HydroGlen

Supporting Environmental Information Report

Appendix H: Noise Impact Assessment

HydroGlen

Noise Impact Assessment

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Contents

1. Introduction

1.1 Background

The James Hutton Institute ('JHI') proposes to develop a hydrogen electrolyser and battery energy storage system ('BESS'), powered by a wind turbine and solar arrays, 'the Proposed Development' at their site at Glensaugh, Aberdeenshire.

The outline layout of the Proposed Development is provided in Drawing 1.

The various components of the Proposed Development will generate noise, and ITPEnergised has been commissioned to undertake a noise assessment in support of the planning application.

1.2 Structure of this Report

This assessment comprises the noise assessments of the two aspects of the Proposed Development; the proposed wind turbine generator (WTG), and all other aspects of the Proposed Development. While the same planning guidance documents are relevant to both aspects, the assessment methods are different, therefore this report considers these two types of development separately.

1.3 About the Author

This assessment has been undertaken by Simon Waddell BSc. (Hons.) MIOA. Simon has over 11 years' experience in environmental noise. He is a corporate member of the Institute of Acoustics (IoA) and has completed the IoA Diploma in Acoustics and Noise Control. He has substantial experience in evaluation of wind turbine and industrial noise.

Technical review has been provided by Gregor Massie BEng (hons) MSc, AMIOA. Gregor is a Senior Consultant at ITPEnergised and has over five years' experience in acoustics. Gregor holds the Institute of Acoustics (IOA) Certificate of Competence in Environmental Noise Measurement and IOA Diploma in Acoustics and Noise Control.

1.4 Scope of Assessment

The scope of this assessment has comprised the following:

- Review of project information;
- Consultation with Aberdeenshire Council Environmental Health Department;
- Prediction and evaluation of wind turbine noise;
- Prediction and evaluation of solar, BESS and electrolyser noise; and
- Specification of appropriate mitigation, where required.

2. Consultation with Aberdeenshire Council

ITPEnergised sent a consultation request to Aberdeenshire Council Environmental Health Department on 24th October 2023, with a follow up on 2nd November 2023, seeking to agree the scope of work and approach to the assessment. No response had been received at the time of writing, however, this assessment assumes that the lack of response indicates agreement with our proposal. We note that the proposed approach meets the requirements of the relevant guidance. Records of our consultation requests are provided in Appendix 1.

3. Wind Turbine Noise Assessment

3.1 WTG Relevant Guidance and Advice

Relevant legislation and guidance documents have been reviewed and taken into account as part of this assessment. Legislation of particular relevance is outlined below.

In lieu of any specific legislation, assessing the effect of such a development during the construction, operational and decommissioning phases must draw on information from a variety of sources. This assessment therefore makes reference to a number of British Standards, official planning policy and advice notes and national guidance. The following guidance and advice is relevant to the evaluation of WTG noise in Scotland.

3.1.1 Scottish Government Online Planning Advice: Planning Advice Note 1/2011 and Technical Advice Note

Published in March 2011 and last updated in 2014, Planning Advice Note 1/2011 (Scottish Government (2014b)) (PAN 1/2011) provides advice on the role of the planning system in helping to prevent and limit adverse effects of noise. Information and advice on noise assessment methods are provided in the accompanying Technical Advice Note: Assessment of Noise (Scottish Government (2011b)) (TAN). Included within the PAN document and the accompanying TAN are details of the legislation, technical standards, and codes of practice for specific noise issues.

Regarding noise from wind turbines, paragraph 29 of PAN 1/2011 states the following:

"There are two sources of noise from wind turbines – the mechanical noise from the turbines and the aerodynamic noise from the blades. Mechanical noise is related to engineering design. Aerodynamic noise varies with rotor design and wind speed and is generally greatest at low speeds. Good acoustical design and siting of turbines is essential to minimise the potential to generate noise. Web based planning advice on renewable technologies for onshore wind turbines provides advice on 'The Assessment and Rating of Noise from Wind Farms' (ETSU-R-97) published by the former Department of Trade and Industry (DTI) and the findings of the Salford University report into Aerodynamic Modulation of Wind Turbine Noise."

Regarding appropriate assessment methods, the 'web-based planning advice' referred to in PAN 1/2011 is contained in an online document titled 'Onshore Wind Turbines', published by the Scottish Government (updated 2014). The document is summarised in the corresponding section below, and also refers to the use of ETSU-R-97 *The Assessment and Rating of Noise from Wind Farms* (The Working Group on Noise from Wind Turbines, 1996) assessment guidance.

The Institute of Acoustics (IoA) has since published '*A Good Practice Guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise*' (IoA, 2013). The Scottish Government accepts that the guide represents current industry good practice.

Neither PAN 1/2011 nor the associated TAN provide specific guidance on the assessment of noise from fixed plant, but the TAN includes an example assessment scenario for '*New noisy development (incl. commercial and recreation) affecting a noise sensitive building*', which is based on BS4142:1997: *'Method for rating industrial noise affecting mixed residential and industrial areas*'. This British Standard has been superseded by BS4142:2014+A1:2019 '*Methods for rating and assessing industrial and commercial sound'* (BSi, 2019).

In summary, national planning policy on the assessment of operational noise impacts from wind farms stipulates the use of the ETSU-R-97 assessment method and application of the IoA Good Practice Guide ('IoA GPG'). These guidance documents, and others relevant to the assessment of possible noise impacts generated by the Proposed Development, are summarised below.

3.1.2 Onshore Wind – Policy Statement Refresh 2021: Consultative Draft

The Scottish Government has provided a consultative draft ('the draft') seeking views on how to tackle barriers to deployment of wind turbines and securing the maximum economic benefit from developments.

Regarding noise the draft notes that noise is a potential environmental barrier to deployment and identifies that ETSU-R-97 may be outdated and is under review. The draft further identifies that public concern about wind turbine noise is increasing despite a lack of empirical evidence for any adverse health impacts.

3.1.3 Regional and Local Planning Policy

Aberdeenshire Council provides supplementary planning guidance 'Assessing Wind Energy Developments – Planning advice PA2023-21' ('PA2023-21') in relation to onshore wind development. PA2023-21 reflects changes following Scottish National Planning Framework 4 ('NPF4').

PA2023-21 notes in regard to noise that a noise impact assessment will require a noise assessment and refers to Aberdeenshire planning guidance SGN1: Assessing Noise from Wind Turbines. PA2023-21 further notes that where cumulative noise is evaluated, the assessment should consider the conditioned noise limit of existing wind turbines.

3.1.4 ETSU-R-97: The Assessment and Rating of Noise from Windfarms (ETSU-R-97)

As referenced for use in PAN/2011 and the online planning advice for renewable technologies: Onshore wind turbines, this document was written by a Noise Working Group including developers, noise consultants and environmental health officers, set up in 1995 by the Department of Trade and Industry through ETSU (the Energy Technology Support Unit).

ETSU-R-97 presents a consensus view of the working group and was prepared to present a common approach to the assessment of noise from wind turbines. The document states that noise from wind turbines or wind farms should be assessed against site specific noise limits.

Noise limits are derived based on a series of acceptable lower limits and based on an allowable exceedance above the prevailing background noise level, including consideration of a variety of different prevailing wind speed conditions. The noise limits should be derived for external areas used for relaxation, or areas where a quiet noise environment is highly desirable. Separate limits are required for night-time and daytime periods. Night-time limits are derived drawing upon measured night-time background noise levels, whilst daytime limits are derived drawing upon the background noise levels arising during 'quiet daytime' periods.

