



# One Earth Solar Farm

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**Volume 3: Technical Appendices Supporting ES Volume 2**

**Appendix 15.4: Operational Noise Assessment**

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## Glossary

Term	Meaning
dB: Decibel	The logarithmically scaled measurement unit of sound.
A-weighting	Frequency weighting applied to measured sound in order to account for the relative loudness perceived by the human ear.
$L_{Aeq,T}$	A-weighted equivalent continuous sound level over a given time period. It is the sound level of a steady sound that has the same energy as a fluctuating sound over the same time period.
$L_{A90,T}$	The A-weighted sound level exceeded for 90% of the measurement period. Often referred to as the background sound level.
Ambient sound level, $L_a = L_{Aeq,T}$	The A-weighted equivalent continuous sound level of the totally encompassing sound for a given situation and time interval, T
Specific sound level, $L_s = L_{Aeq,Tr}$	The A-weighted equivalent continuous sound pressure level produced by the specific sound source at the reference location over a reference time interval, T.
Rating level, $L_{Ar,Tr}$	The specific sound level plus any adjustment for the characteristic features of the sound.

## List of Abbreviations and Acronyms

Term	Meaning
BESS	Battery Energy Storage System
MVPT	Medium Voltage Power Transformer
PCS	Power Converter Station
LOAEL	Lowest Observed Adverse Effect Level
SOAEL	Significant Observed Adverse Effect Level

## A.15 Appendix 15.4 Operational Noise Assessment

### A.15.1 Introduction

- A.15.1.1. An assessment of the likely impacts of operational noise has been carried out for the Proposed Development, based on the details available at the time of writing. It should be noted that certain details of the development are not yet final, therefore where necessary this assessment has been carried out on the basis of indicative information. Where this has been the case, it is identified in the relevant sections of this Appendix.
- A.15.1.2. The assessment presented in this Appendix also assumes that both the western and eastern options for BESS are progressed. This is the worst case scenario in terms of operational noise, since without the battery storage, the only noise sources associated with the operation of the Development would be the PCSs and the substation equipment, which would have minimal noise impacts compared to the BESS compounds.

### A.15.2 Operational Noise, BESS and Substation

#### Study Area

- A.15.2.1. The study area for the assessment of potential effects of operational noise is shown in **6.21 Appendix 15.4 Operational Noise Assessment.pdf**. This includes all noise sensitive properties within 300 m of the BESS and substation compounds and all properties within 250 m of the PCS units.
- A.15.2.2. Noise sensitive receptors within the study area are also identified in Figure 15.8.

#### Assessment Criteria

- A.15.2.3. Criteria for the assessment of noise from fixed plant and equipment associated with the proposed development have been determined from British Standard BS 4142:2014+A1:2019, Methods for Rating and Assessing Industrial and Commercial Sound.
- A.15.2.4. The BS 4142 methodology assesses the likely effects of sound on people and premises used for residential purposes and provides an indication of the likely magnitude of impact.
- A.15.2.5. For residential receptors during the daytime and night-time periods, the SOAEL threshold is set at 10 dB greater than the background sound level, when determined in accordance with the BS 4142 assessment procedure. When this threshold is exceeded, it indicates that a significant adverse effect in EIA terms is likely to occur, subject to factors relating to context.

- A.15.2.6. The LOAEL threshold is set at 5 dB lower than the background sound level, when determined in accordance with the BS 4142 assessment procedure.
- A.15.2.7. Development related noise exposures which fall between LOAEL and SOAEL have the potential to constitute a significant effect, subject to additional considerations, namely:
- > The magnitude of the effect;
  - > The change in magnitude of the effect, where applicable;
  - > The type of effect, including its intermittency;
  - > The existing ambient environment;
  - > How effective the measures employed to mitigate the effect are, including best practicable means (BPM); and
  - > The duration of effect.
- A.15.2.8. In particular, BS 4142 states that:
- “Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night.”*
- A.15.2.9. Reference to Appendix 15.4 shows that average baseline noise levels are typically between 36 dB and 41 dB  $L_{A90}$  during the daytime, apart from at locations close to the A57, where average daytime background noise levels are typically between 46 dB and 53 dB  $L_{A90}$ .
- A.15.2.10. Similarly, during night-time, average background noise levels are between 27 dB and 32 dB  $L_{A90}$ , apart from at one location close to the A57, where average background noise levels were 35 dB  $L_{A90}$ . Background noise levels below approximately 30 to 35 dB  $L_{A90}$  would typically be considered very low in the context of a BS 4142 assessment.
- A.15.2.11. Based on the above, impact thresholds have been derived for daytime and night-time, which are set out in **Table 1** and **Table 2** below.

