Chapter 11: Noise

Contents

11 Noise

11.1 Executive Summary

11.1.1 Green Cat Renewables Ltd were commissioned to undertake a noise impact assessment for the construction and operation of the Proposed Development.

11.1.2 An assessment of construction noise took the form of a desk-based study of the potential construction activities associated with the proposed wind turbines, Battery Energy Storage System (BESS), and associated infrastructure. Noise levels were calculated at the nearest receptor locations relative to construction activities and compared with recommended noise limits. It was shown that all construction activities would comply with the daytime nose limit at affected receptors, and potential impacts would not be significant.

11.1.3 The operational assessment included predicted immissions from the proposed turbines. Given the large setback distance of >1.5 km, the operational effects of the BESS were scoped out of the assessment. No cumulative developments were identified within the agreed study, as such a detailed cumulative assessment was not required.

11.1.4 Noise levels from the operation of the proposed turbines were predicted at the nearest noise assessment locations, as defined by the noise study area, determined by best practice guidance. Background noise surveys were conducted within the study area to gather baseline noise levels and derive ETSU-R-97 noise limits. The results of the study concluded that operational noise levels from the Proposed Development would comply with the derived noise limits in accordance with ETSU-R-97 and national guidance and would not be significant.

11.2 Introduction

11.2.1 This chapter considers the noise impacts which could potentially arise during the construction, operational, and decommissioning phases of the Proposed Development.

11.2.2 The Proposed Development consists of seven turbines, five with a tip height of up to 200 m, two with a tipe heigh of 180 m and an anticipated power output of 7.2 MW. For the purposes of this assessment, the candidate machine was the Vestas V162 at a hub height of up to 119 m, maximum blade tip height of 200 m and rated power output of 7.2 MW. The candidate was selected on the basis that it produced the highest immission levels of the available turbine models that met the design criteria.

11.2.3 The development will also include approximately 23 MW of Battery Energy Storage (BESS), located centrally to the site near the access track. A detailed assessment of the BESS has been scoped out of the following assessment due to the large setback distance to the nearest residential receptor of greater than 1.5 km.

11.2.4 The Proposed Development was assessed using a combination of propagation modelling and noise limits that reference data collected during the background noise survey.

Terminology

11.2.5 A brief description of the terminology used within the chapter is provided below:

- The wind speeds referred to in this report are Standardised 10 m wind speeds (v10). This is calculated from hub height wind speeds translated to 10 m height above ground level assuming a standard roughness length of 0.05 m. All turbine sound power levels are quoted with reference to standardised 10 m wind speeds.
- Sound pressure level (SPL) is a logarithmic measure of the effective sound pressure of a sound relative to a reference value: 20 µPa. It is measured in decibels (dB) above this standard reference level. The SPL descriptors referenced in this report are:
  - $L_{A,eq}$ is the A-weighted equivalent continuous sound pressure level measured over a specific time. Leq is the single figure sound level that contains the same acoustical energy as the actual fluctuating sound level.
  - $L_{A90,10min}$ is the A-weighted sound pressure level exceeded for 90 percent of the time in the averaging time interval specified – in this case 10 minutes – and is the index most widely used for background noise level measurements.
- Sound Power Level (L_{WA}) is the decibel equivalent of the rate of energy (or power) emitted in the form of sound. The sound power level is an inherent property of a sound source. (the reference value for sound power is $1x10^{-12}W$).
- Immission is the propagated sound energy that reaches a receptor.

- Emission is another way of describing sound power (see above).

11.3 Legislation, Policy and Guidelines

Planning Policy

11.3.1 The following sources provide guidance on the assessment of wind turbine noise:

- Onshore Wind: Policy Statement (Scottish Government, 2022);
- Onshore Wind Turbines: Planning Advice (Scottish Government, 2014); and
- Planning Advice Note 1/2011 (PAN1/2011): Planning and Noise (Scottish Government, 2011)

Guidance

Construction/Decommissioning

11.3.2 Guidance for the assessment of construction noise is given in:

- BS 5228-1:2009+A1:2014 - Code of practice for noise and vibration control on construction and open sites (British Standards, 2009;2014)

11.3.3 The standard provides indicative source sound level data for a variety of construction plant for use within the calculations and suggests appropriate fixed noise limits. Assessment of the significance of impacts can be made through comparison of predicted levels with defined criteria.

Operation

11.3.4 Guidance for assessing operational noise from wind farms is given in:

- The Institute of Acoustics, 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise' (The Institue of Acoustics, 2013) (referred to as IoA Good Practice Guide)

11.3.5 This guidance was developed to standardise the approach to noise assessment of wind farms in the UK. The guidance also provides advice on the form of planning conditions that should be adopted for wind farm projects. The IoA Good Practice Guide does not address the question of what noise limits should be applied as this has been determined by government.

11.3.6 The basis for operational wind farm noise limits that have been adopted in the UK is given in:

- The Department of Trade and Industry, 'ETSU-R-97: The Assessment and Rating of Noise from Wind Farms' (The Department of Trade and Industry, 1996) (referred to as ETSU-R-97)

11.3.7 Onshore Wind Policy Statement 2022 endorses the use of ETSU-R-97 and the IoA Good Practice Guide for the assessment of operational wind turbine noise. PAN 1/2011 includes an endorsement of ETSU-R-97 as the overarching assessment framework for wind turbine noise.

Relevant Standards

11.3.8 The International Standard ISO 9613, 'Acoustics – Attenuation of Sound During Propagation Outdoors - Part 2' (International Standard, 2024), noise propagation model has been used for the turbine noise calculations.

11.3.9 The International Electrotechnical Commission's Technical Specification document IEC/TS 61400-14:2005 – 'Part 14: Declaration of apparent sound power level and tonality values' provides a method to derive appropriate sound power level values from a number of independent sources to improve robustness.

