaps as can be seen from Figure 5 below.

Figure 5

8.10.3 Designs vary but to coat a fence panel both sides, complete with the horizontal bars, the assumption here is that the area to be coated would be approximately 70% of the overall panel area. The First Fence 3m palisade bays are 2.75mx3m (8.25m²). 1273 bays are required which is a total area of 10,502m². 70% of that is 7,352m²

8.10.4 The poles did not figure in the Applicant's calculations. First Fence's 3m posts have dimensions of 3725mmx100mmx55mm in an RSJ shape. An approximate and conservative surface area calculation for each post is 0.95m². 1273 posts are required giving an aggregate surface area for posts as 1209m². Therefore the total surface area of palisade bays and poles in need of coating is 8,561m².

8.10.5 Adopting the Applicant's assumptions that 1 litre will cover 5m², and that 1 litre weighs 1.5kg, the volume of paint required will be 1,712 litres weighing 2568kg. The embodied carbon for that amount of paint, again using the Applicant's emission factor would be 9,656tCO_2e.

8.10.6 With regard to the paladin fencing, 992 panels measuring 2518mmx3040mm are required. That covers an area of 7.65m² each with the total area of 7,593m². Applying the 31% guide mentioned in 8.10.1 above, 2,354m² of the steel will be coated. The 992 poles would have a surface area of 942m², bringing the total area of metal to be coated to 3,296m². Copying the factors from 8.10.5 above, that would require 659 litres of paint weighing 989t. The embodied carbon for that amount of paint, again using the Applicant's emission factor would be 3719tCO_2e. The total embodied carbon for the fence coating would be 13,375tCO_2e. **This is an increase of 11,263tCO_2e.**

8.11 Steel Storage containers

8.11.1 The Applicant assumes a worst case number of 754 containers. This seems a very high number. It is sourced from the BESS battery unit numbers. This is likely to be reduced in practice. Page 7 of the Appendix adds another 40 containers. Steel containers are either made of corten steel, galvanised steel or a mixture of both. On page 6 of the Appendix, the Applicant *"assumes steel will be **finished** cold-rolled coil steel as the best estimate of kg CO2e from the ICE database."* However, the steel in that raw form is not suitable for container construction due to corrosion issues. The embodied carbon factor used by the Applicant in ICE v4 is for **unfinished** cold rolled coil steel. This steel can be used in construction. However, it will require retreating to a finished state. No factors to cover this have been added in by the Applicant. The following is taken from the comments for electro-galvanised steel in ICE v4:

> *"World Steel 2023 study. Obtained by electroplating finished cold rolled steel with a thin layer of zinc-nickel to provide corrosion resistance... Hot Dip galvanised Steel features excellent forming properties, paintability, weldability and is suitable for fabrication by forming, pressing and bending."*

8.11.2 The following is the equivalent comment from ICE v4 but for unfinished cold rolled coil steel:

> *"... It can be found on the market in coil, but requires a further heating process before being manufactured into finished products. The various types of cold rolled steel are used as primary material for finished cold rolled coils and coated coils."*

8.11.3 Using the emission factor for galvanised steel, the embodied carbon for these containers would be 4,712tCO_2e, **an increase of 233tCO_2e.**

8.11.4 The same arguments apply to the 40 20ft containers mentioned on page 7 raising the embodied carbon from 206tCO_2e to 217tCO_2e, **an increase of 11tCO_2e.**

8.11.5 The combined weight of these two lots of containers is 1739 tonnes. When one examines the transportation figures (Appendix page 18), only 440 tonnes of containers are delivered. Using the 440t in the equation should have resulted in 25tCO_2e in emissions but the applicant entered 96tCO_2e. When the 1739t is used, the result is 100tCO_2e. That is near enough the Applicant's figure.

8.11.6 When it comes to decommissioning, there are no real clues what happens to these 794 containers. They do not get mentioned. The associated embodied carbon is negligible. However they have to be transported off site and using the Applicant's choice of distance, that would cause **83tCO_2e of emissions.**

8.11.7 It is recognised that the Applicant states that one of the uses of the 40 containers on page 7 of the Appendix is to provide working environments for staff, such as site offices. Shipping containers are not well suited for that purpose and would most likely be replaced with structures similar to Portakabins®. These may well have a lower embodied carbon factor and therefore these totals would reduce. However, it must be noted that not included in the associated emissions for the containers is the not insignificant embodied carbon associated with welding all these containers. There are no other calculations for site offices.

8.11.8 **The total increase in emissions and embodied carbon for the containers is 327tCO_2e.**

8.12 Paint for the Containers

8.12.1 Once the 794 containers are welded, they will need coating by the manufacturer, at least on the outside. The National Grid, in its publication *"NGC SUBSTATIONS AND THE ENVIRONMENT: GUIDELINES ON SITING AND DESIGN"* state *"Materials and colours for buildings, equipment and fencing should be chosen to harmonise with local surroundings."* Just as it is expected that the fencing will be painted green, so should the containers. This process is not mentioned by the Applicant. On Appendix page 5, the Applicant has sourced the weight of a container from a supplier at airsupplycn.com* (accessed 8/09/25) . This helpfully also provides the exterior dimensions for the units. They are below:

Length: 20 feet (6.06m)

Width: 8 feet (2.44m)

Height: 8 feet 6 inches (2.59m)

8.12.2 This means that each container has 2 sides with an area of 15.6965m² (31.39m²). Top and bottom - 14.7864m² each (29.5728m²) and ends - 6.3196m² (12.6492m²). Consequently, each container has an exterior surface area of 73.6m². The combined surface area for the 794 containers is 58,439m²

8.12.3 Again using the Applicant's assumptions for paint from Appendix page 5, this will require 11,688 litres of paint which will weigh 17,532kg. The embodied carbon associated with this amount, using the Applicant's paint emissions factor would consequently be **65,920tCO_2e, all of which counts as an increase.**

8.13 Steel for the substations

8.13.1 The Applicant has again chosen finished cold-rolled coil steel as the choice of metal for steel structures in the open air, but used the factor for unfinished. It is not intended to repeat the argument advanced at 8.11 above. Using the galvanised steel factor, the embodied carbon would be 7,588tCO_2e – **an increase of 392tCO_2e.**

8.13.2 When it comes to delivery of this steel, the Applicant assumes a supplier in England, such as Siemens. Of course, just because the supplier has a base in the UK, this does not mean that the raw materials were UK sourced. It seems highly unlikely that the sub-station plant manufacturers are making the specialist equipment with UK steel, especially at the moment. The Applicant will have the opportunity to clarify this point in any response. For now, it is not intended to add in the factors of 'steel from China'.

8.13.3 Referring back to 8.4.9 above, there is no allowance for this steel in decommissioning. The Applicant makes an assumption that the substations will remain. This does not seem a safe assumption as they will not be connected to anything as most of the cables are being removed and recycled. The Technical Appendix A5.6 – Outline DRP -APP-207 understandably is vague on this issue. But as there will be no power source to the 400kV substation (because the BESS has gone, and all intermediate substations connected to that BESS), then why would the intermediate substations remain?

8.13.4 Page 5 of APP-207 also lists as probably retained Work Area 7, Consented Staythorpe BESS Connection. However this also seems unlikely as planning permission was granted for that BESS with the condition that it be would also be decommissioned after 40 years (Decision Notice here).

8.13.5 It may well be that the substations can be relocated and recommissioned. But leaving them disconnected in the middle of a field does not seem very sensible. The associated embodied carbon is negligible. However, the missing transport emissions for decommissioning amount to **134tCO_2e. This is an increase.** For now, **the total additional tCO_2e for the sub-station steel is 526tCO_2e.**

8.14 Concrete

8.14.1 The Applicant has calculated that 540 tonnes of concrete will be required across the sites. This would be enough to lay 300mm deep plinths with a total size of 750m² for all infrastructure requiring them. On page 6 of the Appendix, the Applicant lists those parts of the infrastructure requiring these plinths. These are the BESS infrastructure, the 5 sub-stations and the transformers. This mirrors what is included in the Concept and Design Parameters and Principles APP -329.