Night-time is defined as the period between 23:00 and 07:00 hours, whilst quiet daytime periods are defined as:

- 18:00 to 23:00 hours on all days;
- 13:00 to 18:00 hours on Saturdays and Sundays; and
- 07:00 to 13:00 hours on Sundays.

For daytime, the suggested limits are 5 decibel (dB) above the prevailing background noise level determined during quiet daytime periods, or 35 to 40 dB(A), whichever is the higher. The absolute criterion between the 35 to 40 dB(A) range is selected taking account of:

- the site environs (e.g. number of local receptors);
- the energy generation capacity (e.g. number of kWh that can be generated) of the proposed development; and
- the associated duration and level of exposure.

During night-time, the suggested limits are 5 dB above the prevailing night time background noise level or 43 dB(A), whichever is the higher. The absolute criterion for the night-time is higher than that for the daytime, as the derivation of this limit is based on preventing sleep disturbance within a building whereas for the daytime, limits are based on occupation of external spaces used for relaxation.

It is required that the prevailing background noise levels be determined in terms of the $L_{A90,10min}$ noise index for both quiet daytime and night-time periods, for wind conditions ranging from 2 ms^{-1} to 12 ms^{-1}.

The noise limits are calculated by undertaking a regression analysis of the $L_{A90,10min}$ noise levels and the prevailing average wind speed for the same 10-minute period, when measured or determined at 10 m above

ground at the location of the proposed turbines. The allowable limit is then defined at +5 dB above the average noise level at each wind speed (as defined by the regression analysis), or the absolute noise level lower limit, whichever is the higher (assuming no financial involvement within the scheme).

ETSU-R-97 also provides a simplified fixed noise limit of 35 $dBL_{A90,10min}$ at all wind speeds, which may be applied to avoid the need to measure background noise levels. The 'simplified ETSU limit' typically applies both during the daytime and night time period.

The ETSU guidance states that the derived limits should be applied to noise from the proposed wind farm or turbines in terms of the $L_{A90,T}$ index, and that the $L_{A90,T}$ of wind farm noise is typically 1.5 dB to 2.5 dB lower than the $L_{Aeq,T}$ measured over the same period.

The derived noise limits are applicable to both the aerodynamic (e.g. 'blade swish') and mechanical (e.g. generator related) components of wind farm noise.

Where noise from the wind farm is tonal, a correction of between 2 dB and 5 dB is to be applied to the wind farm noise. Guidance is provided on how to determine the level of correction required, but typically, for proposed developments, the need for any applicable correction is confirmed by the independent wind turbine-specific noise tests, following standard test procedures, provided by manufacturers.

It is stated within the ETSU-R-97 guidance that "*The Noise Working Group is of the opinion that absolute noise limits and margins above background should relate to the cumulative effect of all wind turbines in the area which contribute to the noise received at the properties in question. It is clearly unreasonable to suggest that, because a wind farm was constructed in the vicinity in the past which resulted in increased noise levels at some properties, that residents of those properties are now able to tolerate still higher noise levels. The existing wind farm should not be considered as part of the prevailing background noise*". Accordingly, where an existing wind farm contributes to the prevailing background noise levels, it is necessary to either include for the contribution of this wind farm when comparing against the allowable noise limit or correct for this contribution when deriving a limit applicable to the proposed development acting alone.

3.1.5 Good Practice Guide to the Application of ETSU-R-97 (IoA GPG)

The IoA GPG presents the report of a 'noise working group' (NWG) assembled in response to a request from the former Department of Energy & Climate Change (DECC). The guide is intended to represent current good practice in applying the ETSU-R-97 method to assessing the noise impact of wind turbine developments with a power rating of over 50 kW.

In addition to detailed consideration of various issues and factors concerned with current 'state of the art' knowledge of UK wind turbine noise assessment, a series of 'summary boxes' (SBs) highlighting key guidance points are included.

The SBs provide clarification and updated guidance on a range of matters relating to ETSU-R-97 noise assessments, including consultation with relevant stakeholders, background noise survey methodology, noise survey data analysis, derivation of noise limits, noise prediction model input data, algorithms and parameters, cumulative impact assessment procedures, assessment reporting, planning conditions and amplitude modulation. A set of supplementary guidance notes (SGNs) also form part of the publication and include further specific detail for different technical areas.

The detail of the IoA GPG has been considered in the preparation of this assessment. Some of the key considerations relevant to this assessment are summarised as follows:

- Due to the potential for non-standard site-specific wind shear (i.e. differences in wind speed at different heights above the ground – a 'standard' profile increases logarithmically with height) background noise levels should be correlated with 10 m height wind speeds derived using a method that 'standardises' the wind speeds using the assumed shear profile. Since wind turbine sound power levels are determined using the same shear profile, this procedure ensures a link between the predicted sound levels at a given hub height wind speed and the background noise levels at receptors near the ground under the same wind speed conditions (obtained using the 'standardised' 10 m height wind speed).

- Calculations of predicted wind turbine noise may be carried out using ISO 9613 2: Acoustics – Attenuation of Sound during Propagation Outdoors (International Organization for Standardization, 1996); preferred receptor heights, meteorological and ground absorption input parameters for this calculation procedure are given.
- Turbine sound power level source data should include appropriate uncertainty corrections. Guidance is given for determining when such uncertainty corrections have been inherently included in turbine source emission data.
- A correction for topographic screening of a maximum -2 dB may be applied where there is no line of sight between the turbine (tip) and the receptor (4 m above ground level).
- A correction for constructive reflection within valleys of +3 dB should apply where concave topography is determined to lie between the turbine and the receptor point.
- 'Excess amplitude modulation' (i.e. where the wind turbine noise has higher variability with momentary time than the 2 – 3 dB(A) considered within ETSU-R-97) is still the subject of research; current practice (at the time of publishing of the IoA GPG) in relation to determining applications for wind turbine developments is to not impose a planning condition specific to this phenomenon.

In addition to the above, the IoA GPG confirms that the ETSU-R-97 noise level limits should be applied cumulatively and provides guidance on appropriate assessment methods for a variety of different cumulative scenarios. These scenarios include 'concurrent applications', 'existing wind farm consented with less than total ETSU-R-97 limits', 'existing wind farm/s consented to the total ETSU-R-97 limits currently operating', and 'permitted wind farms consented to total ETSU-R-97 limits but not yet constructed'.

In the section titled 'existing wind farm/s, consented to the total ETSU-R-97 limits, currently operating' it is stated that *"In the first instance, the consented noise limits should be used within the cumulative noise impact calculations unless otherwise agreed with the local authority. Provided the sum of the noise limits derived for the proposed site when added to those already consented for the operational sites does not exceed the limits that would otherwise be within the requirements of ETSU R-97 for the cumulative impact, then the noise limits derived for the proposed site can be applied directly*".

In practical terms this can be achieved by ensuring that the noise limit for the Proposed Development is set 10 dB or more below that permitted to be generated by the existing development.