Low Frequency Noise

11.3.10 The planning guidance (Scottish Government, 2014) is clear; that there is no empirical evidence that infrasound or low frequency noise (LFN) would result in adverse health effects from a wind farm and refers to the 2006 study carried out by Hayes McKenzie on behalf of the Department of Trade and Industry (DTI) (Hayes McKenzie, 2006). The report investigates the potential impact of infrasound or low frequency noise arising from wind turbines. The study concluded that infrasound or low frequency noise arising from the operation of wind turbines did not result in adverse health impacts.

11.3.11 A further research study stated the level of infrasound due to wind turbines is low in comparison to other technical and natural sources (Landesanstalt für Umwelt, Messungen und Naturschutz Baden-Württemberg, 2016). The findings concluded "*That adverse effects relating to infrasound from wind turbines cannot be expected on the basis of the evidence at hand.*"

11.3.12 This chapter does not therefore give any further consideration to potential low frequency noise effects.

Vibration

11.3.13 In 2005, the Applied and Environmental Geophysics Research Group at Keele University conducted an extensive study titled 'Microseismic and Infrasound Monitoring of Low Frequency Noise and Vibrations from Windfarms' (Styles, Stimpson, Toon, England , & Wright, 2005). The study was requested by the Ministry of Defence (MOD), DTI and the British Wind Energy Association with the aim of establishing an acceptable limit that would not interfere with the detection capabilities of the seismic monitoring site located in Eskdalemuir, Scotland. The results of the investigation found that low levels of vibration and infrasound could be detected, with measurement apparatus, at large distances from the wind turbines included in the survey. The report concluded that a 10 km buffer zone could be adopted at Eskdalemuir to protect the site from the interference due to wind turbines.

11.3.14 The outcome of this study has since been misinterpreted as the potential for adverse effects at residential receptors. The authors of the paper have clarified that:

"The levels of vibration from wind turbines are so small that only the most sophisticated instrumentation and data processing can reveal their presence, and they are almost impossible to detect."

11.3.15 They also confirmed that the level of vibration measured was not unique to wind turbines:

"Vibrations at this level and in this frequency range will be available from all kinds of sources such as traffic and background noise - they are not confined to wind turbines." (Renewable UK, 2010)

11.3.16 A more recent study on the human perception of vibration from wind turbines was published in 2020 (Nguyen, Hansen, & Branko, 2020) . The paper presents vibration measurements from inside properties at varying distances from a wind farm. The study compares the results against criteria given in the documents AS 2670-1 (1990) (Australian Standards, 1990) and BS 6472-1 (2008) (British Standards, 2008) and suggests there is a low probability of adverse impact.

11.3.17 Therefore, as current research continues to conclude that vibration due to wind farms is very unlikely to disturb residential amenity, an assessment of vibration is not within the scope of the Noise Impact Assessment (NIA) carried out for the Proposed Development.

Amplitude Modulation

11.3.18 Amplitude Modulation (AM) as an element of turbine noise has been the subject of considerable research in recent years. The University of Salford conducted a study on behalf of the Department for Business, Enterprise and Regulatory Reform to investigate whether noise complaints arising from wind farms were due to the presence of AM. The report found that complaints were highly likely to be caused by AM in 4 out of the 27 wind farms included in the study. However, it concluded, *"that the causes of AM are not fully understood, and that AM cannot be fully predicted at current state of the art"* (University of Salford, 2007). The findings of the investigation were reconfirmed in 2013 in an updated research report by Renewable UK (Renewable UK, 2013).

11.3.19 The IoA produced 'A Method for Rating Amplitude Modulation in Wind Turbine Noise' (Institute of Acoustics, 2016), in which amplitude modulation is defined as the following:

"Wind turbine amplitude modulation is defined as periodic fluctuations in the level of audible noise from a wind turbine (or wind turbines), the frequency of the fluctuations being related to the blade passing frequency of the turbine rotor(s)."

11.3.20 The report acknowledges that certain levels and/or characteristics of amplitude modulation may lead to disturbance and noise complaints. The guidance does not aim to define the level at which AM could pose an issue but outlines a proposed methodology to assess and rate AM arising from operational wind farms.

11.3.21 The Wind Turbine AM Review - Phase 2 report (WSP | Parsons Brinckerhoff, 2016) went on to propose a penalty scheme that could be applied by planning condition to limit the extent of operational AM, where required.

11.3.22 Currently, there is no established predictive method of assessment for amplitude modulation prior to construction and operation of a wind farm. As such, the assessment of AM is scoped out of the NIA.

11.4 Consultation

11.4.1 A scoping opinion was submitted to the Scottish Governments Energy Consents Unit (ECU) under the reference ECU00005007 in February 2024; with a response received in May 2024.

11.4.2 Table 11.1 provides details of consultation undertaken in respect to noise.

Table 11.1 – Consultation

Consultee and Date	Consultation Response	Applicant Response
Argyll & Bute Council	**Construction Noise** Consultees agree with the methodology provided in scoping to conduct a construction noise impact assessment. The LPA additionally request that road and flight paths are included where necessary. An assessment should be performed before construction noise can be scoped out.	– A construction noise assessment at the nearest receptors has been conducted in accordance with BS 5228-1.
	Operational Noise Assessment Consultees agree and accept the proposed methodology to conduct the operational noise impact assessment, following ETSU-R-97 and the IoA Good Practice Guide (GPG).	– Operational noise impact assessment has been conducted following ETSU-R-97 and the IoA GPG.
	Cumulative Impact Assessment Consultees agree with the cumulative search area of 3 km.	– An updated review of the surrounding area was conducted. No operational, consented, or in planning wind turbines were identified within 3 km of the Proposed Development. – As such, a cumulative assessment has been **scoped out** of this study.
Argyll & Bute Council	**Background Survey Methodology** Consultees look forward to discussions on the Background Noise assessment and their terms of reference.	– The proposed methodology for conducting the background survey was submitted for approval to the Argyll and Bute Environmental Health Team on 07 October 2024. – No response was received, however, the survey was conducted following best practice guidance.