8.14.2 APP-329 states that all these structures will be supported by concrete plinths or steel piles. There are no steel piles included in the Appendix as a material. It therefore has to be assumed that it will be concrete under all infrastructure.

8.14.3 Dealing with the inverter/transformer units, the 2.10 Illustrative Design APP-029 mapping shows 198 of these. APP-329 provides the maximum dimensions for these units. It is not known which ones will be chosen but the illustrative design would suggest a conservative plinth size of 8m x2m (16m²). It is common for such units to be plinth mounted, just as it is common for them to be raised above ground level to avoid water ingress.

8.14.4 The inverters/transformers would require 3,168m² of 300mm thick concrete slabs, based on the information currently provided by the Applicant. That would be 950m³ of concrete which would weigh 2,281 tonnes .This would be approaching the worst case scenario. If concrete strips were used, this could possibly be halved. But this seems not to be feasible as 6m inverters weigh in the region of 15 tonnes. A 300mm slab will be thick enough for such units, as long it is reinforced with rebar (relying on online calculations at British Concrete Polishing* accessed 11/09/25). The Applicant has not included rebar steel in the materials calculations. However, it may be possible to use a thicker concrete plinth without rebar reinforcement.

8.14.5 With regard to the BESS it may not be possible to use concrete strips for the battery containers. The only dimension provided is maximum height (4m). Checking what is available on the market, one can buy a 4MWh BESS Unit (made by BYD* accessed 28/10/25). This BESS would only need 220 of these as opposed to 754. Its dimensions are 6058x2438x2896mm. But it weighs 39 tonnes. Given the Applicant's weight supporting calculation (Appendix page 6) of 750kg per m² and that that container would need a 15m² plinth as a minimum, it is clear that considerably more concrete will be required.

8.14.6 The approved NSIP solar farm at Sunnica (Planning Inspectorate Scheme Ref: EN010106) provides assistance in this regard. That project's design principles saw piling as a worst case scenario and preferred a 1m deep reinforced concrete slab for each container. Our calculations suggest the slab does not need to be that thick as long as it is reinforced with rebar steel. It may be possible to use a plinth 500mm thick. The cells will need to be raised above ground level to avoid water ingress. With this thickness, each slab would consist of 7.5m³ of concrete: all the slabs would be 1,320m³, which would weigh 3,168 tonnes.

8.14.7 For the Appendix calculations, the Applicant has estimated 225m³ of concrete for the whole project. Using a 12m³ concrete truck, the whole project could be completed by just using 19 deliveries. It must be now clear that is wildly out. And there has been no estimation yet of the concrete needs of the substations.

8.14.8 For the purposes of estimating the embodied carbon, a conservative estimate of 7,000 tonnes of concrete will be used. The 500MW Longfield Solar Farm with BESS estimated they would use 6,000 tonnes (PINs ref EN010118). Should more detailed specifications be provided, then this figure will be revised.

8.14.9 ICEv4 strongly advise against using the Applicant's choice of embodied carbon (103kg/tonne) in their comments. However, it is not possible to correct this without more information. The associated emissions for concrete would be 721CO_2e. This is **an increase of 665tCO_2e.** In practice it is likely to be much more. And at some stage this may need to be augmented by a large quantity of rebar. When more details on specifications are available, more accurate estimates will be possible.

8.14.10 All these slabs will not just sit on mud. Each slab will be on top of a compacted layer of gravel or sand. This aggregate has also not been included as a material.

8.14.11 Page 9 of the Appendix includes an additional line for concrete with a mass of 100 tonnes. It is not clear what this concrete is for but given where it is in the table, it might be something to do with roads or tracks. It does say on page 10 that it is nothing to do with plinths or foundations.

8.14.12 Moving on to transporting the concrete, page 6 of the Appendix includes the Applicant's assumption that the concrete is 'Ready-Mixed'. At this stage, it is not clear with regard to the large amount of concrete required at the BESS, whether on-site mixing will be preferred.

8.14.13 The Applicant states that the development will need 640 tonnes of concrete. On page 19 of the Appendix, it only allows for the delivery of 100 tonnes. Even if on-site mixing from a silo is preferred, the cement and aggregate will still need bringing to the site. It may transpire that a silo is erected at the BESS. However, that is unlikely to be used for concrete needs at the likes of Carlton on Trent. If on site mixing is the case, it is not clear where the required water is coming from.

8.14.13 Following the Rochdale principles, transporting 7,000 tonnes for the distance chosen by the Applicant causes 252tCO_2e of emissions. This is **an increase of 248tCO_2e.**

8.14.14 The decommissioning embodied carbon figures are not large enough to warrant a mention given the quantities for concrete are only roughly estimated. However to transport 7,000 tonnes of concrete away, there would be an approximate increase of 76tCO_2e. **This brings the total increase in emissions for concrete to 989tCO_2e.**

8.15 Deer Fencing.

8.15.1 As with the PEIR, the Applicant uses the company Ultimate One Ltd* (accessed 13/09/25) to calculate the required figures for the deer fencing. Still assuming 150km of required fencing made from their 100m rolls* there is agreement that 1,500 rolls are required. According to the supplier, each roll weighs 109kg. That is a total weight of 163.5 tonnes, not 152.6 tonnes as stated by the Applicant on page 8 of the Appendix. The embodied carbon would now be 443tCO_2e as opposed to 414tCO_2e, **an increase of 29tCO_2e.**

8.15.2 As previously mentioned, transportation of fencing figures are only provided as a category and not split by type of fence. Ultimate One's warehouse is in Bridgnorth. The round trip to Newark is a distance of 326km. This would mean the emissions for delivery would be 13tCO_2e.

8.15.3 For decommissioning,as is explained in 8.4.9. above there is no allowance in the Appendix for this steel to be recycled. The embodied carbon is negligible and with the transport emissions only being 7tCO_2e, the total **increase for the deer fencing is only 36tCO_2e.**

8.16 Deer Fence Posts

8.16.1 There is agreement that 50,000 fence posts will be required. The Applicant has chosen a specification, referencing products made by a company called Origin Suregreen Ltd* (accessed 13/09/25), whose warehouse is in Finchingfield, Essex. The product they have chosen is a 2.1m post – to support a 1.8m steel fence. This would mean just 30cm would be below ground. Normally, having checked with several UK post and fencing suppliers, the minimum below ground depth to support 2.1m post should be 600mm. However, Figure 5.11 Illustrative Fence and Gate Elevations - APP-090 suggests a 30cm depth but concreted in so no change is suggested here for now. Of course, this is even more concrete that is required and it is unclear if this has been accounted for by the Applicant in their concrete total.

8.16.2 The unit weight for these posts selected by the Applicant is 2.5kg. The Applicant cites a 2100mm post from Suregreen as having that specification. However, that company only manufacture that height post with a maximum 50mm diameter. The 100mm diameter is specified in Figure 5.11 in APP-090. A 100mmx2.1m treated post* (accessed 13/09/25) supplied by David Musson Fencing Ltd weighs 8kg.This would mean that the aggregate weight of all posts would be 400 tonnes.

8.16.3 Figure 5.11 Illustrative Fence and Gate Elevations - APP-090 also helpfully illustrates that every 60m of fencing, there would be 6m of horizontal bracing timber. This has not been included in the Applicant's calculations.

8.16.4 No specifications are included by the Applicant . A suitable product would be East Coast Fencing's 3mx150mm Wooden Gravel Board* (accessed 13/09/25) These weigh 4kg each. To include these around the 150km of fencing every 60m, one would need 2,273 units. They would weigh a further 9 tonnes. This means that the total weight of the wood for the fences would be 409 tonnes, not 116.

8.16.5 Checks with pole suppliers show that generally, most are in agreement that these poles would have a lifespan of 15-20 years. No evidence was found of any poles projected to last 40 years. There is evidence of 10 year projections. In the Applicant's calculations, poles do not appear in the Replacement's section. For calculations here, a 100% replacement ratio will be adopted, meaning the total pole and bracing bars mass will be 818 tonnes.