It is, however, then discussed that this may not always be necessary, e.g. where there is a 'controlling property', whereby compliance with the noise limit at that controlling property would result in noise levels never realising the noise level limit 'in full' at another property (e.g. because the second property is further removed from the existing development), thereby leaving a proportion of the limits available for use at the second property by the subsequently proposed development. Another reason that is discussed is where there is no realistic prospect of the existing wind farm producing noise levels up to the consented limit, again thereby leaving a proportion of the limit available for the subsequently proposed development.

The process provided in the IoA GPG for determining appropriate noise limits applicable at specific properties is summarised as follows:

- Identify cumulative developments, i.e. those from which the predicted level at properties within the study area are within 10 dB of the Proposed Development. Developments from which the predicted levels are 10 dB or greater different to that of the Proposed Development may be scoped out of further analysis;.
- Determine the consented noise limits for other developments applicable at properties where cumulative effects may occur;
- Predict noise levels from cumulative developments and identify controlling properties (typically those closest to the specific wind farm/turbine without financial involvement (FI); assuming compliance with noise limits at these properties will limit the maximum noise level possible at more distant properties); and

- Confirm that the predicted levels from cumulative developments do not exceed noise limits at controlling properties.

3.2 WTG Method

3.2.1 Overall Approach, Study Area and Noise Sensitive Receptors

Determination of the study area for a wind farm or single WTG typically requires that the 35 dBL_{A90} noise contour is predicted, and noise sensitive receptors (NSRs) which lie beyond the contour are assumed to meet the most stringent ETSU-R-97 noise limit and are therefore scoped out and discounted from further consideration. NSRs which are identified within the 35 dBL_{A90} noise contour are scoped in, and noise impacts are assessed further.

The location of the proposed WTG and the 35 dBL_{A90} operational noise contour for the WTG in isolation (i.e. excluding cumulative developments) at the wind speed at which the proposed WTG generates its maximum sound power level, is shown in Drawing 2. An additional 35 dBL_{A90} contour including a +3 dB correction for concave topography is also shown (refer to 3.1.5).

The study area for the WTG assessment comprises the area within predicted 35 dBL_{A90} noise contour.

The adopted study area is shown in Drawing 2. There are no residential properties or other NSRs within the 35 dBL_{A90} contour, therefore no NSRs have been specifically considered in this assessment, as the turbine meets the simplified ETSU-R-97 criterion (refer to 3.1.4).

The closest NSRs to the proposed WTG have been identified, however, and are listed in Table 3.1 and shown in Drawing 2.

Table 3.1 Nearby NSRs

NSR Name	NSR ID	Coordinates (OS GB)		Commentary
		X	Y	
Bows	NSR1	367197	778627	Property controlled by JHI, closest NSR to proposed WTG however currently long-term unoccupied and JHI has no plans to bring it back into use.
Unknown	NSR2	367040	778353	Closest NSR not controlled by JHI
Unknown	NSR3	366830	778373	Closest NSR not controlled by JHI

On the basis of the 35 dBL_{A90} noise contour, this assessment considers fixed criteria and a baseline noise survey and the derivation of noise limits relative to the prevailing background noise level for the range of operational wind speeds has been scoped out.

We note that the noise limit which applies to financially involved properties is typically 45 dBL_{A90}, and this limit may therefore apply at NSR1. In a robust approach, this assessment assumes that the 35 dBL_{A90} limit will apply.

3.2.2 Potentially Cumulative Developments

JHI currently operates a single WTG to the south of the proposed WTG. The location and 35 dBL_{A90} contour for the existing turbine are shown in Drawing 2. Details of the turbine are as follows:

- Hub height – 29 m;
- Turbine model – 50 kW WTG with 15 m rotor diameter;
- Maximum sound power level – unknown.

No other potentially cumulative developments have been identified.

The WTG's planning consent from 2009 provides a condition for noise specifies a noise limit of 45 $dBL_{Aeq,5min}$ at the nearest house.

3.2.3 Prediction of WTG noise

A noise model has been constructed comprising the proposed WTG and surrounding area, including the adopted NSRs. The model was prepared using the CadnaA® noise modelling which uses the ISO 9613 prediction method and includes prescribed methods for accounting for the effects of geometric divergence, ground absorption, and atmospheric absorption, in accordance with the requirements of ETSU-R-97 and the IoA GPG.

Whilst the IoA GPG presents methodologies for the determination of additional corrections to account for propagation directivity, which could be used for example to account for the effects of wind direction where a receptor is located between two developments, such corrections have not been included within this assessment. The predicted operational noise levels can therefore be considered worst-case in this regard.

- The noise model was configured to ensure noise level predictions in compliance with the IoA GPG, including the following:
- Ground absorption: G=0.5;
- Receptor Height: 4 m;
- A correction from $L_{Aeq,T}$ to $L_{A90,T}$ of -2 dB was applied;
- Temperature: 10°C; and
- Humidity: 70%.

The requirement to apply valley corrections and topographic screening corrections was determined with reference to the IoA GPG. Valley corrections have been determined on a turbine-by-turbine basis for all identified NSRs using proprietary software within Geographic Information System (GIS) software. Where topographic screening is determined to be applicable, no valley correction is applied, since it is assumed that if the turbine is fully screened at the NSRs, then any concavity determined to lie between the turbine and the NSR will not result in constructive acoustic reflections.

This assessment has determined that a correction for concavity will apply at NSR1, however no corrections apply at other NSRs.

The noise assessment is based on a Vestas V52 850kW candidate turbine. The source noise terms of the V52 have been obtained by ITPEnergised as octave band data for 9 ms^{-1} wind speed and A-weighted broad-band sound power levels over the operational range of hub-height wind speeds, standardised to 10 m. This may not be the final turbine chosen for the Proposed Development, but the Applicant will ensure any change in turbine meets the adopted noise criterion (limit).

The operational sound power level of the candidate turbine is provided in Table 3.2. An appropriate uncertainty correction of +2 dB has been added, in accordance with the IoA GPG.

Table 3.2 Sound power levels for Vestas V52 standardised 10 m height wind speed

Wind speed, ms^{-1}	4	5	6	7	8	9+
Reported sound power level, dB(A)	93.0	96.0	100.0	103.8	104.2	104.5
Applied sound power level, dB(A)	95.0	98.0	102.0	105.8	106.2	106.5

The WTG has been assumed to operate at a constant sound power level at wind speeds greater than 9 ms^{-1}.

Octave band data for operation at the maximum sound power levels is provided in Table 3.3. This spectrum has been applied at every wind speed, normalised to the A-weighted broad-band levels provided in Table 3.2.

Table 3.3 Reported octave band values for Vestas V52 at 9 ms^{-1} standardised wind speed

Octave band centre frequency, Hz	63	125	250	500	1,000	1,000	4,000	8,000	Total, dB(A)
Sound power level, dB(A)	48.7	91.1	96.8	98.9	98.8	97.1	91.6	77.9	104.5

3.3 WTG Results

As shown in Drawing 2, the predicted level for the WTG, meets 35 dBL_{A90} at all NSRs at its maximum sound power level. The predicted operational levels for the WTG at the closest NSRs are provided in Table 3.4.

Table 3.4 Predicted operational noise levels - WTG

NSR ID	Standardised 10 m wind speed, ms^{-1}					
	4	5	6	7	8	9+
	Predicted level, $dBL_{A90,10min}$					
NSR1* (unoccupied)	19.0	22.0	26.0	29.8	30.2	30.5
NSR2	13.6	16.6	20.6	24.4	24.8	25.1
NSR3	13.2	16.2	20.2	24.0	24.4	24.7

*predicted level includes concave topography correction.