11.5 Assessment Methodology and Significance Criteria

Study Area

11.5.1 The Site is located approximately 2.1 km northwest of Dunoon and 1.5km south-west of Sandbank, Argyll & Bute. The surrounding landscape is predominantly commercial forestry, characterised by several raised peaks and scattered dwellings.

Construction

11.5.2 All construction activities are planned to occur within the project boundary. Figure 11.1 shows the location of the turbines, new access tracks, substation, BESS, and hard standing areas at the Site.

11.5.3 Receptors chosen for inclusion within the assessment were those located nearest to the construction activities in order to assess the potential worst-case impacts. The identified construction noise receptors (CNR) are shown on Figure 11.1.

Operation

11.5.4 The study area adopted for the identification of NSRs was the 35 dB(A) noise contour as calculated from the Proposed Development.

11.5.5 Where NSRs were located adjacent to each other or readily formed a grouping, a single Noise Assessment Location (NAL) was selected representing the closest of the adjacent receptors to the Proposed Development. NALs were positioned at NSRs, 15 m from a dwelling facade in the direction of the nearest turbine or as far in that direction as the curtilage would allow.

11.5.6 This approach follows the ETSU-R-97 principle of assessing nearest receptors; focussing on the highest impacts allows for a more concise assessment.

11.5.7 The identified NALs are shown on Figure 11.2.

Desk Study

Construction

11.5.8 Sound power details for construction equipment has been assumed from the data provided within BS5228-1.

11.5.9 The methodology for determining the levels of the construction noise involves calculating the total sound pressure level at the nearest sensitive receptor for a construction task, $L_{Aeq(12hr)}$, [equation 1], by summing the total potential sound power level for a given construction phase [equation 2] and subtracting a correction for its distance from the nearest property, K_S [equation 3]. These three equations are shown below:

$$L_{Aeq,T} = L_{WA} - K_S$$
[equation 1]

$$L_{WA} = 10 \cdot log\{10^{\frac{Lactivity1}{10}} + 10^{\frac{Lactivity2}{10}} \dots\}$$
[equation 2]

$$K_S = 25 \cdot \log(R) + 1 \; [for \; R > 25m]$$
[equation 3]

11.5.10 The calculations assume by default that each activity lasts for the full daytime period at 100% intensity.

Operation

Sound Power Levels

11.5.11 The candidate model for the Proposed Development is the Vestas V162 with an output of 7.2 MW and a hub height of 119 m. The turbine rotors would be fitted with Trailing Edge Serration (TES), a technology that reduces noise emissions. These reductions are reflected in the sound power values obtained from the manufacturer's sound power report[1] dated 2020-12-07 as given in Table 11.2.

Table 11.2 - Octave band sound power level for the Vestas V162 7.2MW

Octave Band (Hz)	Standardised V10 wind speed (m/s)								
	4	5	6	7	8	9	10	11	12
	Sound Power Level (L_{WA}) for a hub height of 119m [dB(A)]								
63	78.7	83.1	87.2	88.2	88.5	88.6	88.5	88.5	88.5
125	85.8	90.5	94.8	95.9	96.0	96.2	96.4	96.4	96.4
250	88.7	93.5	98.0	99.0	99.1	99.4	99.7	99.8	99.8
500	89.6	94.1	98.2	99.2	99.4	99.7	100.1	100.2	100.2
1000	88.2	92.5	96.5	97.6	97.7	98.1	98.6	98.7	98.7
2000	83.9	88.1	91.9	93.0	93.2	93.6	94.1	94.2	94.2
4000	76.6	80.6	84.3	85.3	85.6	86.1	86.5	86.6	86.6
8000	66.2	70.0	73.6	74.6	75.0	75.5	75.9	75.9	75.9
Total	**94.9**	**99.4**	**103.6**	**104.6**	**104.8**	**105.1**	**105.4**	**105.5**	**105.5**
Uncertainty	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
IoA Total	**96.9**	**101.4**	**105.6**	**106.6**	**106.8**	**107.1**	**107.4**	**107.5**	**107.5**

11.5.12 Information regarding tonality was not included in the manufacturer's sound power report. The provision of manufacturer warranties regarding tonality may be requested at discharge of planning conditions.

Propagation Model

11.5.13 The International Standard ISO 9613 (2024), 'Acoustics – Attenuation of Sound During Propagation Outdoors - Part 2', sound propagation model has been used for the turbine immission calculations. L_{Aeq} sound propagation was modelled using WindFarm v5.0.1.2 by ReSoft. Predicted turbine immission levels were calculated, inclusive of appropriate allowance for measurement uncertainties.

11.5.14 L_{A90} levels were derived by subtracting 2 dB from the L_{Aeq} values as per the ETSU-R-97 guidance and subsequent IoA Good Practice Guide. The input parameters shown in Table 11.3**.** have been used and are consistent with the IoA Good Practice Guide.

1 Performance Specification V162-7.2MW 50/60Hz. Document no.: 0114-3777 V03

Table 11.3 - Propagation input parameters

Atmospheric Attenuation Assumptions	
Temperature (°C)	10
Humidity (%)	70
Ground Attenuation Assumptions	
Attenuation factor, G (all regions)	0.5 (semi-soft ground)
Receptor height (m)	4.0

11.5.15 The attenuation of sound as it travels through the air varies with frequency. The atmospheric attenuation coefficients used in the assessment, corresponding to the assumptions in Table 11.3, are tabulated in Table 11.4

Table 11.4 - Attenuation coefficients used for the sound propagation model

Octave Band (Hz)	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Attenuation Coefficient (dB/km)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88

11.5.16 Line of sight visibility was checked between the proposed turbines and each receptor's assessment position at 4 m height. Where a turbine is not visible from any particular assessment position (at 4 m height) a -2 dB adjustment to the predicted level from the screened turbine(s) is applicable. Applicable adjustments are discussed in 11.9.5 and detailed in Table 11.16.