8.16.6 For embodied carbon calculation, the Applicant adopts 493kgCO_2 per tonne. This figure, taken from ICEv4, is the factor for wood on average. Treated wood has a higher emissions factor due to added chemicals and pressure treating. However, the Group were unable to find a factor for treated and machined wood and so no change is possible here. This means the actual emissions for poles will be higher than the calculation below, but it is not known by how much.

8.16.7 The embodied carbon for the poles, including replacements will be 403tCO_2e. This is **an increase of 345tCO_2e.**

8.16.8 Transportation for the poles would be 47tCO_2e It is now possible to calculate all transportation for fencing components- 56tCO_2e as opposed to 20tCO_2e. **This is an increase of 36tCO_2e.**

8.16.9 When it comes to decommissioning,the embodied carbon becomes 5tCO_2e and transportation 9tCO_2e. This means that for all wood fencing components (excluding delivery), there **is an increase of 359tCO_2e.**

8.17 Grit for Access Tracks

8.17.1 The access tracks are new features over land currently available for agricultural use. The Applicant intends to create 43km of such tracks by using compacted aggregate. What happens to this grit upon decommissioning has an effect on emissions.

8.17.2 The Applicants based calculations for this material on page 9 of the Appendix on the following dimensions – 43,000m length, 4.5m wide and 15cm deep. The Applicant then calculates this to be 28,350m^3. Unfortunately, the maths is again incorrect and should read 29,025m^3. However, the Applicant somehow still arrives at the correct total weight. It is also stated that the emissions factor has been taken from ICEv3 as it is not in version 4. That is incorrect.

8.17.3 As for transporting this material to site, the Applicant has failed to include this material in their calculations. Using the same distance the Applicant uses for another aggregate entry, **this is an additional 1,393tCO_2e.**

8.18 Double Counting on Waste

8.18.1 Table A15.1.8 (page 21 of the Appendix) double counts 2 items in Table A15.1.22 (page 47) and Table A15.1.23 (page 51). These relate to Worker Waste and Water which appear in all three tables. This double counting brings about **a decrease in emissions of 57tCO_2e.**

8.19 Tarmac

8.19.1 One of the biggest miscalculations made by the Applicant actually works in their favour. Page 9 of the Appendix wrongly assigns the embodied carbon factor as per kilogram of tarmac when it should be per tonne (ICE v4). This means the total should be 225tCO_2e, not 225,504tCO_2e. **This is a reduction of 225,279tCO_2e.**

8.19.2 The Applicant estimates the mass of tarmac required as 4,320 tonnes (page 9). Unfortunately, it does not appear in the transportation calculations. Assuming a round trip distance of 100km, the missing emissions amount to **104tCO_2e which is an increase.** **The adjusted tarmac emissions are a reduction of 225,175tCO_2e**

8.19.3 There appears to be some confusion over whether the tarmac is to be decommissioned. The last 4 words on page 21 of the Appendix state that the Tarmac track will remain. The first table line on page 48 of the same document shows the tarmac being recycled. The Technical Appendix A5.6 – Outline DRP -APP-207 (page 5) does not really assist either way.

8.20 Thermal Sand

8.20.1 The relevant standards covering the cable runs are contained within the UK Power Networks *Engineering Construction Standard ECS 02-0019(2024) (accessed 15/09/2025). The Applicant has entered 133,325 tonnes as an estimate for the required mass of thermal sand. This appears to be on the low side. The reason for this might be derived from guidance in the Environmental Statement Figure 5.9 Illustrative Cable Trench Cross Section APP-088. In this illustration, the widest trench shown is 1.75m wide.

8.20.2 Paragraph 57 of Environmental Statement Volume 1 – Non-Technical Summary - Part 1 of 4 - Rev 1 APP-039 states that the maximum cable trench width will be 12m though most will be much less. On page 51 of Chapter 8-Ecology and Biodiversity APP-051, the Applicant describes Work no 2 Cables as being 60m wide in 3 separate locations. These working corridors seem excessive for trenches less than 2m wide as shown in APP-088.

8.20.3 In the Group's Statutory Consultation submission, the Group included the following two comments:

> *"The final material not included in the Applicant's estimates is thermal sand. This will be required to encase the underground cables, in order to dissipate the heat more efficiently. The Applicant has helpfully provided their calculations for total cable distance - 15km of 33kV, 30km of 132kV cabling and 1km of 400kV cabling."*

> *"The Applicant states that trenches can be as wide as 30m. However, the Applicant's staff have been spoken to and they have stated that 8m to 10m would be the most common for the 3 phase medium voltage runs. Trenching in the array compounds will be less wide but staff have explained that some higher voltage trenches could easily be 15-20m wide. For calculations, a conservative average trench width of 5m will be used for 33kv cabling, 10m for the 132kv and 8m for the 400kv. If more details are provided about trench width, then this issue will be revisited."*

8.20.4 At that stage, it was suggested that more details about trench width would hopefully be submitted. Unfortunately so far, that does not appear to have happened to a satisfactory level.

8.20.5 In his Statement of Evidence in the matter of THE NATIONAL GRID ELECTRICITY TRANSMISSION PLC (SCOTLAND TO ENGLAND GREEN LINK 2) COMPULSORY PURCHASE ORDER 2023* (accessed 14/09/25), Mr D Rogerson (Lead Transmission Engineer National Grid Electricity Transmission plc) helpfully explains that, as opposed to the backfill surrounding the cable being just sand, it would often be stabilised backfill (Cement Bound Sand- CBS). He goes on to say this "*would have a significant carbon impact on the project not only in the cement content of the back fill,...".* The Environmental Statement Figure 5.9 Illustrative Cable Trench Cross Section APP-088 shows that the thermal sand will in fact be "Thermal compound (cement bound sand or similar)". The embodied carbon emissions factor for this aggregate will be higher than just sand but the Applicant uses the factor just for sand.

8.20.6 ICEv4 does not provide a specific embodied carbon factor for CBS. However, Tarmac*, Heidelberg Materials* and OC Regeneration Ltd* (accessed online 14/09/25) all produce CBS for cable trenches with a mix ratio of 14/1 sand cement. Portland cement (BS EN 197-1, CEM 1) appears to be the common choice. 7% of the 133,325 tonnes of the CBS will have an embodied carbon factor of 0.84kgCO_2e/kg (source ICEv4)-that factors out at 7,839tCO_2e. The pure sand's embodied carbon would now be 926tCO_2e. This means that the CBS has approximate embodied carbon emissions of 8,765tCO_2e. **This is an increase of 7,769tCO_2e.**

8.20.7 In the PEIR documents, the Applicant mentioned waterproof protective ducting for the cable runs. These do not appear in the cross section APP-088. However, they are included in Table 2.2: Works No.2 Concept Design Parameters and Principles App-329 It would be helpful in any response if, in addition to more detailed specifications for the cable trenches, the Applicant could confirm how much ducting will be needed.

8.20.8 Turning to the Appendix calculations, unfortunately the Applicant failed to add the thermal sand to the delivery transportation table. Adopting the Applicant's distance for aggregate(100km), this would lead to **an increase of 3,200tCO_2e. The total increase will be 10,969tCO_2e**

8.21 Container shipping

8.21.1 So far, the calculations for delivery of materials have been based on the materials' net weight. For materials like sand and aggregate this makes perfect sense. However, some of the infrastructure (especially those parts travelling by sea) will be inside a container. Transporting those containers also has an emissions factor.

8.21.2 Data for containers has been taken from Santova Logistics Ltd* (accessed 26/09/25). The largest containers normally transported on UK roads are the 40ft units. Typical weight 3,750kg. They would have a maximum payload capacity of 27,600kg.

8.21.3 For the ease of calculations, the number of containers required for any one material will be aggregate weight divided by maximum payload. It is accepted that for some of the less dense and larger items, one might not be able to fit 27 tonnes into one container (panels for example).

8.21.4 Using this simple formula, the 30,576 tonnes of BESS cells (including replacements at a rate of 300%- discussed below) would need 1,107 containers. Their combined weight would be 4,152 tonnes. Travelling from Shenzhen by sea, the associated emissions would be 10,579tCO_2e (if one uses the Applicant's emission factor.) The two HGV journeys add a further 2605tCO_2e. Therefore there is **an additional 13,184tCO_2e** due to transporting the cells in containers.

