



# Hill of Fare Wind Farm

## Technical Appendix 12.3

### Calculating Standardised Wind Speed

---

Author	Peter Brooks
Date	12 September 2023
Ref	04542-6411044

---

This document (the “Report”) has been prepared by Renewable Energy Systems Ltd (“RES”). RES shall not be deemed to make any representation regarding the accuracy, completeness, methodology, reliability or current status of any material contained in this Report, nor does RES assume any liability with respect to any matter or information referred to or contained in the Report, except to the extent specified in (and subject to the terms and conditions of) any contract to which RES is party that relates to the Report (a “Contract”). Any person relying on the Report (a “Recipient”) does so at their own risk, and neither the Recipient nor any person to whom the Recipient provides the Report or any matter or information derived from it shall have any right or claim against RES or any of its affiliated companies in respect thereof, but without prejudice to the terms of any Contract to which the Recipient is party.

## Contents

1	Calculating Standardised Wind Shear.....	1
---	--	---

# 1 Calculating Standardised Wind Shear

## 1.1 Introduction

- 1.1.1 In order to derive appropriate noise limits the ETSU-R-97 guidance requires the correlation of background noise survey data with wind speed data referenced to 10 m height. In contrast, acoustic emission measurements on turbines are undertaken in accordance with international standard IEC 61400-11, 'Wind Turbine Generator Systems - Part 11: Acoustic Noise Measurement Techniques'<sup>1</sup>, which specifies that the turbine noise emission should be reported as a function of 'standardised' wind speed at 10 m height. In practice this involves extrapolating hub height wind speed down to 10 m height using a specified, and fixed, relationship. The resulting 'standardised' 10 m wind speed is essentially a proxy for hub height wind speed which is the primary driver of noise emission from the turbine.
- 1.1.2 The use of a fixed relationship between hub height and 10 m wind speed means that potential exists for the background noise data and acoustic emission data to be misaligned i.e. a wind speed measured at 10 m height is not necessarily equivalent to a 'standardised' 10 m wind speed of the same magnitude, with the difference depending upon the site specific shear exponent (the rate of change of wind speed with height).

## 1.2 Methodology

### Accounting for Site Specific Shear

- 1.2.1 To account for the effects of site-specific shear, the background noise data is referenced to the same wind speed as the acoustic emission data. The approach used is consistent with that recommended in an article published in the Institute of Acoustics Bulletin and the subsequent Good Practice Guide (option b in paragraph 2.6.3).
- 1.2.2 To account for site specific wind shear effects in accordance with the aforementioned approach, the standardised 10 m height wind speed is found by:

---

<sup>1</sup> 'Wind turbine generator systems - Part 11: Acoustic noise measurement techniques', IEC 61400-11:2003 (Amendment 1: 2006)

Calculating the shear exponent from the wind speed measured at two heights. The following formula is used to determine the shear exponent:

$$\alpha = \frac{\log\left(\frac{v_2}{v_1}\right)}{\log\left(\frac{h_2}{h_1}\right)}$$

Where:  $v_2$  = upper height wind speed

$v_1$  = lower height wind speed

$h_2$  = height of upper wind speed (125 m)

$h_1$  = height of lower wind speed (115 m)

$\alpha$  = wind shear exponent

Extrapolating the measured wind speed to the proposed hub height using the calculated wind shear exponent. The hub height wind speed for each 10 minute period may be calculated using this equation:

$$v_{hub} = v_{top} \left( \frac{h_{hub}}{h_{top}} \right)^\alpha$$

Where:  $v_{top}$  = wind speed measured closest to hub height

$v_{hub}$  = wind speed at proposed hub height

$h_{top}$  = height of closest measurement (125 m)

$h_{hub}$  = maximum proposed hub height (122.5 m)

$\alpha$  = calculated wind shear exponent

The corresponding ‘standardised’ 10 m wind speeds are then calculated from the derived hub height wind speed using the following formula and it is this resultant standardised 10 m wind speed that shall be used in correlation with the measured background noise levels:

$$v_s = v_{hh} \left[ \frac{\ln \frac{z_{ref}}{z_0}}{\ln \frac{hh}{z_0}} \right]$$

Where:  $v_s$  is the ‘standardised’ wind speed

$v_{hh}$  is the hub height wind speed

$z_0$  is the reference roughness length (0.05 m)

$z_{ref}$  is the reference height (10 m)

$hh$  is the maximum proposed hub height (122.5 m)

The resulting 'standardised' 10 m wind speed is correlated with the measured background noise survey data.

- 1.2.3 Referencing the background noise levels to standardised 10 m wind speed calculated from the wind speed at 122.5 m height means that the resulting noise limits will also be referenced to wind speed at this height.