11.5.17 Certain topographic characteristics have the potential to reinforce the propagation of sound between two locations. The IoA Good Practice Guide refers to these characteristics as a 'valley' to describe a concave topographic profile. Where these criteria are met, a +3 dB correction should be added to the predicted noise levels. No applicable adjustments have been made in this assessment.

11.5.18 Where turbine sound propagates from opposing directions relative to an NSR, the result will be a reduction in predicted noise, as the receptor will not experience simultaneous downwind conditions from both directions. Example reductions are given in the IoA Good Practice Guide at section 4.4. Any adjustments for directivity are reported.

Site Visit

11.5.19 A background survey was conducted, in consultation with Argyll and Bute Council, between 07 November and 03 December 2024 at the nearest receptors, Stronsaul Cottage and Glenkin Cottage, to gather the prevailing background noise data at these locations.

11.5.20 Wind data was collected at concurrent 10 m intervals using a LiDAR capable of measuring wind speed and direction up to 200 m above ground level. Hub height wind speed data was standardised to 10 m wind speeds and correlated with noise level data using regression analysis with 'best fit' polynomial trends of up to fourth order. Once extraneous or atypical data had been removed, these trend lines then formed the basis of the ETSU-R-97 limits against which immission levels from the Proposed Development were assessed.

11.5.21 **Table 11.5** details the two locations that background sound levels were conducted.

Table 11.5 - Background Noise Measurement Locations

Location	**ID**	**Easting**	**Northing**
Stronsaul Cottages	MP1	213083	679853
Glenkin Cottage	MP2	212917	679899

11.5.22 Full details of the baseline survey and data analysis are provided in Technical Appendix 11.1.

Assessment of Potential Effect Significance

Construction Noise

11.5.23 The assessment of noise impacts from construction activities includes the installation of ancillary infrastructure as well as the turbines themselves.

11.5.24 The factors influencing the impact of plant noise are:

- The number and character of noise sources;
- The duration of activity and hours of work;

- Separation distance between source and receptor; and
- Reduction of noise by absorption or screening

11.5.25 The exact construction schedule is not yet known, however, through the experience of assessing similar scale developments, an estimate of worst-case impacts can be made. These should be treated as indicative.

11.5.26 Although BS 5228-1 does not specify absolute noise limits relating to construction activities, it does provide detailed guidance on the steps that can be taken to minimise potential noise effects.

11.5.27 During the construction phase of the project, it is expected that noise levels in the area will be greater due to the operation and movement of plant. In BS 5228-1, the ABC method outlined in E3[2] sets out the following for classifying the significance of the construction noise:

"*Noise levels generated by construction activities are deemed to be significant if the total noise (pre-construction ambient plus construction noise) exceeds the pre-construction ambient noise by 5 dB or more, subject to lower cut-off values of 65dB, 55dB and 45dB $L_{Aeq,T}$, from construction noise alone, for the daytime, evening and night-time periods, respectively; and a duration of one month or more, unless works of a shorter duration are likely to result in significant impact.*"

11.5.28 Works and operation of plant on this site are expected to be limited to the daytime periods: Monday to Friday (07.00−19.00) and Saturdays (07.00−13.00). As a result, the cut off value for significant construction noise impact is deemed to be 65 dB(A) $L_{Aeq,T}$. It is possible that, due to weather constraints (e.g. the impact of weather on crane operation), the erection of the turbines could occur outside of the working hours defined above. For this or any other activity that extends beyond daytime periods, the lower cut-off limits of 55 dB(A) and 45 dB(A) would apply dependent on time of day.

Operational Noise

11.5.29 The assessment of operational noise impacts arising from the Proposed Development takes the form of an ETSU-R-97 assessment following the IoA Good Practice Guide.

11.5.30 Noise impacts from the operation of the Proposed Development have initially been assessed as a singular project; the potential for cumulative effects has then been considered.

11.5.31 The ETSU-R-97 guidelines recommend that turbine noise should be limited to an absolute lower limit between 35 and 40 dB(A) [$L_{A90,10min}$] for quiet daytime periods and 43 dB(A) for night-time periods (defined in Table 11.6), or 5 dB(A) above the background noise levels, whichever is the greater. In the context of cumulative turbine noise from more than one development, it is suggested that the various wind farms be considered as a single entity in the setting of the amenity lower fixed limit for the cumulative noise impact.[3]

11.5.32 For locations where the resident has a demonstrable financial involvement in the project, a higher fixed limit of 45 dB(A) is applicable, or 5 dB(A) above the background noise levels, whichever is the greater.

Table 11.6 - ETSU-R-97 assessment periods

Assessment Period	Time	Day
Quiet Daytime	18:00 – 23:00	Monday to Friday
	13:00 – 23:00	Saturdays
	07:00 – 23:00	Sundays
Night-time	23:00 – 07:00	Every day

11.5.33 For a project whose immission levels are not expected to exceed 35 dB(A) at the closest NSRs, a simplified approach may be taken that allows the project to be approved with a single fixed 35 dB(A) noise limit, or 45 dB(A) where a resident has financial involvement; applicable at all times and for v_{10} wind speeds up to 10 m/s.

11.5.34 Where noise levels from the Proposed Development exceed 35 dB(A), an ETSU-R-97 noise assessment should be undertaken that references noise limits derived from measured background noise levels. Such ETSU-R-97 limits will also be required where cumulative turbine noise exceeds applicable lower fixed limits.