The predicted noise levels meet the 35 $dBL_{A90,10min}$ criterion at all NSRs. At NSR2 and NSR3 the predicted level meets the criterion by a margin of approximately 10 dB or greater.

3.4 WTG Findings and Recommendations

The predicted operational noise level due to the proposed WTG at the closest identified NSRs meets the adopted 35 $dBL_{A90,10min}$ criterion.

At NSR2 and NSR3 predicted levels are more than 10 dB below the consented noise limit for the existing WTG; assuming a 2 dB correction from dBL_{Aeq} to dBL_{A90} the predicted levels (existing WTG consented to a dBL_{Aeq} limit). On this basis, in accordance with the IoA GPG, no cumulative effects will occur.

At NSR1, which is long-term unoccupied and is controlled by JHI, the predicted level is approximately 14 dB below the 45 dBL_{A90} consented limit for the existing WTG. This assessment considers that it is unlikely that the existing WTG will operate at its consented limit, however, there is insufficient information available to demonstrate this.

We note that NSR1 lies between the existing WTG and the proposed WTG, such that it cannot lie downwind of both simultaneously, giving likely reductions in the actual noise level due to WTG noise directivity effects. As such, no cumulative effects are expected at NSR1.

4. Non-Turbine Noise Assessment

4.1 Non-Turbine Relevant Guidance and Advice

Guidance relevant to the assessment of non-turbine plant includes PAN1/2011 (refer to Section 3.1.1) and the following additional documents.

4.1.1 BS4142:2014+A1:2019 – Methods for Rating and Assessing Industrial and Commercial Sound ('BS4142')

BS4142:2014 describes methods for rating and assessing sound[1] from industrial or commercial premises. The methods detailed in the standard use outdoor sound levels to assess the likely effects on people inside or outside a residential dwelling upon which sound is incident.

The standard provides methods for determining the following:

- Rating levels for sources of industrial and commercial sound;
- Ambient, background and residual sound levels; and
- The audibility of tones in sound: 1/3 octave method.

These may be used for assessing sound from proposed, new, modified or additional sources of sound of a commercial or industrial nature or to assess the suitability of introducing a receptor near an existing commercial or industrial site.

The standard makes use of the following terms:

- **Ambient sound level, La = $L_{Aeq,T}$** – the equivalent continuous sound pressure level of the totally encompassing sound in a given situation at a given time, usually from multiple sources, at the assessment location over a given time interval, T.
- **Background sound level, $L_{A90,T}$** – the A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90 percent of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels.
- **Specific sound level, Ls = $L_{Aeq,Tr}$** – the equivalent continuous sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, T.
- **Rating level, $L_{Ar,Tr}$** – the specific sound level plus any adjustment for the characteristic features of the sound.
- **Residual sound level, Lr = $L_{Aeq,T}$** – the equivalent continuous sound pressure level at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound, over a given reference time interval, T.

The standard determines the degree of noise impact by comparison of the background noise level at NSRs in the absence of the industrial or commercial facility (the specific source) with the ambient sound level when the specific source is operational.

The standard sets out methods by which a representative background level may be determined, noting the following:

> *"In using the background sound level in the method for rating and assessing industrial and commercial sound it is important to ensure that values are reliable and suitably represent both the particular circumstances and periods of interest. For this purpose, the objective is not simply to ascertain a lowest measured background sound level, but rather to quantify what is typical during particular time periods"*

Where particular characteristics such as tones, intermittency or impulsivity are present in the noise emissions of the specific source and perceptible at the receptor, the standard requires that 'penalties' be added to the specific sound level to account for the increased annoyance that these can cause.

[1] The standards refers to 'sound', however, this assessment adopts the term 'noise'.

The following evaluation impact significance identifiers are provided in the standard, in which the difference between the specific sound level and measured background level are considered:

- The greater the difference, the greater the magnitude of impact;
- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact;
- A difference of around + 5 dB is likely to be an indication of a low adverse impact;
- The lower the rating level, relative to the measured background level, the less likely that the specific sound source will have an adverse (or significant adverse) impact; and
- Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact.

The standard also makes the following comments:

"Where the initial estimate of the impact needs to be modified due to the context, take all pertinent factors into consideration, including the following:

The absolute level of sound. For a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high than for an acoustic environment where the residual sound level is low.

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.

Where residual sound levels are very high, the residual sound might itself result in adverse impacts or significant adverse impacts, and the margin by which the rating level exceeds the background might simply be an indication of the extent to which the specific sound source is likely to make those impacts worse.

The character and level of the residual sound compared to the character and level of the specific sound. Consider whether it would be beneficial to compare the frequency spectrum and temporal variation of the specific sound with that of the ambient or residual sound to assess the degree to which the specific sound source is likely to be distinguishable and will represent an incongruous sound by comparison to the acoustic environment that would occur in the absence of the specific sound. Any sound parameters, sampling periods and averaging time periods used to undertake character comparisons should reflect the way in which sound of an industrial and/ or commercial nature is likely to be perceived and how people react to it.

The sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal and/or outdoor acoustic conditions, such as:

facade insulation treatment;

ventilation and/or cooling that will reduce the need to have windows open so as to provide rapid or purge ventilation; and

acoustic screening."

Earlier versions of the BS4142 standard recommended that a background level of 30 dBL_{A90} (or lower) and a rating level of 35 $dBL_{Ar,Tr}$ (or lower) may be considered 'objectively low'.

4.1.2 BS 8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings

BS8233:2014 provides guidance on the control of noise in and around buildings. The standard sets out acceptable noise levels for new and refurbished buildings and amenity areas according to their use.

For external amenity areas BS8233:2014 specifies a 'desired' level of 50 $dBL_{Aeq,T}$ and an 'upper guideline level' of 55 $dBL_{Aeq,T}$.

The standard provides noise limits for rooms within buildings by type of use; (bedroom, living room, office) and by time of day. Target noise levels within habitable rooms (bedrooms and living rooms) are 35 dB during the daytime period and 30 dB during the night-time period.

Methods are provided for simplified calculation of internal noise levels from external levels, and for detailed calculations. The simplified method relies on a reduction to façade levels provided either by open or closed windows, which are assumed to provide attenuation of approximately 15 dB and 33 dB respectively.

4.2 Non-Turbine Study Area and NSRs

The closest NSRs to the proposed plant at the Glensaugh site comprise on-site accommodation for JHI staff and NSR2 and NSR3, as considered in the WTG assessment.

Table 4.1 NSRs – non-turbine plant

NSR ID	NSR type, distance and direction from Proposed Non-Turbine Development	Grid Coordinates (OSGB)	
		X	Y
NSR1	NSR controlled by JHI. 370 m to north	367196	778639
NSR2	Off-site NSR approx. 80 m to north-west	367046	778339
NSR3	Off-site NSR approx. 270 m to west-north-west	366845	778372
NSR4	On-site NSR approx. 108 m to north-west	366999	778323
NSR5	On-site NSR approx. 103 m to west	366993	778299
NSR6	On-site NSR approx. 114 m to west	366976	778279
NSR7	On-site NSR approx. 130 m to west	366957	778262
NSR8	On-site NSR approx. 520 m to south-west	366863	777792

Note: properties denoted as 'on-site' are controlled by JHI.