*Table 1 Criteria for magnitude of daytime operational noise impacts and night-time impacts where existing night-time background noise levels are greater than 30 dB  $L_{A90}$ , derived following BS 4142.*

Magnitude of Impact	Noise Rating Level (dB $L_{Aeq}$ )
Major	Greater than a level of 10 dB above prevailing background
<i>Significant Observed Adverse Effect Level (SOAEL) = 10 dB above prevailing background noise level</i>	

Magnitude of Impact	Noise Rating Level (dB L <sub>Aeq</sub> )
Moderate	Greater than or equal to a level of 5 dB above background and less than a level of 10 dB above background
Minor	Greater than or equal to a level of 5 dB below background and less than a level of 5 dB above background
<i>Lowest Observed Adverse Effect Level (LOAEL) = 5 dB below prevailing background noise level</i>	
Negligible	Less than a level of 5 dB below background.

Table 2 Criteria for magnitude of night-time operational noise impacts, derived following BS 4142.

Magnitude of Impact	Noise Rating Level (dB L <sub>Aeq</sub> )
Major	Greater than 40 dB L <sub>Aeq</sub>
<i>Significant Observed Adverse Effect Level (SOAEL) = 40 dB L<sub>Aeq</sub></i>	
Moderate	Greater than or equal to 35 dB L <sub>Aeq</sub> above background and less than 40 dB L <sub>Aeq</sub>
Minor	Greater than or equal to a level of 30 dB L <sub>Aeq</sub> and less than 35 dB L <sub>Aeq</sub>
<i>Lowest Observed Adverse Effect Level (LOAEL) = 30 dB L<sub>Aeq</sub></i>	
Negligible	Less than 30 dB L <sub>Aeq</sub>

## Assessment Methodology

- A.15.2.12. In order to calculate potential levels of operational noise and therefore the associated impacts, locations and specifications of fixed plant associated with the scheme are required. The precise locations of plant and the precise specification of plant that will be used are yet to be determined, therefore this assessment has been based on indicative plant locations.
- A.15.2.13. Noise source data for representative items of plant and equipment has been sourced from the equipment manufacturers. It should be noted that manufacturers of solar and BESS plant and equipment typically only provide noise source data relating to the worst-case operation of the plant (i.e. under maximum load and at relatively high ambient temperatures). For the BESS units and the MVPT skids, these assumptions are likely to be conservative, as the equipment will not be under full load 24 hours a day. The PCSs will only be under load when the solar panels are generating power, and therefore will not be under load at night. It is understood that, when not under load, the PCSs

generate minimal noise, therefore these sources have only been included in the daytime operational noise assessment.

- A.15.2.14. In addition, items of plant which feature cooling systems, in particular the BESS units, will generate less noise when ambient temperatures are lower, as the required cooling load will be lower. The manufacturers' data referenced in this assessment relates to a maximum ambient temperature of 35 °C. As such, cooling systems would be expected to operate at a significantly reduced load as compared to the tested conditions, particularly during the night. The actual noise output of the plant is therefore expected, in reality, to be lower than the manufacturers' noise specifications.
- A.15.2.15. The assumed source noise levels, as quoted by the equipment manufacturers, are summarised in **Table 3** below.