8.21.5 The second item which will be virtually certain to travel by container are the PV panels. The 87,877 tonnes of panels (including replacements at a rate of 50%- discussed later) will require at least 3,501 containers which would weigh 13,128 tonnes. This would lead to emissions at sea of 35,902tCO_2e (if one uses the Applicant's emission factor). Combined HGV journeys result in 2,331CO_2e and train emissions a further 1,458tCO_2e. The total **increase for the panel containers is 39,691tCO_2e**.

8.21.6 The following is a quote Chinese export company Zheng Sourcing* from regarding importing steel from China;

"Sea freight is the primary method for shipping large quantities of steel internationally due to its cost-effectiveness for bulk goods. Steel is often transported in containers, bulk carriers, or breakbulk, depending on the form and quantity." (accessed 28/09/25)

8.21.7 As there is some doubt about how the steel for the framework will travel, no calculations are planned here, unless new information comes to light. The same applies to the Aluminium which could also be shipped by a bulk carrier.

8.21.8 Research suggest that importing central inverters by sea from China is most often done with 20ft or 40ft containers. Given the size of central inverters, a slight change is intended here. Earlier the 198 field based inverters were assumed to be like the Sungrow SG3400, which are 3 metres long. Two will fit in a 40 foot container, meaning 99 containers would suffice. For the BESS inverters, one is only told the weight. It seems more likely they will be similar to the Sungrow SG3425 (see 8.3.5 ante). The weight is consistent with needing 147 containers though, as with the SG3400 they will probably be bespoke containers ordered by the manufacturer as these larger inverters are fractionally too wide for a standard 20ft or 40ft container. For the purpose of this exercise, the tare weight for a 20ft container will be used. The total mass for containers would be 709 tonnes.

8.21.9 The maritime emissions would be 1939tCO_2e, HGV journeys for the PV inverters- 61tCO_2e, HGV journeys for the BESS inverters- 55tCO_2e, bringing about **a total for inverter containers of 2055tCO_2e.**

8.21.10 There is no certainty about shipping for mineral oil and the transformers. If containers are to be used, such as with flexitanks for the oil, the emissions are not likely to be very high so no further calculations are intended in this category for now. However, if new information is received (like for instance regarding the combiner boxes), then it will be revisited. The provisional total for **container journeys is an increase of 54,930tCO_2e.**

8.22 Geotextile Membrane

8.22.1 Paragraph 5.29 of the Outline Soil Management Plan Part 1 App-290 describes how a geotextile membrane is spread over the upper subsoil during construction of the access tracks. The aggregate will then go on top of the membrane. It is also pictured in Environmental Statement Figure 5.8 Illustrative Access Track Cross Section APP-087.

8.22.2 The Appendix states on page 9 that there will be 43km of access tracks, 4.5m wide. The membrane is not mentioned in the Appendix calculations. A suitable product would be Fastrack 609 Woven Geotextile, Full Roll, Black, 4.5mx100m.* (accessed 30/09/2025), sold by various builders merchants. The access roads would require 430 rolls of this polypropylene product which weighs 75kg per roll. Total weight would therefore be 32.25 tonnes for the tracks.

8.22.3 Paragraph 5.4 of the Outline Soil Management Plan Part 1 App-290 describes how the construction compounds will also require a geotextile matting, though it does not provide details. Research shows that this will most likely be polypropylene again and the largest rolls appear to be made by Terram* (accessed 30/09/2025) at 6mx100m.

8.22.4 Page 10 of the Appendix states there will be 32 construction compounds which are 50mx75m. That works out at 7 rolls a compound and therefore 224 rolls which would each weigh 112kg, bringing their total weight to 25 tonnes. Total weight of all polypropylene would be 57 tonnes.

8.22.5 The embodied carbon for that material would be 196tCO_2e. Adopting a round trip transportation distance of 240km, those emissions would be 11tCO_2e. The associated emissions factor for recycling would be negligible. Using the Applicant's distance figure for decommissioning plastics (200km), the last emissions for this material would be 3tCO_2e. Therefore the **total emissions associated with this matting would be 210tCO_2e.**

8.23 Replacement BESS Cells and PV Panels

8.23.1 It was established at 6.14-6.22 above that the batteries would need replacing at 12,24 and 36 years into the project lifespan.

Consequently, the embodied carbon would increase by 469,920tCO_2e. Using the Applicant's maritime emissions factor for now, sea travel would add another 29,214tCO_2e and HGV diesel emissions would increase by 742tCO_2e. Decommissioning would account for an extra 244tCO_2e with an additional 550tCO_2e for transportation. **This totals an additional 500,670tCO_2e.**

8.23.2 As for the 50% panel replacements, embodied carbon rises by 314,048tCO_2e. HGV delivery emissions will rise by 4,162tCO_2e. Train emissions increase by 2,604tCO_2e and using the same maritime emissions factor , sea emissions rise by 47,672tCO_2e (taking into account 8.2.1 above). Decommissioning increases by 150tCO_2e with associated transport emissions of 5tCO_2e. **This totals an additional 368,641tCO_2e. The corrected battery and panel replacements add an additional 869,311tCO_2e.**

8.24 Corrected Maritime emissions.

8.24.1 The Applicant has used an incorrect emissions factor for maritime emissions by a factor of 10. A fair figure assuming a mix of the two largest container ships factors (sourced from the GHG factors) would be 0.014kgCO_2e per tonne.km, not 0.13. This completely changes all the maritime emissions. Below are the recalculations.

8.24.2 BESS cells including the 300% replacements: the new total should be 8,390tCO_2e, not 77,904tCO_2e. **This is a reduction in emissions of 69,514tCO_2e.**

8.24.3 Sailing the panels from Shanghai (a voyage of 21,027km), **there is now a reduction of 210,080tCO_2e.**

8.24.4 Referencing 8.3.6 above, the total weight for the inverters including replacements would be 3217 tonnes which would sail from Shanghai. **This is a reduction of 6,900tCO_2e.**

8.24.5 The maritime emissions for the 49,280 tonnes of framework steel from China **is reduced by 115,164tCO_2e.**

8.24.6 The same adjustments are needed for the Chinese aluminium. The sea journey of 22,286km for the 25,872 tonnes including replacements sees **a reduction of 66,884tCO_2e.**

8.24.7 The BESS inverters will sail from Shanghai with a weight including replacements of 6,600 tonnes. The correct voyage distance is 21,037km. **There is a reduction here of 16,105tCO_2e.**

8.24.8 The 535 tonnes of steel for the transformers leaving China via the port of Ningbo will see **a reduction of 1,303tCO_2e.** The transformer oil leaves the same port and would see **a reduction of 621tCO_2e.**

8.24.9 Section 8.21 above dealt with the emissions associated with shipping the weight of the containers used to transport the BESS cells, inverters and PV panels. Adopting the correct shipping emission this would lead to a reduction of **5,900tCO_2e for the BESS containers and 21,358tCO_2e for the panels. The reduction for the inverter containers would be 1,731tCO_2e.**

8.24.10 **The reduction for maritime emissions when using the corrected factor is 515,560tCO_2e.**

9. Absent Carbon Emissions

9.1 In addition to any embodied carbon and transport emissions mistakenly omitted in the Appendix, as corrected above, there are other significant CO_2 emissions that are associated with this development and that have not been included in the calculations by the Applicant or the Group.

9.2 The first is the transport and embodied tCO_2e associated with the combiner boxes. The Design and Access Statement APP-327 introduces these parts of the infrastructure at paragraph 13, saying...