4.3 Non-Turbine Method

4.3.1 Overall Method Outline

This assessment considers an unrealistic worst-case scenario, in which all of the components of the Proposed Development are operating simultaneously. In practice, this is unlikely to occur, however, the likely combination of worst-case noise sources is unknown and adopting this approach will enable the freedom to operate all aspects of the Proposed Development in any combination.

Reasonable worst-case assumptions have been made throughout the prediction and evaluation process, such that the assessment provides a worst-case evaluation of the potential noise impacts. Actual operational noise levels are likely to be lower, and consequently the impacts will be lesser than as assessed.

4.3.2 Baseline Noise Survey Method

ITPEnergised measured the baseline noise environment from 7th November to 8th November 2023.

The chosen measurement location was representative of the noise environment within external amenity areas of the closest identified representative NSRs to the proposed plant. The noise monitoring position (NMP) used was representative of the garden areas of residential dwellings and is shown in Drawing 3.

ITPEnergised undertook monitoring in accordance with the requirements of BS4142, using a Rion NL-52 Class I integrating sound level meter (SLM). The SLM was within its two-year laboratory calibration period and a calibration check was performed before and after each measurement with no drift in calibration noted. Photographs of the SLM in position at NMP1 are provided in Appendix 2.

During the survey we measured the noise indices L_{Aeq}, L_{A90} and L_{Amax} at a resolution of 5 minutes. One-third octave band data was recorded throughout.

An on-site weather station is operated by JHI and data from this was used to screen out noise data from periods when weather conditions were outside the requirements of BS4142 (raining/too windy).

Measured noise levels from the survey are provided in Appendix 2.

4.3.3 Prediction Method and Modelling Assumptions

Noise levels due to the proposed solar array, battery and hydrogen electrolyser and associated infrastructure have been predicted at identified representative NSRs within noise modelling software CadnaA, using the propagation method set out in ISO9613. The model assumes the following:

- Soft ground conditions, with absorption set to G=1.0.
- Screening provided by local topography, covered in the form of 50 m digital terrain mapping.
- NSRs have been modelled at 4 m representative of a first-floor bedroom window.
- A typical air temperature of 10°C and relative humidity of 70%.

The non-turbine components of the Proposed Development which have been modelled, and the modelling assumptions adopted, are provided in Table 4.2. The modelled items are shown in Drawing 3.

Table 4.2 Modelled non-turbine plant and modelling assumptions

Item	Modelling method	Assumptions
Hydrogen electrolyser	Building with noise breakout via walls and roof as vertical area and horizontal area sources	The noise level within the building has been assumed to meet the 80 dB Lower Exposure Action Value (LEAV) provided in the Control of Noise at Work Regulations[2], such that workers will not require hearing protection to enter. This is expected to be a conservative assumption, and actual internal levels are likely to be lower. Noise breakout via the façades and roof has been determined assuming that the building will be of steel frame construction with single-skin steel cladding providing a reduction of 26 dB to internal levels. Noise from external sources e.g. cooling fans and vents, has been assumed to be negligible in comparison to breakout noise. These assumptions are expected to be robust and to represent a 'worst-case' scenario.
Solar inverters	Point source on top of a 3D object 3 m tall for the ground level for the ground-based array.	The rooftop array string inverters are small and are not expected to be significant sources of noise; they are similar to items designed to be installed within houses and have been discounted from operational noise predictions accordingly. The ground level inverter has been assumed to be 3 m tall and the point source has been placed on top, using a representative sound power level and spectrum.
Containerised battery energy storage system	Point sources at either end of a 3D object (battery) and point source (inverter)	The battery and inverter have been assumed to be installed externally to represent 'worst-case' noise levels. The actual model of battery and inverter are not known at this stage, therefore a representative sound power level and spectrum have been applied.

[2] The Control of Noise at Work Regulations 2005. UK Government, 2005.

Item	Modelling method	Assumptions
Transformers; private substation and DNO substation	Point sources on top of 3D objects 3 m tall	The actual models of transformers are not known at this stage, therefore a representative sound power level and spectrum have been applied.

The applied sound power levels for the proposed plant are provided Table 4.3 as octave-band data and the broad-band A-weighted level to which the noise spectrum has been normalised within the model.

Table 4.3 Sound power data for non-WTG equipment

Item	Sound power level (dB) by octave band (Hz)									A-weighted overall broad-band level, dBA
	31.5	63	125	250	500	1k	2k	4k	8k	
Battery - two sources	59.3	52.6	55.5	44.8	44.1	48.6	34.4	26.4	19.5	79.0
Inverter	52.0	66.0	76.0	84.0	83.0	84.0	84.0	89.0	72.0	85.0
Grid transformers	-	63.0	65.0	60.0	54.0	49.0	44.0	37.0	37.0	75.0

The model assumes that all other items of plant will have a sound power level at least 10 dB lower than the modelled plant and will therefore have a negligible contribution to the total noise emissions.

4.4 Non-Turbine Results

4.4.1 Characterisation of Baseline Noise Environment

The noise environment was observed by the surveyor during commissioning and decommissioning of the monitoring equipment and the following was recorded:

- The dominant noise source was distant running water; and
- Transient noise sources included infrequent vehicle passes on the unclassified road which passes the Glensaugh site, and mobile plant moving around the farm yard.

Instances of mobile plant noise were noted to be of short duration and infrequent occurrence.

Throughout the measurement the weather conditions were within the requirements of BS4142, with wind speeds below 5 ms^{-1} and no rainfall. There was moderate to heavy rainfall at the end of the measurement, and this data has been excluded from further analysis.

A summary of measured noise levels at NMP1 is provided in Table 4.4.

Table 4.4 Summary of measured baseline noise data

NMP	Period	Duration, T	Measured level		
			$dBL_{Aeq,T}$	dBL_{A90}	dBL_{Amax}
NMP1	Daytime	7 hours	41	34	70
	Night-time	8 hours	31	29	53

The measured levels indicate a low background noise level, both during the daytime and the night-time period, consistent with subjective observations.

4.4.2 Predicted Operational Noise Levels

The predicted worst-case noise levels at each of the identified NSRs are provided in Table 4.5. Predicted levels are rounded to the nearest integer dB, in accordance with the BS4142 method.

Table 4.5 NSRs – non-turbine plant

NSR ID	Predicted level due to worst-case operations, $dBL_{Aeq,T}$
NSR1	17
NSR2	28
NSR3	11
NSR4	18
NSR5	19
NSR6	18
NSR7	20
NSR8	17

The predicted level is highest at NSR2; at all other NSRs the predicted level is at least 8 dB lower. Noise impacts associated with the Proposed Development will be greatest at NSR2; this assessment therefore utilises NSR2 as a proxy for the evaluation of noise impacts all other NSRs.

4.4.3 BS4142 Evaluation

Noise associated with operation of the facility based on predictions using data measured by ITPEnergised at the operational facility has been evaluated at NSR2 in Table 4.6.