11.5.35 The Proposed Development has been assessed against ETSU-R-97 noise limits, referring to 35dB(A) quiet daytime and 43dB(A) night-time limits or background +5 dB, whichever is greater. For locations where noise levels from the Proposed Development do not exceed 35 dB(A), a single fixed 35 dB(A) noise limit has been applied.

2 BS 5228-1 'Code of practice for noise and vibration control on construction and open sites', p119

3 The Institue of Acoustics. (2013). A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise, 5.3.1, P24

Requirements for Mitigation

Construction

11.5.36 In the instance that construction noise is determined to have the potential for significant impacts, mitigation will be required. Provisional best practice mitigation for construction noise is discussed further in paragraph 11.7.1.

Operation

11.5.37 Turbine blades selected for the Proposed Development feature TES, a noise reduction technology fitted as standard in this case.

11.5.38 Where operational noise from the proposed turbines exceeds derived ETSU-R-97 noise limits at any given receptor, additional mitigation beyond TES will be required.

Assessment of Residual Effect Significance

Sensitivity

11.5.39 All noise sensitive receptors identified within the operational and construction noise study areas in Figure 11.1 and Figure 11.2, are noted to be residential dwellings and therefore, of high sensitivity.

Construction

11.5.40 BS 5228-1 informative Annex E3[4] provides example criteria which can be used to determine the magnitude of construction site noise impacts. Values presented in BS 5228-1 Table E.1, shown in Table 11.7, represent example noise limit thresholds based on the level of ambient noise level rounded to the nearest 5 dB.

11.5.41 Should the calculated site noise level exceed the appropriate category threshold values outlined in Table 11.7 then a potential for significant effect is indicated.

Table 11.7 - Threshold of Potential Significant Effects

Assessment category and threshold value period	Threshold value (dB) ($L_{Aeq,T}$)		
	Category A	Category B	Category C
Night-Time (23:00-07:00)	45	50	55
Evening and weekends	55	60	65
Daytime (07:00-19:00) and Saturdays (07:00-13:00)	65	70	75

11.5.42 The predicted significance of effect as a result of construction noise was determined through a standard method of assessment which considers both sensitivity of the NSR and exceedance of threshold values.

Operation

11.5.43 Significance of operational wind turbine noise is made with reference to ETSU-R-97 and Scottish Planning Guidance:

- Where operational and cumulative noise levels at receptors are below the derived ETSU-R-97 noise limits, this is determined to be adverse but "not significant".
- Where operational and cumulative noise levels at receptors are above the derived ETSU-R-97 noise limits, this is determined to be adverse and "significant".

Cumulative Assessment

11.5.44 A review of third-party developments within 3km of the Proposed Development was undertaken. At the time of this study, no operational, consented, or in planning third-party turbines were identified within this search area.

11.5.45 It was noted that a recent scoping application for Inverchaolain Wind Farm (ECU00006012) was submitted in January 2025. The project is expected to consist of up to 13 turbines at a maximum tip height of 200 m and rated power output of 6.5 MW. However, the project is in the early stages of design and far from a final layout or candidate machine. Additionally, this project is located 3 km away from the Proposed Development NSRs and would be unlikely to contribute to cumulative levels.

11.5.46 Therefore, a cumulative assessment has been scoped out of this study.

Limitations to Assessment

11.5.47 In the assessment of construction noise impacts, predicted noise levels are based on the assumption of standard machinery and plant which are operated as intended by their manufacturers. Sound power

4 BS 5228-1 'Code of practice for noise and vibration control on construction and open sites', p119

levels for each item have been provided in BS 5228-1 and assume that each operate at the nearest point relative to NSRs. This will tend to lead to an overestimation of impacts.

11.5.48 Operational noise predictions have been made with the manufacturers provided sound power level data. In the absence of warranted uncertainty, an additional 2 dB has been applied to the manufacturers listed sound power values.

11.5.49 It is assumed at this stage that the proposed candidate machine will be used during the operational cycle of the Proposed Development however this is subject to procurement and therefore may differ from the final design when the Proposed Development becomes operational. The proposed candidate machine is the Vestas V162 7.2 MW and has been selected as representative of the upper end of the range of noise emissions for turbines which fit the design criteria of the Proposed Development.

11.6 Baseline Conditions

11.6.1 Technical Appendix 11.1 provides full details of the background noise survey locations and graphical representations of the prevailing noise conditions at each monitoring position outlined in Table 11.5.

11.6.2 A range of windspeeds from 2-15 m/s were captured with the prevailing winds for the area predominantly being north westerlies. Background profiles for quiet-daytime and night-time periods were derived in accordance with ETSU-R-97.

11.6.3 ETSU-R-97 requires the exclusion of data which may be affected by rainfall. A rain gauge was installed at one monitoring location (Glenkin Cottage) to determine periods of rainfall throughout the survey which were later marked for exclusion from the analysis.

11.6.4 Following the removal of extraneous data points, time synchronisation between all data sets was confirmed using correlations and time series plots. Noise levels were plotted against wind speeds between 4-12 m/s on scatter graphs; their relationship was established using polynomial trend lines of third order, selected to provide the optimal fit to the data.

11.6.5 After exclusions, a minimum of ~288 data points were available for analysis for each of the datasets collected, satisfying the minimal requirement of 200 data points as outlined in the IOA GPG.

11.6.6 In accordance with the IOA GPG[5], where a noise curve increases at lower wind speeds, the lowest background noise level has been fixed at the minima shown for low wind speeds.

11.6.7 The resultant quiet-daytime and night-time background noise levels at each monitoring location are provided in Table 11.8 and Table 11.9.