> *"Combiner Boxes - The purpose of Combiner Boxes (CB) is to aggregate the output from the strings while maintaining the string voltage and thereby reduce the number of inputs required in the central inverter."*

9.3 The number of boxes required is not known and they are not mentioned in the Appendix. In terms of weight, the tonnage is not likely to be high. Researching units on the market delivers the following information:

"Common materials include:

- Enclosure body:
    - Powder-coated steel – strong, impact-resistant, used in less harsh environments.
    - Aluminium – lightweight, corrosion-resistant, good for coastal or humid areas.
    - Fiberglass-reinforced polyester (FRP) – excellent corrosion resistance, often used in marine or chemical

    environments.
    - Polycarbonate or other UV-stabilized plastics – lightweight, non-conductive, resistant to UV and impact.
- Internal busbars and connections:
    - Copper – excellent conductivity; often tin-plated to reduce oxidation.
    - Aluminium – lighter and cheaper, but less conductive, sometimes used in large-scale systems with proper treatment.
- Seals and gaskets:
    - EPDM or silicone rubber – weatherproof, heat- and UV-resistant, ensures an IP-rated (e.g., IP65/IP66) waterproof/dustproof seal.
- Hardware:
    - Stainless steel (304 or 316) – for screws, bolts, and hinges to resist rust"

9.4 The second absent category is a reminder of paragraph 8.16.2 above. 50,000 deer fence posts are going to be needed. The embodied carbon factor used by the Applicant is one for general wood. These posts will require machining and pressure treating with a chemical. The energy required and the chemicals will have embodied carbon associated with them. Here though, no criticism is implied for just using 'average wood'. As mentioned before (and possibly just like the Applicant), the Group have been unable to source an emissions factor for machined pressure treated wood. That of course does not mean that the CO_2 emissions would not be higher than the Applicant's total, it is just it is not possible to quantify the increase.

9.5 Probably by far the biggest associated activity not assessed in the Appendix are the transport related loading and unloading emissions. These would be included in the Scope 3 emissions category. They will include the loading of HGVs and trains in China and the UK, their unloading when changing mode of transport, port of origin container handling and bulk material crane handling. Then there is the port of arrival unloading and reloading onto HGVs.

9.6 In theory, by using artificial intelligence (AI), it might be possible to calculate the CO_2 emissions for all these processes. For instance, AI calculates that a typical Rubber-Tyred Gantry crane at a container port emits 24-43kg CO_2 per hour. However, this is a huge exercise to cover all freight movements with no gold standard guarantee in the results. No criticism can be levelled at the Applicant for not doing this. But suffice to say, the associated CO_2 emissions for all freight handling, if quantifiable, would be a significant emissions addition. This may be revisited by the Group at a later stage.

9.7 When addressing the concrete needs for this development, it became clear that there was a possibility that some concrete slabs may need to be reinforced. If rebar steel is therefore going to be used, that steel needs to be included. It probably will not need to come from China as there are apparently suppliers much closer to home. This cannot be quantified until more specifications for plinths and the sub-stations are provided.

9.8 The Environmental Statement Figure 5.9 Illustrative Cable Trench Cross Section APP-088 helpfully provides more details of actually what is intended to go in the trenches. As previously stated, the Applicant has previously provided their calculations for total cable distance - 15km of 33kV, 30km of 132kV cabling and 1km of 400kV cabling. So materials shown in the cross section will be needed for most of the 39km of trenches. They will probably not all be needed where the trenches are horizontally drilled under a road etc.

9.9 It can be seen that on the cross section, the design includes 14mm plastic tiles and warning tape (presumably plastic) covering the full trench widths for 39km. There is also fibre optic cable. None of these are included in the Applicant's calculations.

Table 4. Emission Corrections

Section in this document	Material	Change in Emissions (tCO_2e)
8.2	PV Panels	15,115
8.3	Inverters	6,495
8.4	Steel Panel framework	3,688
8.5	Aluminium	8,212
8.6	BESS Inverters	1,591
8.7	Steel for the Transformers	9,797
8.8	Transformer Mineral Oil	-227
8.9	Security Fencing	458
8.10	Security Fence Paint.	11,263
8.11	Steel Storage containers	327
8.12	Paint for the Containers	65,920
8.13	Steel for the substations.	526
8.14	Concrete	989
8.15	Deer Fencing	36
8.16	Deer Fence Posts	359
8.16	Transportation for all Fencing	36
8.17	Grit for Access Tracks	1,393
8.18	Double Counting on Waste	-57
8.19	Tarmac	-225175
8.20	Thermal Sand	10,969
8.21	Container Shipping	54930
8.22	Polypropylene Geotextile	210
8.23	Replacement BESS Cells and PV Panels	869311
8.24	Corrected maritime emissions.	-515560
	Total	**320,606**

11 Redesign Changes

11.1 The Applicant's website originally described the extent of development:

> *"The solar PV area of the development is approximately* ***1,372 hectares*** *(3,390 acres) with the remaining area designated for enhancement, cables and access."*

11.2 By the time one gets to the PEIR, the following is stated on page 25 of Technical Appendix A4.1: Design Approach Document

> *"The Order Limits cover approximately 2,900 ha, of which approximately* ***1,500 ha*** *will be developed for solar PV."*

11.3 The Design and Access Statement APP-327 included in the ES now states at paragraph 25:

> *"The area of solar PV fields (including field margins) required for the generation of 800 MW (AC) is c.* ***1,025 ha****"*

11.4 According to the Applicant's own figures, the area to be covered by panels has reduced by nearly a third. However, the predicted panel output has not changed since project launch. It is possible that the original plan was to install 600Wp panels but it is now intended to use 650Wp units. That would mean the amount of land required could be 12% less. But not 30%. However, the PEIR Technical appendix A15 assumes 650W panels so this cannot be a factor.

11.5 2 potential scenarios play out here. Either the original planned panel acreage was significantly larger than was needed to produce 800MW AC. Or the currently planned 1,025ha (2,533 acres) is not enough to produce that amount of power.

11.6 The DCO for Sunnica NSIP solar farm (PINS Reference EN010106) allows up to 1534 acres (621 ha) of ground-mounted solar PV to generate 500MW AC. The DCO for the Gate Burton NSIP solar farm (PINs reference EN010131) allows panel fields on 1176 acres

(476ha), generating 500MW. The Botley West NSIP (PINs reference EN010147) uses 2081 acres (842ha) of panel fields to generate 840MW. These NSIPs are designed to produce 325-425kW an acre.

11.7 The Applicant's initial plans to need 3,390 acres to produce 800MW meant that they were expecting just 236kw an acre. This is not in line with what should have been generated per acre by an NSIP solar farm. However, now that the panel field area has been significantly reduced, the average amount of power per acre is 316kW. This is much more in line with the acreage of panel fields needed to produce 800MW in an NSIP solar farm. It is still a little low and if the connection agreement stipulates a design generation target of 800MW, then it is likely that the Applicant may have to lose a few more fields, or be inefficient in design.

11.8 Given that there are still planned to be 2532 acres of panels, adopting a ball park 350kW per acre generation, the current planned array acreage using 650W panels would be generating circa 886MW- 10% more than agreed. One could therefore reasonably expect some more fields being removed during the examination phase, not as a reaction to pressure, but as a technical necessity.

11.9 This does pose the question as to why the Applicant chose the first design of 3,390 acres.

11.10 Since the PEIR calculations, there has been a significant reduction in the size of the project. This is not however reflected in the Appendix. With some materials, the tonnage has actually increased since the PEIR version, as is the case with the cabling.

11.11 Some material categories will see a reduction from the amended totals arrived at by adding the Group's increases to the Applicant's Appendix figures.

11.12 For the 'big ticket items', there will be few changes. All items associated with the BESS will remain unchanged. There should be no reduction in the PV panels as their number should have been calculated to achieve 800MW AC, not how many one can fit on an acre. The PV steel and aluminium figures will have been calculated from the number of panels that needed supporting.

11.13 The inverter number were taken from the new ES maps so that has already been updated. There may be a slight reduction in the transformer steel and oil figures. The PEIR included four substations as with the ES so there should be no reductions linked to intermediate substations. One can expect reductions in storage and steel containers, concrete, cabling, thermal sand, aggregate for access tracks and construction compounds, deer fencing and deer posts.