*Table 3 Summary of source noise level assumptions for fixed plant and equipment, based on manufacturers' specifications.*

Item of Equipment	Manufacturer's Specification (dB(A))	Derived Total Sound Power Level (dB)
BESS unit	≤ 69 dB(A) @ 1m for temperatures ≤ 35 °C	90 dB(A) SWL
MVPT skid	≤ 75 dB(A) @ 1m	96 dB(A) SWL
PCS	80 dB(A) @ 1m	103 dB(A) SWL

### Assessment Methodology

- A.15.2.16. Predictions of noise levels from operational plant and equipment on the site have been carried out using Stapelfeldt's LimA noise modelling software, which implements the calculation methodology set out in ISO 9613-2:2024 Acoustics – Attenuation of Sound During Propagation Outdoors, Part 2, Engineering Method for the Prediction of Sound Pressure Levels Outdoors.
- A.15.2.17. Calculations have been carried out by modelling the BESS, MVPT skids and PCSs as 3D sound radiating objects, with the sound power levels for the 3D sources calibrated against the manufacturers' source noise specifications for each item of plant. The modelling takes account of variations in ground height over the site and, since the site and the surrounding area is agricultural in nature, modelling has assumed acoustically "mixed" ground (i.e. a mix of acoustically absorptive and reflective ground). The model also takes account of the screening effects of buildings etc., but no noise mitigation in the form of noise barriers is included.



A.15.2.18. It should be noted that the currently available noise data does not indicate characteristics that would attract a penalty under the BS 4142 assessment methodology, therefore the prediction results set out in the following section do not include penalties for tonal or impulsive characteristics. In addition, no information is currently available on the plant and equipment that will be required for the substation, therefore this equipment cannot be included in the noise modelling at this stage. The substation will, however, be located immediately adjacent to the western BESS compound, and therefore the sources of noise associated with the substation are likely to be minimal relative to the BESS compound.

### Assessment

A.15.2.19. Modelling has been carried out separately for the BESS units, the MVPT skids and the PCSs, as well as the overall cumulative total operational noise level. Prediction results for all receptors that are predicted to experience a noise impact greater than Negligible during day or night are given in **Table 4** below.

*Table 4 Summary of predicted operational noise impacts - BESS.*

Receptor	Background Noise Level (dB L <sub>A90</sub> )		Predicted Noise Levels (dB L <sub>Aeq</sub> )		Predicted Impact	
	Day	Night	Day	Night	Day	Night
Far Hill Farm, Farhill Lane, Ragnall	39	29	32	31	Negligible	Minor
Gibraltar Farm, Woodcotes Lane, Darlton	39	29	37	36	Minor	<b>Moderate</b>
Vicarage Farm, Farhill Lane, Ragnall	39	29	35	33	Minor	Minor
Northfield Farm, Northfield Lane, North Clifton	36	30	36	34	Minor	Minor
Hall Farmyard, Gainsborough Road, North Clifton	36	30	34	31	Minor	Minor

Table 5 Summary of predicted operational noise impacts – MVPT Skids.

Receptor	Background Noise Level (dB L <sub>A90</sub> )		Predicted Noise Levels (dB L <sub>Aeq</sub> )		Predicted Impact	
	Day	Night	Day	Night	Day	Night
Far Hill Farm, Farhill Lane, Ragnall	39	29	36	37	Minor	<b>Moderate</b>
Gibraltar Farm, Woodcotes Lane, Darlton	39	29	42	43	Minor	<b>Major</b>
1 Station Cottage, Fledborough	39	32	32	32	Negligible	Minor
Top Farm, Fledborough	39	29	34	35	Negligible	Minor
2 Station Cottage, Fledborough	39	32	32	32	Negligible	Minor
Vicarage Farm, Farhill Lane, Ragnall	39	29	37	38	Minor	<b>Moderate</b>
Fledborough House, Fledborough	39	29	32	32	Negligible	Minor
Mill Hill House, Gainsborough Road, North Clifton	36	30	32	33	Minor	Minor
1 Long Row, Fledborough	39	29	33	34	Negligible	Minor
North Clifton Hall, Gainsborough Road, North Clifton	36	30	30	31	Negligible	Minor
3 Long Row, Fledborough	39	29	33	34	Negligible	Minor
2 Long Row, Fledborough	39	29	33	34	Negligible	Minor