Table 11.8 - Quiet-Daytime Measured Background Noise Level

Location	Standardised V10 wind speed (m/s)								
	4	5	6	7	8	9	10	11	12
Stronsaul Cottages	32.6	32.6	32.6	32.6	32.9	33.6	35.0	37.2	40.3
Glenkin Cottage	28.8	28.8	28.8	28.8	29.1	29.8	31.2	33.6	37.2

Table 11.9 – Night-time Measured Background Noise Level

Location	Standardised V10 wind speed (m/s)								
	4	5	6	7	8	9	10	11	12
Stronsaul Cottages	32.4	32.4	32.4	32.5	33.0	33.8	34.9	36.1	37.5
Glenkin Cottage	28.2	28.2	28.2	28.5	29.3	30.5	32.0	33.7	35.5

11.7 Embedded Mitigation

Construction

11.7.1 To reduce the potential impacts associated with construction noise, the following good practice measures are proposed and where appropriate are to be included in the Construction Environmental Management Plan (CEMP).

- Works and operation of plant on this site are expected to be limited to the daytime periods: Monday to Friday (07.00−19.00) and Saturdays (07.00−13.00). It is possible that, due to weather constraints erection of the turbines could occur outside of the working hours defined above however will only

5 Institute of Acoustics (2014). A Good Practice Guide to The Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise. Supplementary Guidance Note 2: Data Processing & Derivation of ETSU-R-97 Background Curves p. 15.

take place outside these times with the prior approval of Argyll and Bute Council and are not anticipated to give rise to significant noise levels outside the Site Boundary.

- All construction activities shall adhere to good practice as outlined in BS 5228-1.
- All equipment will be maintained and in good working order, operated and supervised by the appropriate parties.
- Construction plant which may result in significant noise levels will be limited in duration to minimise disturbance at surrounding receptors.

Operational

11.7.2 The assessment of operational immission from the Proposed Development assumed that the turbines would operate in their standard mode of operation using rotor blades fitted with trailing edge serration.

11.8 Receptors Brought Forward for Assessment

Construction

11.8.1 The nearest construction noise receptors (CNR) to proposed construction works are shown in Figure 11.1 and detailed in Table 11.10:

Table 11.10 - Nearest noise sensitive receptors to construction activities

Location	ID	Easting	Northing	Distance to nearest activity (m)
Balagowan	CNR1	213237	681649	300
Stronsaul Cottages	CNR2	213076	679848	1025

11.8.2 It was identified that CNR1 (Balagown) would be the nearest receptor to construction activities related to the proposed access tracks. Conversely, CNR2 (Stronsaul Cottages) would remain the nearest receptors to construction activities associated with the proposed turbines and BESS.

Operation

11.8.3 Figure 11.2 shows the identified NALs in relation to the Proposed Development. The blue contours enclose an area predicted to receive an L_{90} turbine noise level in excess of 35 dB(A) from the Proposed Development; given for a v10 wind speed of 11 m/s (maximum sound power for the candidate turbine in normal operating mode).

11.8.4 Table 11.11 lists the names, noise assessment location, GPS coordinates and minimum distance to the proposed turbines for each NSR.

Table 11.11 - Details of Noise Assessment Locations

Location	NSR	Easting	Northing	NAL	Easting	Northing	Distance to site (m)
Chromain Cottage	NSR1	215948	680010	NAL1	215943	679993	1450
Stronsaul Cottages	NSR2	213077	679848	NAL2	213085	679827	1235
Glenkin Cottage	NSR3	212870	679923	NAL3	212906	679925	1425

Assigned Noise Limits

11.8.5 Overall noise limits for each receptor have been derived from the background noise for quiet-daytime and night-time periods, outlined in Table 11.8 and Table 11.9 respectively, in accordance with ETSU-R-97 and the IOA Good Practice Guide. NAL1 (Chromain Cottage) which is predicted to receive noise emissions of less than 35dB(A) from the Proposed Development, has been assigned a lower fixed limit of 35 dB(A) for all periods.

11.8.6 Table 11.12 and Table 11.13 detail the overall ETSU-R-97 noise limits for all noise assessment locations.

Table 11.12 - Quiet-Daytime ETSU-R-97 limits

NAL	Location	Standardised V10 wind speed (m/s)								
		4	5	6	7	8	9	10	11	12
NAL1	Chromain Cottage	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
NAL2	Stronsaul Cottages	37.6	37.6	37.6	37.6	37.9	38.6	40.0	42.2	45.3

NAL	Location	Standardised V10 wind speed (m/s)								
		4	5	6	7	8	9	10	11	12
NAL3	Glenkin Cottage	35.0	35.0	35.0	35.0	35.0	35.0	36.2	38.6	42.2

Table 11.13 - Night-time ETSU-R-97 limits

NAL	Location	Standardised V10 wind speed (m/s)								
		4	5	6	7	8	9	10	11	12
NAL1	Chromain Cottage	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
NAL2	Stronsaul Cottages	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL3	Glenkin Cottage	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0

11.9 Potential Effects

Construction

11.9.1 An estimate of typical activities required for each construction objective has been made based on experience at similar developments. The construction assessment assumes all plant runs at full capacity at all times. It assumes all activities take place concurrently and occur at their minimum distance to each receptor.

11.9.2 The assessment of relevant Proposed Development construction activities and resulting sound levels for Balagowan and Stronsaul Cottages, are detailed in Table 11.14 and Table 11.15.