11.14 According to the Applicant, the total carbon emissions associated with these materials would be under 12,000tCO_2e. A third reduction is not really going to change things a great deal. However, a third reduction in totals arrived at by the Group could have a more significant effect. A 30% reduction in container paint would see a drop in emissions of over 23,000tCO_2e. In the end, it will be for the Applicant to produce a third version of the Appendix calculations, based on the latest design. This will hopefully incorporate the Group's amendments in the next ES calculations, as happened at the PEIR stage.

12 Consolidation of Revised Calculations

12.1 Table 5 below shows the Applicant's estimate for production emissions plus the revisions from Table 4

Table 5. Revised Production Emissions

Applicant's Total (Appendix Page 2)	3,194,264tCO_2e
Emissions Increase from Table 4 (in this report)	320,606tCO_2e
Total Emissions	**3,514,870tCO_2e**

12.2 In terms of how this affects the the net carbon savings for this proposal, taking into account the corrected method of calculating solar generation, Table 6 below shows the corrected total. The emissions saved figure is taken from Table 1 above. That table is based on the Applicant's highly unlikely premise that the gas intensity figures remain at the 2026 figure for the next 40 years.

Table 6.

Emissions Saved	2,415,259tCO_2e
Emissions produced	**3,514,870**tCO_2e
Total net emissions savings	**-1,099,611tCO_2e**

12.3 The second calculation in Table 7 below is based on the more likely scenario where there is a reduction after 10 years in the gas intensity figures. The total savings figure is taken from Table 2 above.

Table 7.

Emissions Saved	1,273,338tCO_2e
Emissions produced	**3,514,870**tCO_2e
Total net emissions savings	-**2,241,532tCO_2e**

12.4 So, far from assisting in tackling climate change, it can now be seen that completely the opposite is true. One can put the Table 10 estimated greenhouse gas increases associated with this project in some form of context. With an average family petrol car producing around 3tCO_2e each year, the amount of emissions above is equivalent to the annual GHG emissions from over 745,000 cars.

12.5 Lastly, one can consolidate the figures based on the BESS savings founded on the DESNZ modelling This third forecast is shown below in Table 8, using the calculations in table 3 above.

Table 8

Emissions Saved	795,858tCO_2e
Emissions produced	**3,514,870**tCO_2e
Total net emissions savings	**-2,719,012tCO_2e**

13 National Planning Guidance

13.1 The Examining Authority will no doubt wish to evaluate the cost/benefits of this project, mindful of the guidance provided in the National Planning Police Framework 2024 (NPPF) and the National Policy Statements (NPS). To quote from the NPPF (paragraph 5)... Framework

> *"The Framework does not contain specific policies for nationally significant infrastructure projects. These are determined in accordance with the decision-making framework in the Planning Act 2008 (as amended) and relevant national policy statements for major infrastructure, as well as any other matters that are relevant (which may include the National Planning Policy Framework). National policy statements form part of the overall framework of national planning policy, and may be a material consideration in preparing plans and making decisions on planning applications."*

13.2 It will principally be the NPS which guide applications such as this one. However the NPPF does offer the following in Paragraph 164:

> *"New development should be planned for in ways that:*
> *a)…*
> *b) help to reduce greenhouse gas emissions, such as through its location, orientation and design."*

13.3 It will have been seen that the emissions relating to the operational phase are not the main cause of the large GHG calculations. The most significant operational emissions come from the replacement infrastructure. In accordance with paragraph 5.3.12 of EN-1,the *"Secretary of State does not, therefore need to assess individual applications for planning consent against **operational** carbon emissions and their contribution to carbon budgets, net zero and our international climate commitments".*

13.4 Paragraph 5.3.9 of the same document does state that *"The Secretary of State should be content that the applicant has taken all reasonable steps to reduce the GHG emissions of the construction and decommissioning stage of the development"*

13.5 The National Policy Statement for Renewable Energy Infrastructure (EN-3) addresses national planning standards for solar power. It is silent on the issue of solar generating stations being huge net polluters of GHG. The assumption behind virtually all policy statements is that renewable energy is clean energy. In terms of meeting targets, this project will contribute to the Government's target for solar power generation. Because the United Kingdom has broadly exported a large section of it manufacturing abroad, the impact on the country's carbon budget is limited. The Government calculates national emissions on a territorial basis. However, the very large GHG emissions associated with this project are caused by the UK. Whether it will contribute to energy security may depend on the findings of enquiries in Germany and the USA of covert remotely activated dead switches in Chinese inverters.

13.6 It is not immediately obvious whether it was considered that in terms of GHG, building, operating and decommissioning a generating station such as this project would actually do more harm to the climate than it prevented.

14 Conclusions

14.1 The methodology used by the Applicant in calculating the predicted power generation levels is inconsistent with accepted practice, resulting in unreliable data. Assumptions about the BESS storage benefits were based on a best case scenario which is inconsistent with Rochdale principles.

14.2 As happened with the PEIR version of Appendix 15, numerous omissions or wrong calculations have again been found. Virtually all of them under-report GHG emissions for the project. There are still some emission categories (e.g. freight handling) which have not been quantified and the Group will endeavour to progress those areas.

14.3 The project will produce energy from a renewable source and will contribute to national solar generation capacity. However, given the huge CO_2 emissions and embodied carbon associated with the project, it could not be classed as green or clean power. If allowed, it will contribute to global warming.

Appendix A
Solar Generation with replacement panels

Year Number	Year	Panels last 40 years	30yrs	31yrs	32yrs	33yrs	34yrs	Total Mwh AC
1	2026	184,641	36,928	36,928	36,928	36,928	36928	369,281
2	2027	275,853	55,170	55,170	55,170	55,170	55170	551,703
3	2028	366,334	73,266	73,266	73,266	73,266	73266	732,664
4	2029	364,869	72,973	72,973	72,973	72,973	72,973	729,733
5	2030	363,409	72,681	72,681	72,681	72,681	72,681	726,814
6	2031	361,956	72,390	72,390	72,390	72,390	72,390	723,907
7	2032	360,508	72,101	72,101	72,101	72,101	72,101	721,012
8	2033	359,066	71,812	71,812	71,812	71,812	71,812	718,127
9	2034	357,629	71,525	71,525	71,525	71,525	71,525	715,255
10	2035	356,199	71,239	71,239	71,239	71,239	71,239	712,394
11	2036	354,774	70,954	70,954	70,954	70,954	70,954	709,544
12	2037	353,355	70,670	70,670	70,670	70,670	70,670	706,706
13	2038	351,942	70,388	70,388	70,388	70,388	70,388	703,879
14	2039	350,534	70,106	70,106	70,106	70,106	70,106	701,064
15	2040	349,132	69,826	69,826	69,826	69,826	69,826	698,260
16	2041	347,735	69,546	69,546	69,546	69,546	69,546	695,467
17	2042	346,344	69,268	69,268	69,268	69,268	69,268	692,685
18	2043	344,959	68,991	68,991	68,991	68,991	68,991	689,914
19	2044	343,579	68,715	68,715	68,715	68,715	68,715	687,154
20	2045	342,205	68,440	68,440	68,440	68,440	68,440	684,406
21	2046	340,836	68,166	68,166	68,166	68,166	68,166	681,668
22	2047	339,473	67,894	67,894	67,894	67,894	67,894	678,941
23	2048	338,115	67,622	67,622	67,622	67,622	67,622	676,226
24	2049	336,762	67,352	67,352	67,352	67,352	67,352	673,521
25	2050	335,415	67,082	67,082	67,082	67,082	67,082	670,827

Year Number	Year	Panels last 40 years	30yrs	31yrs	32yrs	33yrs	34yrs	Total Mwh AC
26	2051	334,073	66,814	66,814	66,814	66,814	66,814	668,143
27	2052	332,737	66,547	66,547	66,547	66,547	66,547	665,471
28	2053	331,406	66,281	66,281	66,281	66,281	66,281	662,809
29	2054	330,081	66,015	66,015	66,015	66,015	66,015	660,158
30	2055	328,760	65,751	65,751	65,751	65,751	65,751	657,517
31	2056	327,445	73,266	65,488	65,488	65,488	65,488	662,665
32	2057	326,135	72,973	73,266	65,226	65,226	65,226	668,054
33	2058	324,831	72,681	72,973	73,266	64,965	64,965	673,682
34	2059	323,532	72,390	72,681	72,973	73,266	64,706	679,548
35	2060	322,237	72,101	72,390	72,681	72,973	73,266	685,649
36	2061	320,949	71,812	72,101	72,390	72,681	72,973	682,906
37	2062	319,665	71,525	71,812	72,101	72,390	72,681	680,174
38	2063	318,386	71,239	71,525	71,812	72,101	72,390	677,454
39	2064	317,113	70,954	71,239	71,525	71,812	72,101	674,744
40	2065	315,844	70,670	70,954	71,239	71,525	71,812	672,045
							Total	**27,122,168**

Table Notes

The Applicant's formula was based on its maximum DC MWp output (1120MWp) as its baseline to create its most productive annual MWh theoretical year before degradation. The above figures have as their baseline the equivalent real world best year without degradation as 736,344MWh AC based on an maximum 800MW AC generation capacity.The Applicants ratio of charging the BESS for years 1 to 3 have been retained. Columns 4-8 above all relate to 10% of the full array and represent replacements.