Receptor	Background Noise Level (dB L <sub>A90</sub> )		Predicted Noise Levels (dB L <sub>Aeq</sub> )		Predicted Impact	
	Day	Night	Day	Night	Day	Night
Mudros, Gainsborough Road, North Clifton	36	30	31	32	Negligible	Minor
4 Long Row, Fledborough	39	29	33	34	Negligible	Minor
Rose Cottage, Main Street, Ragnall	39	29	29	30	Negligible	Minor
Mill Farm Cottage, Mill Lane, North Clifton	36	30	31	32	Minor	Minor
House Farm, Fledborough	39	29	32	32	Negligible	Minor
2 Collingham Road, Newton-On-Trent	48	35	30	31	Negligible	Minor
Northfield Farm, Northfield Lane, North Clifton	36	30	39	40	Minor	<b>Moderate</b>
4 Collingham Road, Newton-On-Trent	48	35	31	32	Negligible	Minor
North Farm, Fledborough	39	29	34	35	Minor	<b>Moderate</b>
Hall Farmyard, Gainsborough Road, North Clifton	36	30	35	36	Minor	<b>Moderate</b>
Chestnut Cottage, Main Street, Ragnall	39	29	29	30	Negligible	Minor

Receptor	Background Noise Level (dB L <sub>A90</sub> )		Predicted Noise Levels (dB L <sub>Aeq</sub> )		Predicted Impact	
	Day	Night	Day	Night	Day	Night
The Cottage, Mill Lane, North Clifton	36	30	31	32	Minor	Minor
1 Southmoor Road, Newton-On-Trent	48	35	31	32	Negligible	Minor
The Lodge, Gainsborough Road, North Clifton	36	30	30	30	Negligible	Minor
The Manor, Gainsborough Road, North Clifton	36	30	30	31	Negligible	Minor
Stonehaven, Main Street, Ragnall	39	29	29	30	Negligible	Minor
1 Collingham Road, Newton-On-Trent	48	35	32	33	Negligible	Minor

Table 6 Summary of predicted operational noise impacts – PCSs.

Receptor	Background Noise Level (dB L <sub>A90</sub> )		Predicted Noise Levels (dB L <sub>Aeq</sub> )		Predicted Impact	
	Day	Night	Day	Night	Day	Night
Far Hill Farm, Farhill Lane, Ragnall	39	29	37	-	Minor	Negligible
Vicarage Farm, Farhill Lane, Ragnall	39	29	36	-	Minor	Negligible
The Gables, Fledborough	36	30	31	-	Minor	Negligible
The Chase, Main Road, South Clifton	36	30	35	-	Minor	Negligible
North Clifton Hall, Gainsborough Road, North Clifton	36	30	34	-	Minor	Negligible
Station House, Gainsborough Road, North Clifton	36	30	35	-	Minor	Negligible
Evening Star, Gainsborough Road, North Clifton	36	30	33	-	Minor	Negligible
Moor Farm, Moor Lane, North Clifton	36	30	34	-	Minor	Negligible
Mill Farm Cottage, Mill Lane, North Clifton	36	30	38	-	Minor	Negligible
The Station, Gainsborough Road, North Clifton	36	30	36	-	Minor	Negligible

Receptor	Background Noise Level (dB L <sub>A90</sub> )		Predicted Noise Levels (dB L <sub>Aeq</sub> )		Predicted Impact	
	Day	Night	Day	Night	Day	Night
Northfield Farm, Northfield Lane, North Clifton	36	30	35	-	Minor	Negligible
Hall Farmyard, Gainsborough Road, North Clifton	36	30	32	-	Minor	Negligible
The Cottage, Mill Lane, North Clifton	36	30	33	-	Minor	Negligible
1 Station Cottage, Gainsborough Road, North Clifton	36	30	33	-	Minor	Negligible
Moor Farm, Moor Lane, South Clifton	36	30	33	-	Minor	Negligible
Far Hill Farm, Farhill Lane, Ragnall	39	29	37	-	Minor	Negligible
Vicarage Farm, Farhill Lane, Ragnall	39	29	36	-	Minor	Negligible
The Gables, Fledborough	36	30	31	-	Minor	Negligible
The Chase, Main Road, South Clifton	36	30	35	-	Minor	Negligible
North Clifton Hall, Gainsborough Road, North Clifton	36	30	34	-	Minor	Negligible