Table 11.14 - Construction Noise Impact Assessment for CNR1 – Balagowan

Task	Plant/Equipment	Sound Power Level (dB(A))	BS 5228-1:2009 Ref	Total SPL for task (dB(A))	To nearest 5dB(A)	Distance to NSR	Equivalent noise level at NSR [$L_{Aeq,T}$ (dB(A))]
Construct access tracks	Dozers	116	Table D.3-67	118	120	300	57
	Tipper	113	Table D.3-112				
	Vibrating rollers	106	Table D.3-116				
	Excavator	105	Table D.3-97				
	Dumper	102	Table D.3-110				
	Road Lorry (39T)	111	Table C.6-22				
Construct crane hardstanding	Excavator	105	Table D.3-97	115	115	2310	30
	Concrete mixer	108	Table D.5-11				
	Batching plant	112	Table D.5-12				
	Dumper	102	Table D.3-110				
	Roller	106	Table D.3-116				
	Road Lorry (39T)	111	Table C.6-22				
Construct turbine foundations	Excavator	105	Table D.3-97	118	120	2310	30
	Tipper	113	Table D.3-112				
	Concrete mixer	108	Table D.5-11				
	Batching plant	112	Table D.5-12				
	Compressor	100	Table D.6-19				
	Water pumps	109	Table D.7-71				

Task	Plant/Equipment	Sound Power Level (dB(A))	BS 5228-1:2009 Ref	Total SPL for task (dB(A))	To nearest 5dB(A)	Distance to NSR	Equivalent noise level at NSR [$L_{Aeq,T}$ (dB(A))]
	Vibratory pokers	102	Table D.6-20				
	Road Lorry (39T)	111	Table C.6-22				
Excavate and lay site cable (Turbines)	Excavator	105	Table D.3-97	107	105	2310	30
	Dumper	102	Table D.3-110				
Erect turbines	Cranes	113	Table D.7-117	114	115	2310	25
	Generators	108	Table D.7-60				
Reinstatement/clearance works	Dozer	109	Table D.3-62	114	115	2310	30
	Dump Truck	110	Table D.3-60				
	Tracked loader	105	Table D.3-59				
	Dumper	102	Table D.3-110				
Battery and substation foundations	Excavator	105	Table D.3-97	115	115	2270	28
	Concrete mixer	108	Table D.5-11				
	Batching plant	112	Table D.5-12				
	Dumper	102	Table D.3-110				
	Roller	106	Table D.3-116				
Battery and substation installation	Tracked crane	102	Table D.7-112	113	115	2770	28
	Compressor	100	Table D.7-126				
	Lorry (Unloading)	112	Table D.7-122				
Excavate and lay site cable (BESS)	Excavator	105	Table D.3-97	107	105	2770	18
	Dumper	102	Table D.3-110				
All activities						**Total**	**57**

Table 11.15 - Construction Noise Impact Assessment for CRN2 – Stronsaul Cottages

Task	Plant/Equipment	Sound Power Level (dB(A))	BS 5228-1:2009 Ref	Total SPL for task (dB(A))	To nearest 5dB(A)	Distance to NSR	Equivalent noise level at NSR [$L_{Aeq,T}$ (dB(A))]
Construct access tracks	Dozers	116	Table D.3-67	118	120	1025	44
	Tipper	113	Table D.3-112				
	Vibrating rollers	106	Table D.3-116				
	Excavator	105	Table D.3-97				
	Dumper	102	Table D.3-110				
	Road Lorry (39T)	111	Table C.6-22				
Construct crane hardstanding	Excavator	105	Table D.3-97	115	115	1105	38
	Concrete mixer	108	Table D.5-11				
	Batching plant	112	Table D.5-12				
	Dumper	102	Table D.3-110				
	Roller	106	Table D.3-116				

Task	Plant/Equipment	Sound Power Level (dB(A))	BS 5228-1:2009 Ref	Total SPL for task (dB(A))	To nearest 5dB(A)	Distance to NSR	Equivalent noise level at NSR [$L_{Aeq,T}$ (dB(A))]
	Road Lorry (39T)	111	Table C.6-22				
Construct turbine foundations	Excavator	105	Table D.3-97	118	120	1105	38
	Tipper	113	Table D.3-112				
	Concrete mixer	108	Table D.5-11				
	Batching plant	112	Table D.5-12				
	Compressor	100	Table D.6-19				
	Water pumps	109	Table D.7-71				
	Vibratory pokers	102	Table D.6-20				
	Road Lorry (39T)	111	Table C.6-22				
Excavate and lay site cable	Excavator	105	Table D.3-97	107	105	1105	28
	Dumper	102	Table D.3-110				
Erect turbines	Cranes	113	Table D.7-117	114	115	1105	33
	Generators	108	Table D.7-60				
Reinstatement/clearance works	Dozer	109	Table D.3-62	114	115	1105	38
	Dump Truck	110	Table D.3-60				
	Tracked loader	105	Table D.3-59				
	Dumper	102	Table D.3-110				
Battery and substation foundations	Excavator	105	Table D.3-97	115	115	1605	34
	Concrete mixer	108	Table D.5-11				
	Batching plant	112	Table D.5-12				
	Dumper	102	Table D.3-110				
	Roller	106	Table D.3-116				
Battery and substation installation	Tracked crane	102	Table D.7-112	113	115	1605	34
	Compressor	100	Table D.7-126				
	Lorry (Unloading)	112	Table D.7-122				
Excavate and lay site cable (BESS)	Excavator	105	Table D.3-97	107	105	1605	34
	Dumper	102	Table D.3-110				
All activities						**Total**	**47**

11.9.3 At both receptors, the calculated noise levels meet the 65 dB(A) daytime noise limit. Turbine erection activities, should they need to happen during the evening, have been shown to meet the lower 55 dB(A) evening and weekend limit at both receptors.

11.9.4 These assumptions make for a very conservative assessment of the worst-case scenario. In practice construction activities would take place sequentially and plant would not be running at full intensity for the duration of the work to be carried out. Calculations are also based on the minimum distance to Site and some activities would take place with further separation from receptors. To minimise impact of construction noise, activities would be limited to daytime hours where possible. Overall, noise impacts as a result of construction activities have therefore been determined to result in a **minor** impact.

Operation

11.9.5 Topographic screening was identified between receptor locations and the Proposed Development. Concave topography profiles were not identified between the Proposed Development and NALs, as

such no valley correction has been applied. No adjustments for directivity have been included as the assessment assumes simultaneous downwind propagation. All topographic adjustments are shown in Table 11.16.