With year 3 being the most productive year, what might be expected is that that year would produce the 736,344MWh maximum as opposed to 732,668MWh as in the above table. However, just as he Applicant has done, the year 3 figure takes account of the 0.4% degradation in the panels installed in the first 2 years.

The totals in this calculation do not take into account the Marginal carbon Intensity (kgCO2e/kWh) which will be applied in Appendix B. Save for the years in which panels are replaced, this table replicates the 0.4% panel degradation per annum assumed by the Applicant. All figures are in MWh AC.

Appendix B
Panel direct to Grid Emission Avoidance

Year Number	Year	Marginal carbon Intensity (kgCO2e/kWh)	Panel Production (Mwh) AC	Charged to BESS	Panel to Grid (Mwh) AC	Carbon Avoidance tCO2e
1	2026	0.174	369,281	174,465	194,816	33,898
2	2027	0.154	551,703	169,232	382,471	58,901
3	2028	0.133	732,664	163,821	568,843	75,656
4	2029	0.11	729,733	163,165	566,568	62,322
5	2030	0.085	726,814	162,513	564,302	47,966
6	2031	0.0652	723,907	161,863	562,044	36,645
7	2032	0.0501	721,012	161,215	559,796	28,046
8	2033	0.0384	718,127	160,570	557,557	21,410
9	2034	0.0296	715,255	159,928	555,327	16,438
10	2035	0.0226	712,394	159,288	553,106	12,500
11	2036	0.0174	709,544	158,651	550,893	9,586
12	2037	0.0133	706,706	158,017	548,690	7,298
13	2038	0.0102	703,879	157,385	546,495	5,574
14	2039	0.0079	701,064	156,755	544,309	4,300
15	2040	0.006	698,260	156,128	542,132	3,253
16	2041	0.0057	695,467	155,504	539,963	3,078
17	2042	0.0036	692,685	154,882	537,803	1,936
18	2043	0.0028	689,914	154,262	535,652	1,500
19	2044	0.002	687,154	153,645	533,509	1,067
20	2045	0.0013	684,406	153,030	531,375	691
21	2046	0.0013	681,668	152,418	529,250	688
22	2047	0.0013	678,941	151,809	527,133	685
23	2048	0.0014	676,226	151,201	525,024	735
24	2049	0.0013	673,521	150,597	522,924	680
25	2050	0.0023	670,827	149,994	520,832	1,198

Year Number	Year	Marginal carbon Intensity (kgCO2e/kWh)	Panel Production (Mwh) AC	Charged to BESS	Panel to Grid (Mwh) AC	Carbon Avoidance tCO2e
26	2051	0.0023	668,143	149,394	518,749	1,193
27	2052	0.0023	665,471	148,797	516,674	1,188
28	2053	0.0023	662,809	148,201	514,607	1,184
29	2054	0.0023	660,158	147,609	512,549	1,179
30	2055	0.0023	657,517	147,018	510,499	1,174
31	2056	0.0023	662,665	148,169	514,495	1,183
32	2057	0.0023	668,054	149,374	518,679	1,193
33	2058	0.0023	673,682	150,633	523,049	1,203
34	2059	0.0023	679,548	151,944	527,603	1,213
35	2060	0.0023	685,649	153,308	532,340	1,224
36	2061	0.0023	682,906	152,695	530,211	1,219
37	2062	0.0023	680,174	152,084	528,090	1,215
38	2063	0.0023	677,454	151,476	525,978	1,210
39	2064	0.0023	674,744	150,870	523,874	1,205
40	2065	0.0023	672,045	150,267	521,778	1,200
					Total	**454,034**

Table notes.
The final column represents the avoidance for panel direct to grid. The marginal intensity figures mirror those used by the Applicant. The annual panel generation figures are drawn from Appendix A and include the replacement panels being introduced over 5 years towards the end of the project lifespan.

There is a change to the Applicant's methodology with regard to the calculation of the Charged to BESS figures. The Applicant used a straight line year on year 0.3% reduction. Now that replacement panels have been introduced, this would distort the transfers during the last 10 years. Consequently, with the above, the ratio of the Charged to BESS figure to panel generation for year 4 has been applied to all subsequent years. The net effect of this is that the BESS will receive more charge during the last 10 years than if the straight line approach was maintained.

Appendix C
BESS emission avoidance with battery and panel replacements included
(3 scenarios)

1. Pegged 2026 intensity

	Year	Evening Peak Carbon Intensity (Gas Peaker) (kg CO2e/kWh)	Charged to BESS (Mwh) AC	Energy Discharged to Inverters (MWh)	400kv AC to Grid	Carbon Avoidance (tCO2e)
1	2026	0.365	174,465	170,976	164,137	59,910
2	2027	0.365	169,232	162,463	155,964	56,927
3	2028	0.365	163,821	153,992	147,832	53,959
4	2029	0.365	163,165	150,112	144,108	52,599
5	2030	0.365	162,513	146,262	140,411	51,250
6	2031	0.365	161,863	142,439	136,742	49,911
7	2032	0.365	161,215	138,645	133,099	48,581
8	2033	0.365	160,570	134,879	129,484	47,262
9	2034	0.365	159,928	131,141	125,895	45,952
10	2035	0.365	159,288	127,431	122,334	44,652
11	2036	0.365	158,651	123,748	118,798	43,361
12	2037	0.365	158,017	154,856	148,662	54,262
13	2038	0.365	157,385	151,089	145,046	52,942
14	2039	0.365	156,755	147,350	141,456	51,631
15	2040	0.365	156,128	143,638	137,892	50,331
16	2041	0.365	155,504	139,953	134,355	49,040
17	2042	0.365	154,882	136,296	130,844	47,758
18	2043	0.365	154,262	132,665	127,359	46,486
19	2044	0.365	153,645	129,062	123,899	45,223
20	2045	0.365	153,030	125,485	120,466	43,970
21	2046	0.365	152,418	121,935	117,057	42,726
22	2047	0.365	151,809	118,411	113,674	41,491
23	2048	0.365	151,201	114,913	110,317	40,266
24	2049	0.365	150,597	147,585	141,681	51,714

	Year	Evening Peak Carbon Intensity (Gas Peaker) (kg CO2e/kWh)	Charged to BESS (Mwh) AC	Energy Discharged to Inverters (MWh)	400kv AC to Grid	Carbon Avoidance (tCO2e)
25	2050	0.365	149,994	143,994	138,235	50,456
26	2051	0.365	149,394	140,431	134,813	49,207
27	2052	0.365	148,797	136,893	131,417	47,967
28	2053	0.365	148,201	133,381	128,046	46,737
29	2054	0.365	147,609	129,896	124,700	45,515
30	2055	0.365	147,018	126,436	121,378	44,303
31	2056	0.365	148,169	124,462	119,484	43,612
32	2057	0.365	149,374	122,487	117,587	42,919
33	2058	0.365	150,633	120,506	115,686	42,225
34	2059	0.365	151,944	118,516	113,776	41,528
35	2060	0.365	153,308	116,514	111,854	40,827
36	2061	0.365	152,695	149,641	143,655	52,434
37	2062	0.365	152,084	146,001	140,161	51,159
38	2063	0.365	151,476	142,387	136,692	49,893
39	2064	0.365	150,870	138,800	133,248	48,636
40	2065	0.365	150,267	135,240	129,830	47,388
				Total		**1,917,007**