Table 7 Summary of predicted operational noise impacts – Combined

Receptor	Background Noise Level (dB L <sub>A90</sub> )		Predicted Noise Levels (dB L <sub>Aeq</sub> )		Predicted Impact	
	Day	Night	Day	Night	Day	Night
Far Hill Farm, Farhill Lane, Ragnall	39	29	40	38	Minor	<b>Moderate</b>
Gibraltar Farm, Woodcotes Lane, Darlton	39	29	43	44	Minor	<b>Major</b>
1 Station Cottage, Fledborough	39	32	33	33	Negligible	Minor
Top Farm, Fledborough	39	29	36	35	Minor	<b>Moderate</b>
2 Station Cottage, Fledborough	39	32	33	33	Negligible	Minor
Vicarage Farm, Farhill Lane, Ragnall	39	29	40	39	Minor	<b>Moderate</b>
Fledborough House, Fledborough	39	29	34	33	Negligible	Minor
Mill Hill House, Gainsborough Road, North Clifton	36	30	35	34	Minor	Minor
1 Long Row, Fledborough	39	29	35	34	Minor	Minor
The Cottage, Main Street, Ragnall	39	29	34	31	Negligible	Minor
The Gables, Fledborough	36	30	32	29	Minor	Negligible
The Chase, Main Road, South Clifton	36	30	35	-	Minor	Negligible
North Clifton Hall, Gainsborough Road, North Clifton	36	30	34	33	Minor	Minor
Oak Tree Cottage, Main Street, Ragnall	39	29	34	31	Minor	Minor

Receptor	Background Noise Level (dB L <sub>A90</sub> )		Predicted Noise Levels (dB L <sub>Aeq</sub> )		Predicted Impact	
	Day	Night	Day	Night	Day	Night
3 Long Row, Fledborough	39	29	35	34	Minor	Minor
Station House, Gainsborough Road, North Clifton	36	30	35	26	Minor	Negligible
Evening Star, Gainsborough Road, North Clifton	36	30	33	26	Minor	Negligible
2 Long Row, Fledborough	39	29	35	34	Minor	Minor
Mudros, Gainsborough Road, North Clifton	36	30	35	33	Minor	Minor
4 Long Row, Fledborough	39	29	35	34	Minor	Minor
Moor Farm, Moor Lane, North Clifton	36	30	35	29	Minor	Negligible
Corner Cottage, Main Street, Ragnall	39	29	34	31	Negligible	Minor
Rose Cottage, Main Street, Ragnall	39	29	33	32	Negligible	Minor
Mill Farm Cottage, Mill Lane, North Clifton	36	30	39	32	Minor	Minor
House Farm, Fledborough	39	29	34	33	Negligible	Minor
The Station, Gainsborough Road, North Clifton	36	30	36	26	Minor	Negligible
2 Collingham Road, Newton-On-Trent	48	35	34	33	Negligible	Minor



Receptor	Background Noise Level (dB L <sub>A90</sub> )		Predicted Noise Levels (dB L <sub>Aeq</sub> )		Predicted Impact	
	Day	Night	Day	Night	Day	Night
Northfield Farm, Northfield Lane, North Clifton	36	30	42	41	<b>Moderate</b>	<b>Major</b>
4 Collingham Road, Newton-On-Trent	48	35	36	34	Negligible	Minor
North Farm, Fledborough	39	29	37	36	Minor	<b>Moderate</b>
Hall Farmyard, Gainsborough Road, North Clifton	36	30	38	37	Minor	<b>Moderate</b>
Chestnut Cottage, Main Street, Ragnall	39	29	35	32	Minor	Minor
The Cottage, Mill Lane, North Clifton	36	30	36	33	Minor	Minor
1 Southmoor Road, Newton-On-Trent	48	35	36	34	Negligible	Minor
The Lodge, Gainsborough Road, North Clifton	36	30	34	32	Minor	Minor
1 Station Cottage, Gainsborough Road, North Clifton	36	30	33	26	Minor	Negligible
The Manor, Gainsborough Road, North Clifton	36	30	34	33	Minor	Minor
Stonehaven, Main Street, Ragnall	39	29	33	32	Negligible	Minor
1 Collingham Road, Newton-On-Trent	48	35	36	34	Negligible	Minor
Moor Farm, Moor Lane, South Clifton	36	30	33	-	Minor	Negligible