Table 4.6 Evaluation of impacts at NSR2

NSR1	Level	Notes
Daytime period (07:00 – 23:00) – weekday/weekend		
Daytime Period background level	34 $dBL_{A90,T}$	Background level consistent throughout measurement period. Quiet location representative of amenity area of representative dwelling. High level of confidence measurement is representative. Rounded to nearest integer dB.
Predicted specific level	28 $dBL_{Aeq,T}$	Predicted level assuming all plant simultaneously operational at maximum output, a robust and unlikely-case scenario.
Rating correction	+2 dB	Tonal elements may be present at source locations but unlikely to be perceptible at receptors given specific level is below background; a correction of up to +2 dB for 'just perceptible' tonality may be appropriate. Baseline noise environment includes intermittent use of agricultural plant and occasional vehicle passes on the road.
Rating level	30 $dBL_{Ar,Tr}$	Includes +2 dB tonality correction
Excess over daytime background	-4 dB	Rating level is 4 dB below the measured background level during daytime operation and meets the 35 dB 'objectively low' criterion (refer to Section 4.1.1). Adverse noise impacts can arise above background +5 dB, depending on context.
Uncertainty	-	Representative background level adopted is below the level which occurred for most of the daytime period. Prediction uncertainty associated with ISO9613 method will be limited given comparatively small distance of propagation. Uncertainty around actual operational noise levels of the electrolyser, however, robust assumptions have been made in the predictions. Uncertainty unlikely to affect the findings of the assessment.
Significance	-	**Low impact** during daytime operation
Night-time period (23:00 – 07:00) – weekday/weekend		
Night-time Period background level	29 $dBL_{A90,T}$	Background level consistent throughout measurement period. Quiet location representative of amenity area of representative dwelling. High level of confidence measurement is representative. Rounded to nearest integer dB.
Predicted specific level	28 $dBL_{Aeq,T}$	Predicted level assuming all plant simultaneously operational at maximum output, a robust and unlikely-case scenario, particularly given solar components will only operate during daylight hours.

NSR1	Level	Notes
Rating correction	+2 dB	Tonal elements may be present at source locations but unlikely to be perceptible at receptors given specific level is below background; a correction of up to +2 dB for 'just perceptible' tonality may be appropriate. Baseline noise environment includes intermittent use of agricultural plant and occasional vehicle passes on the road.
Rating level	30 $dBL_{Ar,Tr}$	Includes +2 dB tonality correction
Excess over night-time background	+1 dB	Rating level is 1 dB above the measured background level during night-time operation and meets the 35 dB 'objectively low' criterion (refer to Section 4.1.1). Adverse noise impacts can arise above background +5 dB, depending on context.
Uncertainty	-	Measured background level was consistent throughout the measurement period and conditions were appropriate for measuring. Prediction uncertainty associated with ISO9613 method will be limited given comparatively small distance of propagation. Uncertainty around actual operational noise levels of the electrolyser, however, robust assumptions have been made in the predictions, particularly given that some components will not operate during the hours of darkness. Uncertainty unlikely to affect the findings of the assessment.
Significance	-	**Low impact** during daytime operation

Noise impacts at the closest NSR associated with worst-case operation of the Proposed Development meet the criteria for a low impact, both during the daytime and the night-time period, assuming worst-case operation. Actual noise levels are likely to be lower and impacts lesser.

4.5 Non-Turbine Findings and Recommendations

Noise associated with the non-WTG components of the Proposed Development has been evaluated as having a low impact, both during the daytime and night-time periods, and no specific mitigation is therefore proposed.

The assumptions made in the prediction of operational noise from the electrolyser are the greatest source of uncertainty in the assessment. JHI will therefore confirm that the assumptions made in this assessment remain accurate when further detail of the electrolyser design is available. Should it be determined that the electrolyser is likely to be noisier than assumed in this assessment, a further noise assessment will be undertaken to confirm that the Proposed Development can meet appropriate criteria.

5. Conclusion and Summary of Recommendations

ITPEnergised has undertaken an assessment of noise associated with the WTG and non-WTG components of the Proposed Development. The assessment has considered noise from these aspects separately, since they are covered by different guidance.

In the course of our assessment we have characterised the baseline noise environment by survey, predicted operational noise levels from the proposed WTG and non-WTG noise sources and evaluated the predicted levels in accordance with the relevant guidance.

The predicted noise levels from the proposed WTG meet 35 dBL_{A90} at all wind speeds. Meeting the 'simplified ETSU' limit means that no further assessment is required, and the WTG may be consented to a 35 dBL_{A90} noise limit at all existing NSRs. Our assessment has considered potential cumulative effects with the existing small turbine currently operated by JHI and found these to be not significant.

Prior to installation the source noise terms of the selected WTG (if different to that assessed) will be compared with those used in the assessment to confirm expected compliance with the adopted noise limit.

The predicted worst-case operational noise level due to the non-WTG plant meets appropriate noise limits at all NSRs, resulting in a low noise impact, both during the daytime and the night-time. Actual noise levels are expected to be lower and impacts will be lesser.

The assessment makes assumptions about noise from the electrolyser. Prior to construction of the electrolyser the assumptions will be confirmed by comparison with the design specification. Where the actual noise level of plant is likely to be higher than that assumed, or the level of attenuation provided by the building is lesser, further assessment will be undertaken to confirm that appropriate noise limits can be met at all NSRs.

6. References

BSi. (2014/2019). BS4142:2014+A1:2019: Methods for rating and assessing industrial and commercial sound.

BSi. (2009/2014). BS 5228-1:2009+A1:2014: Code of Practice for Noise and Vibration Control on Construction and Open Sites, Noise.

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Standards for Highways. (2020). Design Manual for Roads and Bridges, LA 111 – Noise and Vibration. https://www.standardsforhighways.co.uk/search/cc8cfcf7-c235-4052-8d32-d5398796b364

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IOA. (2013). A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise. Retrieved from https://www.ioa.org.uk/sites/default/files/IOA%20Good%20Practice%20Guide%20on%20Wind%20Turbine%20Noise%20-%20May%202013.pdf

Drawings

N

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Legend

- Glensuagh Estate Boundary
- Proposed WTG
- Turbine Access Track
- Hydrogen Facility
- BESS
- DNO Substation
- Private Substation
- PV Modules
- Inverters
- EV Chargers

0 0.45 0.9 km

Scale 1:18,500 @ A3

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James Hutton Institute - HydroGlen
Noise Impact Assessment

Drawing 1

Proposed Development Layout and Location

Date:	Drawn by:	Checked by:	Version:
12/12/2023	AJM	GS	Draft/V1

Project Number: XXXX

N

+3 dB Buffer

35 dB Contour

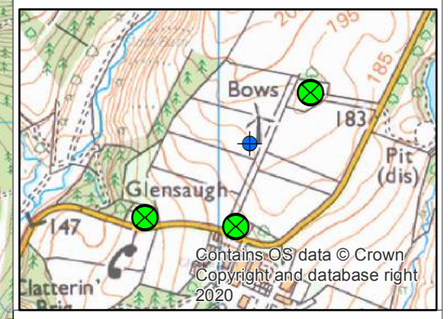
NSR1
*Unoccupied

NSR2

NSR3

Legend

- Glensuagh Estate Boundary
- Proposed Wind Turbine Generation (WTG)
- 35 dB contour
- +3 dB Buffer
- Existing WTG
- Noise Sensitive Receptors (NSRs)