2. Group's Future Scenario

	Year	Evening Peak Carbon Intensity (Gas Peaker) (kg CO2e/kWh)	Charged to BESS (Mwh) AC	Energy Discharged to Inverters (MWh)	400kv AC to Grid	Carbon Avoidance (tCO2e)
1	2026	0.365	174,465	170,976	164,137	59,910
2	2027	0.365	169,232	162,463	155,964	56,927
3	2028	0.365	163,821	153,992	147,832	53,959
4	2029	0.365	163,165	150,112	144,108	52,599
5	2030	0.365	162,513	146,262	140,411	51,250
6	2031	0.365	161,863	142,439	136,742	49,911
7	2032	0.365	161,215	138,645	133,099	48,581
8	2033	0.365	160,570	134,879	129,484	47,262
9	2034	0.365	159,928	131,141	125,895	45,952
10	2035	0.365	159,288	127,431	122,334	44,652
11	2036	0.310	158,651	123,748	118,798	36,857
12	2037	0.264	158,017	154,856	148,662	39,204
13	2038	0.224	157,385	151,089	145,046	32,513
14	2039	0.191	156,755	147,350	141,456	26,952
15	2040	0.162	156,128	143,638	137,892	22,332
16	2041	0.138	155,504	139,953	134,355	18,495
17	2042	0.117	154,882	136,296	130,844	15,310
18	2043	0.099	154,262	132,665	127,359	12,667
19	2044	0.085	153,645	129,062	123,899	10,474
20	2045	0.072	153,030	125,485	120,466	8,657
21	2046	0.061	152,418	121,935	117,057	7,150
22	2047	0.052	151,809	118,411	113,674	5,902
23	2048	0.044	151,201	114,913	110,317	4,868
24	2049	0.038	150,597	147,585	141,681	5,315

	Year	Evening Peak Carbon Intensity (Gas Peaker) (kg CO2e/kWh)	Charged to BESS (Mwh) AC	Energy Discharged to Inverters (MWh)	400kv AC to Grid	Carbon Avoidance (tCO2e)
25	2050	0.032	149,994	143,994	138,235	4,408
26	2051	0.027	149,394	140,431	134,813	3,654
27	2052	0.023	148,797	136,893	131,417	3,027
28	2053	0.020	148,201	133,381	128,046	2,507
29	2054	0.017	147,609	129,896	124,700	2,075
30	2055	0.014	147,018	126,436	121,378	1,717
31	2056	0	148,169	124,462	119,484	0
32	2057	0	149,374	122,487	117,587	0
33	2058	0	150,633	120,506	115,686	0
34	2059	0	151,944	118,516	113,776	0
35	2060	0	153,308	116,514	111,854	0
36	2061	0	152,695	149,641	143,655	0
37	2062	0	152,084	146,001	140,161	0
38	2063	0	151,476	142,387	136,692	0
39	2064	0	150,870	138,800	133,248	0
40	2065	0	150,267	135,240	129,830	0
				Total		**775,086**

3. DESNZ Modelling

	Year	Evening Peak Carbon Intensity (Gas Peaker) (kg CO2e/kWh)	Charged to BESS (Mwh) AC	Energy Discharged to Inverters (MWh)	400kv AC to Grid	Carbon Avoidance (tCO2e)
1	2026	0.365	174,465	170,976	164,137	59,910
2	2027	0.323	169,232	162,463	155,964	50,384
3	2028	0.279	163,821	153,992	147,832	41,244
4	2029	0.231	163,165	150,112	144,108	33,252
5	2030	0.178	162,513	146,262	140,411	25,036
6	2031	0.137	161,863	142,439	136,742	18,702
7	2032	0.105	161,215	138,645	133,099	13,988
8	2033	0.081	160,570	134,879	129,484	10,430
9	2034	0.062	159,928	131,141	125,895	7,817
10	2035	0.047	159,288	127,431	122,334	5,800
11	2036	0.036	158,651	123,748	118,798	4,336
12	2037	0.028	158,017	154,856	148,662	4,148
13	2038	0.021	157,385	151,089	145,046	3,103
14	2039	0.017	156,755	147,350	141,456	2,344
15	2040	0.013	156,128	143,638	137,892	1,736
16	2041	0.012	155,504	139,953	134,355	1,606
17	2042	0.008	154,882	136,296	130,844	988
18	2043	0.006	154,262	132,665	127,359	748
19	2044	0.004	153,645	129,062	123,899	520
20	2045	0.003	153,030	125,485	120,466	329
21	2046	0.003	152,418	121,935	117,057	319
22	2047	0.003	151,809	118,411	113,674	310
23	2048	0.003	151,201	114,913	110,317	324
24	2049	0.003	150,597	147,585	141,681	386

	Year	Evening Peak Carbon Intensity (Gas Peaker) (kg CO2e/kWh)	Charged to BESS (Mwh) AC	Energy Discharged to Inverters (MWh)	400kv AC to Grid	Carbon Avoidance (tCO2e)
25	2050	0.005	149,994	143,994	138,235	667
26	2051	0.005	149,394	140,431	134,813	650
27	2052	0.005	148,797	136,893	131,417	634
28	2053	0.005	148,201	133,381	128,046	618
29	2054	0.005	147,609	129,896	124,700	602
30	2055	0.005	147,018	126,436	121,378	586
31	2056	0.005	148,169	124,462	119,484	576
32	2057	0.005	149,374	122,487	117,587	567
33	2058	0.005	150,633	120,506	115,686	558
34	2059	0.005	151,944	118,516	113,776	549
35	2060	0.005	153,308	116,514	111,854	540
36	2061	0.005	152,695	149,641	143,655	693
37	2062	0.005	152,084	146,001	140,161	676
38	2063	0.005	151,476	142,387	136,692	659
39	2064	0.005	150,870	138,800	133,248	643
40	2065	0.005	150,267	135,240	129,830	626
				Total		**297,606**

Notes for tables.
The Charged to BESS figures are taken from column 5 in Appendix B.The energy to inverters column assumes a straight line 2% reduction in efficiency of the cells towards End of Life during each 12 year period. The penultimate column in all three tables adopts the 4% power loss from inverting and step up transforming tp 400kv.

Appendix D
*URLs of Sources.

Page	Company/Organisation	URL
11	Wemake Renewable Energy Consulting	[redacted]
12	International Electrotechnical Commission	[redacted]
		[redacted]
		[redacted]
15	Canadian Solar	[redacted]
15	JA Solar	[redacted]
15	Trina Solar	[redacted]
17	PV Magazine Energy Storage	[redacted]
18	North Sea Transition Authority	[redacted]
23	Sungrow SG250HX 250 kW string inverter	[redacted]
24	Sungrow's SG3400 central inverters	[redacted]
24	Sungrow SG3425 inverter	[redacted]
26	Tata Steel	[redacted]
26	World Steel Association	[redacted]
29	National Grid	[redacted]
30	First Fence	[redacted]
		[redacted]
34	airsupplycn.com	[redacted]
37	British Concrete Polishing	[redacted]
37	BYD	[redacted]

Page	Company/Organisation	URL
38	Ultimate One Fencing	[redacted]
40	Origin Suregreen Ltd	[redacted]
40	David Musson Fencing	[redacted]
41	East Coast Fencing's 3mx150mm Wooden Gravel Board	[redacted]
43	UK Power Networks	[redacted]lation-of-underground-cables-lv-to-132kv.pdf
44	National Grid Electricity Transmission PLC	[redacted]
45	Tarmac	[redacted]
45	Heidelberg Materials	[redacted]
45	OC Regeneration Ltd	[redacted]
46	Santova Logistics Ltd	[redacted]
46	Zheng Sourcing	Website now down.
48	Fastrack 609 Woven Geotextile	[redacted]
48	Terram	[redacted]