- A.15.2.20. As can be seen from **Table 7** above, in the combined case there is one Moderate impact predicted during daytime (at Northfield Farm), and five moderate and two major impacts predicted during the night. As can be seen in **Table 4, Table 5** and **Table 6**, the MVPT units are the most significant contributors to noise levels, with five Moderate and one Major impact predicted at night due to noise from the MVPT skids. The BESS units and PCSs result in comparatively modest noise impacts, with one Moderate impact during the night due to the BESS units and only minor daytime impacts due to the PCSs.
- A.15.2.21. It should, however, be noted that the above are absolute worst case noise levels, assuming that all equipment other than the PCSs is operating at full load at all times, including during the night. This is likely to be a very conservative assumption, as much of the equipment will not be operating at full load during the night. On this basis, night-time noise levels are likely to be lower than those predicted, however the predictions set out above do indicate that consideration of noise levels at a number of nearby sensitive receptors, and in particular Gibraltar Farm and Northfield Farm, will be necessary during the next stage of the design.

### Mitigation

- A.15.2.22. As described above, the noise modelling has identified the potential for moderate and major noise impacts at a number of properties around the site, particularly at night. These are, however, based on conservative assumptions due to the limitations of the noise source data that can be provided by the equipment manufacturers, in particular that all equipment operates at full load all of the time and that the ambient temperature is up to 35 °C at all times. As such, it is likely that noise levels will be below those predicted, especially during the night. A reduction in noise levels of 9 dB<sup>1</sup> would result in predicted noise impacts that are, at worst, minor during both daytime and night-time.
- A.15.2.23. Consequently, plant and equipment will be selected and designed to achieve a rating level of no more than 35 dB(A) L<sub>Aeq</sub> at noise sensitive receptors under normal operating conditions and loads. This is considered achievable with a combination of the following mitigation measures:
- > Where feasible, selection of quieter plant and equipment.
  - > Where practicable, siting and orientating noise generating equipment to reduce noise levels at sensitive receptors.
  - > Installation of manufacturers' noise reduction kits where available.

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<sup>1</sup> Note that this reduction assumes that no character penalties apply under the methodology set out in BS 4142. If plant is selected that would result in character penalties, additional noise mitigation would be required to achieve at worst minor noise impacts at all receptors.

- > Inclusion of noise barriers where feasible. This is likely to be most effective for PCS units that are relatively close to properties, as noise barriers can be located close to the units and of relatively short length.

- A.15.2.24. Given the uncertainties in the manufacturer's noise data, particularly during night-time operation, prior to installation of plant and equipment on the site, measurements will be undertaken of the proposed plant under operating conditions representative of the conditions during a typical night-time. This will include both load and ambient temperature conditions that are representative of night-time operation. This will enable the most effective noise mitigation measures (both in terms of cost and noise reduction) to be included in the design. Noise measurements will be undertaken in accordance with relevant standards (e.g. ISO 3744: 2010 Acoustics, Determination of sound power levels and sound energy levels of noise sources using sound pressure, Engineering methods for an essentially free field over a reflecting plane).
- A.15.2.25. Given the above, mitigated operational noise impacts would be at worst Minor. As discussed at the start of this Appendix, this is considered to be the worst case impact of operational noise due to the scheme, as the assessment is based on the assumption that both the eastern and western BESS compounds are developed as part of the Proposed Development.



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