0 0.45 0.9 km

Scale 1:18,000 @ A3

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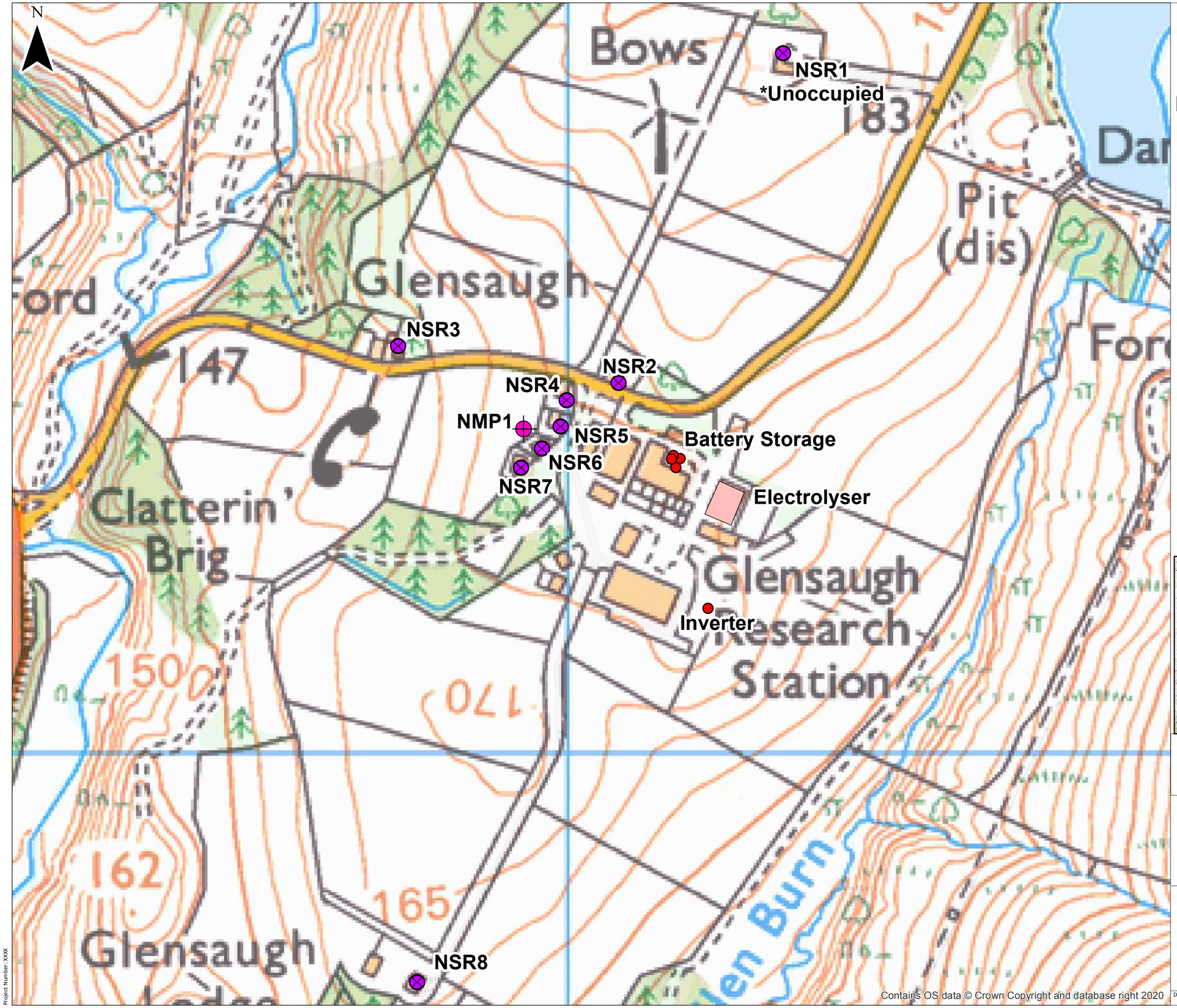
James Hutton Institute - HydroGlen
Noise Impact Assessment

Drawing 2

WTG Study Area and 35 dBL Noise Contour

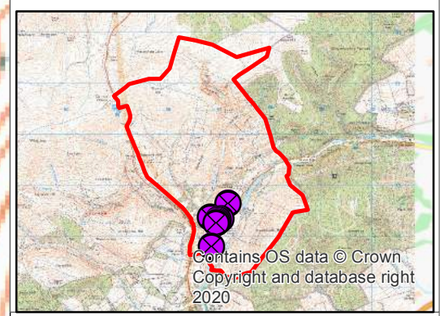
Date:	Drawn by:	Checked by:	Version:
12/12/2023	AJM	GS	Draft/V1

Project Number: XXXX



Legend

- Noise Monitoring Position (NMP) 1
- Noise Sensitive Receptors (NSRs)
- Hydrogen Facility
- Non-Wind Turbine Generator (WTG) noise sources



0 0.085 0.17 km

Scale 1:3,300 @ A3

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Noise Impact Assessment

Drawing 3

NMP and Modelled non-WTG Noise Sources

Date:	Drawn by:	Checked by:	Version:
12/12/2023	AJM	GS	Draft/V1

Project Number: XXXX

Appendix 1 – Record of Correspondence

From: Simon Waddell
Sent: Thursday, November 2, 2023 1:31 PM
To: 'environmental@aberdeenshire.gov.uk' <environmental@aberdeenshire.gov.uk>
Cc:
Subject: RE: ENQ/2023/0387 - Hydroglen - noise assessment of proposed single wind turbine and hydrogen electrolyser

Good afternoon,

Further to the request below, please can you confirm whether you are happy with our proposed approach? We hope to undertake our survey next week, taking advantage of a forecast weather window, and to complete our assessment by mid-November. Should we not hear back from you we will assume that you accept our proposals.

I am available at the mobile number below; should you have any questions or wish to discuss any aspect I would welcome a call from you.

With thanks in advance,

Simon

Simon Waddell *(he/him)* **| Associate | ITPEnergised**

Office: +44 (0)131 557 8325 | Mobile:

4th Floor | Centrum House | 108-114 Dundas Street | Edinburgh | EH3 5DQ

www.itpenergised.com

From: Simon Waddell
Sent: Tuesday, October 24, 2023 3:14 PM
To: environmental@aberdeenshire.gov.uk
Cc:

Subject: ENQ/2023/0387 - Hydroglen - noise assessment of proposed single wind turbine and hydrogen electrolyser
Importance: High

Good afternoon,

ITPEnergised has been appointed to undertake the noise assessment of a proposed development comprising a single wind turbine, solar array and ancillary electrical infrastructure and battery energy storage system (BESS).

The development will be relatively small-scale and has been screened out of requiring an EIA.

Overall approach

In the determination of our overall scope and approach we note the following:

- Given the small scale of the development, we do not expect significant noise impacts from the construction phase. We therefore do not propose to assess construction noise, on the assumption that an appropriate management plan will be put in place to manage noise.
- Simplified ETSU assessment of proposed wind turbine.
- BS4142 assessment of noise from all other project components.

Detailed layout drawings of the project will be included with the planning application, however, we provide below an aerial image (Figure 1) showing the proposed locations of the various project components and the closest identified Noise Sensitive Receptors. Figure 2 shows a closer view of the project components excluding the wind turbine.

Figure 1 – Proposed project components, on-site and off-site NSRs and proposed NMP

Figure 2 – close up of non-WTG project components.