Table 11.16 - Applicable adjustments for screening

NAL	Location	Screening Adjustment (LA90)						
		T1	T2	T3	T4	T5	T6	T7
NAL1	Chromain Cottage	-2	-2	0	0	0	0	0
NAL2	Stronsaul Cottages	0	0	0	0	0	0	0
NAL3	Glenkin Cottage	0	0	0	0	-2	0	0

11.9.6 The following predicted LA90 immission levels were calculated using the octave band sound power levels detailed in Table 11.2 that are inclusive of an additional +2dB uncertainty and adjustments for topographic screening.

Table 11.17 - Proposed Development predicted immission levels

NAL	Location	Standardised V10 wind speed (m/s)								
		4	5	6	7	8	9	10	11	12
NAL1	Chromain Cottage	24.1	28.7	33.0	34.0	34.1	34.4	34.7	34.8	34.8
NAL2	Stronsaul Cottages	25.6	30.2	34.4	35.5	35.6	35.9	36.2	36.3	36.3
NAL3	Glenkin Cottage	24.6	29.2	33.5	34.5	34.7	34.9	35.2	35.3	35.3

11.9.7 Table 11.18 and Table 11.19 detail the exceedance of the Proposed Development immission levels relative to the derived ETSU-R-97 noise limits given in Table 11.18 and Table 11.19 for daytime and night-time periods.

Table 11.18 - Margin of Proposed Development levels below daytime ETSU-R-97 limits

NAL	Location	Standardised V10 wind speed (m/s)								
		4	5	6	7	8	9	10	11	12
NAL 1	Chromain Cottage	-10.9	-6.3	-2.0	-1.0	-0.9	-0.6	-0.3	-0.2	-0.2
NAL 2	Stronsaul Cottages	-12.0	-7.4	-3.2	-2.1	-2.3	-2.7	-3.8	-5.9	-9.0
NAL 3	Glenkin Cottage	-10.4	-5.8	-1.5	-0.5	-0.3	-0.1	-1.0	-3.3	-6.9

Table 11.19 - Margin of Proposed Development levels below night-time ETSU-R-97 limits

NAL	Location	Standardised V10 wind speed (m/s)								
		4	5	6	7	8	9	10	11	12
NAL 1	Chromain Cottage	-10.9	-6.3	-2.0	-1.0	-0.9	-0.6	-0.3	-0.2	-0.2
NAL 2	Stronsaul Cottages	-17.4	-12.8	-8.6	-7.5	-7.4	-7.1	-6.8	-6.7	-6.7
NAL 3	Glenkin Cottage	-18.4	-13.8	-9.5	-8.5	-8.3	-8.1	-7.8	-7.7	-7.7

11.9.8 Results in Table 11.17 show that the Proposed Development is predicted to produce a maximum level of 36.3 dB(A) at a wind speed of 11 m/s, at NAL2 (Stronsaul Cottages), the nearest sensitive receptor.

11.9.9 All noise assessment locations are expected to meet the derived ETSU-R-97 noise limits during all periods by a minimum margin of 0.1 dB at a wind speed of 9 m/s at NAL3 (Glenkin Cottage).

11.9.10 Results of the operational noise assessment demonstrate that the Proposed Development would comply with the derived ETSU-R-97 noise limits, therefore operational noise impact is considered to be acceptable and **not significant**.

11.10 Additional Mitigation

Construction

11.10.1 An assessment of construction noise from the Proposed Development, assuming all plant items run simultaneously, has been shown to meet the lower daytime BS 5228-1 noise limit of 65 dB(A) at both nearest receptors relative to construction activities. Additionally, should turbine erection works require to be conducted in the evening, both receptors would meet the lower night-time limit of 55 dB(A).

11.10.2 It is not anticipated that works will be required during evening hours but are expected to be limited to the daytime periods: Monday to Friday (07.00−19.00) and Saturdays (07.00−13.00). Given the

unlikelihood of evening construction works and inherent conservatism in the assessment, no mitigation is expected to be required beyond best practice, as detailed in BS 5228-1[6].

Operational

11.10.3 The assessment of operational immission from the Proposed Development assumed that the turbines would operate in their standard mode of operation using rotor blades fitted with trailing edge serration. The results demonstrated that immission from the proposed turbines would be able to meet derived ETSU-R-97 noise limits outlined in Table 11.12 and Table 11.13 for all assessment locations. Therefore, the operational noise assessment demonstrates that no additional mitigation is required.

11.11 Residual Effects

Construction

11.11.1 Noise as a result of construction activities related to the Proposed Development has been determined to be minor and would not warrant the requirement for additional mitigation beyond the recommended best practices. As such, the residual effect remains **not significant**.

Operation

11.11.2 Results from the operational noise assessment concluded that the Proposed Development would meet the derived ETSU-R-97 noise limits at all assessment locations, assuming all turbines would operate in their standard mode of operation, with trailing edge serration. As a result, the residual effect remains **not significant**.

11.12 Summary

11.12.1 Using the preceding baseline data, a noise modelling exercise was undertaken to assess potential impacts from the Proposed Development.

11.12.2 Calculated results for activities associated with the construction phase of the project would meet the lower daytime 65 dB(A) BS 5228-1 noise limit at the nearest receptors.

11.12.3 A maximum operational predicted level of 36.3 dB(A) was shown at the nearest receptor, NAL2 (Stronsaul Cottages). Predicted immissions from the proposed turbines were found to comply with the derived quiet daytime and night-time ETSU-R-97 noise limits at all assessment locations.

11.12.4 A review of third-party developments in the area identified no cumulative turbines which would merit inclusion in a cumulative noise impact assessment therefore no cumulative impacts were identified.

11.12.5 It is therefore concluded both construction and operational noise impacts would **not be significant** at the nearest surrounding receptors

11.13 References

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