Evaluation of wind turbine noise

- Modelling predictions using the proposed candidate turbine (Vestas V52) indicate that the 35 dBL_{A90} noise contour, accounting for potential concavity, will not exceed 35 dB at the closest NSRs.
- ***We therefore propose to scope out a baseline survey and to evaluate the proposed wind turbine (shown as WTG in Figure 1) against a 'simplified ETSU' criterion of 35 dBL_{A90} both during the daytime and the night-time.***
- Predictions of wind turbine noise will be undertaken in accordance with the Institute of Acoustics' (IoA) Good Practice Guide (GPG).

Evaluation of noise from other project components

- The closest NSRs to the proposed solar array, BESS and hydrogen electrolyser are accommodation units associated with the James Hutton Institute Glensaugh research farm.
- There are off-site NSRs at greater distances from the proposed plant
- We propose to undertake a baseline noise survey at a location representative of on-site and off-site NSRs, in accordance with the requirements of BS4142.

- The noise monitoring position will be determined during a site walkover to identify a suitably representative location, however, an example location is provided in Figure 1.
- We expect that representative noise levels can be determined by monitoring at single measurement location for a period of up to 24 hours, with supplementary short-term measurements of approximately 30 minutes at additional locations, if required.
- We will seek to undertake the survey within a weather window which meets the requirements of BS4142. We may collocate a rain gauge or weather station to
- The baseline data will be evaluated and non-representative noise (e.g. from mobile plant from the farm) will be excluded from the determination of a representative background noise level.
- ***In accordance with BS4142, our assessment will consider that noise impacts will be 'low' where the rating level exceeds the background by 5 dB or less***, depending on the context.
- ***Where representative background noise levels are objectively low (i.e. <30 dB) our assessment will seek to demonstrate compliance with an 'objectively low' rating level of 35 dB.***

Road traffic movements associated with the project are expected to be minimal, and we expect to be able to screen out detailed assessment of road traffic noise impacts using DMRB screening criteria.

Please can you confirm whether you agree with our proposed approach?

Should you wish to discuss any aspect, please call me on my mobile (number below) or email me to arrange a Teams call.

We hope to undertake the baseline survey in the next available weather window, so if you can confirm by response at your earliest convenience, that would be greatly appreciated.

Many thanks in advance,

Simon

Simon Waddell *(he/him)* **| Associate | ITPEnergised**

Office: +44 (0)131 557 8325 | Mobile:

4th Floor | Centrum House | 108-114 Dundas Street | Edinburgh | EH3 5DQ

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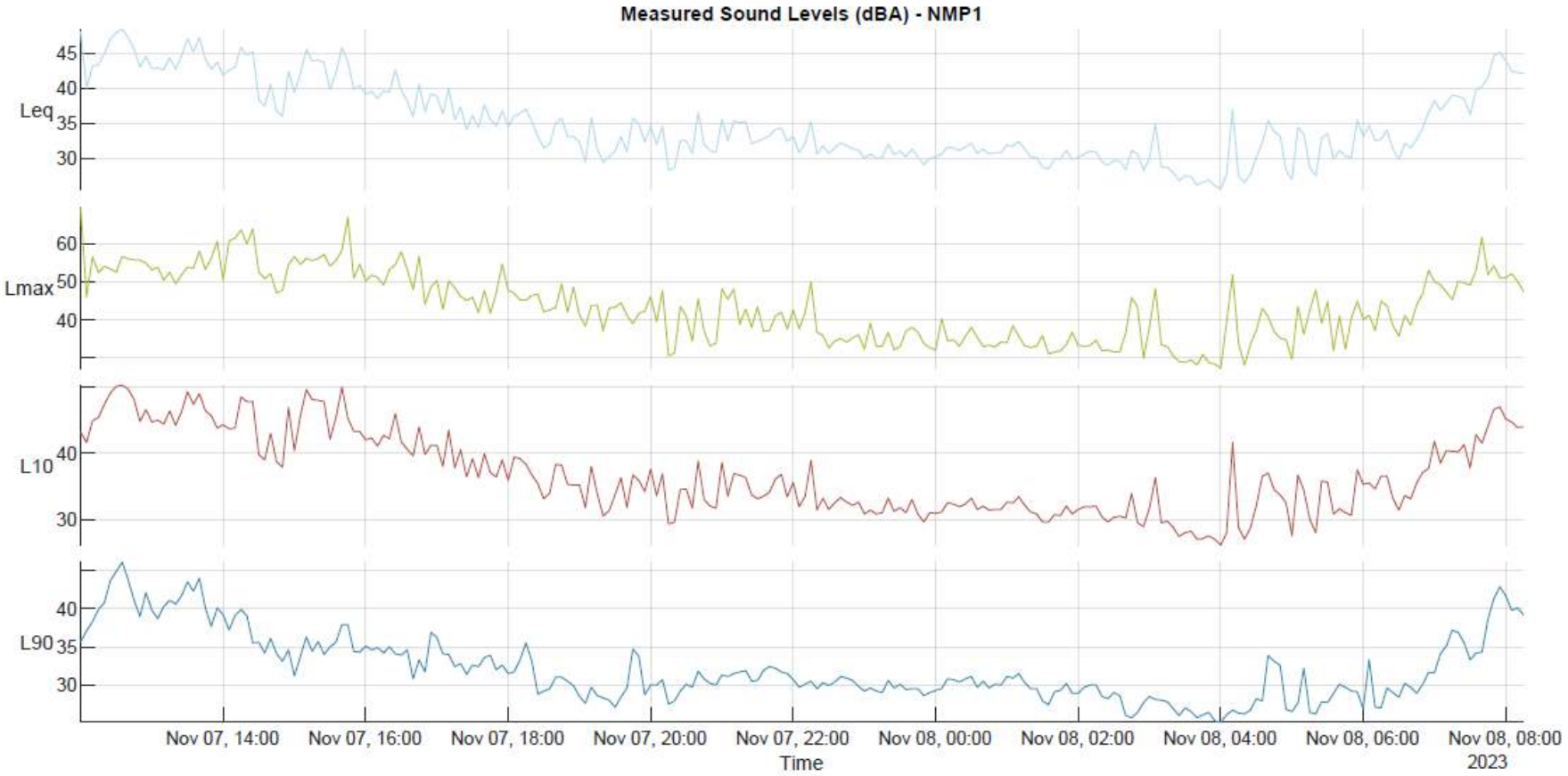
Appendix 2 – Details of Baseline Survey and Results of Baseline Measurements

Photos of Sound Level Meter at Measurement Location

Record of Noise Survey

Item	Note
Sound level meter serial number	00721019
Calibration value at start of survey	94.0
Date and time at start of measurement	11:41 07/11/2023
SLM file number	0711
Weather conditions at start of measurement	Still (<2 m/s) with no rainfall, 16C, 70% cloud cover
Dominant noise source	Distant sound of running water
Transient/lesser noise sources	Bird calls, mobile agricultural plant operating nearby
Calibration value at end of survey	94.0
Date and time at end of measurement	08:15 08/11/2023
Weather conditions at start of measurement	Still (<2 m/s) with heavy rainfall, 8C, 100% cloud cover (rain started at 07:00)


Measured Sound Levels (dBA) - NMP1
Leq
45
40
35
30
Lmax
60
50
40
L10
40
30
L90
40
35
30
Nov 07, 14:00
Nov 07, 16:00
Nov 07, 18:00
Nov 07, 20:00
Nov 07, 22:00
Nov 08, 00:00
Nov 08, 02:00
Nov 08, 04:00
Nov 08, 06:00
Nov 08, 08:00
Time
2023

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