



Acoustic Report Supplement

Evoco 10kW Acoustic Data

for ETSU-R-97

Background

This document is intended to supplement the MCS acoustic report for the Evoco 10kW wind turbine and should be read in conjunction with that report, which Evoco has a duty to publish as an MCS accredited manufacturer.

This report is designed to present the independent MCS test acoustic data in a format which is compatible with the ETSU-R-97 guidance typically applied by planning authorities.

Incompatibility of MCS Approach and ETSU-R-97

The differing approaches of MCS and ETSU-R-97 are a common cause of confusion. Here is a summary of the key differences –

	ETSU-R-97	MCS
Base wind speed for threshold tests	10m/s	8m/s
Relevant hub noise level	LA(90)	LA(eq) – corrected to 95% confidence
Attenuation model	Spherical Propagation	To calculate hub sound power from distant reading, Spherical Propagation. To calculate sound pressure at slant distance from hub, Hemispherical Propagation. (See Note 1 below)
Acceptable noise threshold taking account of background noise (Daytime)	Background noise + 5dB(A)	N/A – no account taken of background noise
Acceptable noise threshold (Night time)	43dB(A) absolute, regardless of background noise	45dB(A) absolute, regardless of background noise
Acceptable noise threshold daytime without background noise analysis	40dB(A) to 35dB(A) absolute having regard to the impact of the level chosen on the viability of the wind turbine project	45dB(A) absolute
Acceptable noise threshold at any time if the affected party has a financial interest in the turbine	45dB(A) absolute	45dB(A) absolute

Note 1 – Inconsistent use of both hemispherical and spherical models introduces a 3dB(A) error (overstatement) in slant distance noise levels calculated in accordance with MCS procedure. MCS noise map is therefore both incompatible with ETSU-R-97 procedure and intrinsically inaccurate.

Evoco 10kW Hub Sound Power

In the MCS noise report, the sound power of the Evoco 10kW at hub is expressed to 95% confidence as the upper extreme of a 90% confidence interval around the LA(eq),8m/s. This is calculated by taking mean sound power at 8m/s wind speed and adding 1.645 x the standard error in the entire testing result set. 1.645 is the statistical t-value representing a 90% confidence interval around mean. The upper bound of the interval is 5% from the extreme of the distribution (100% - 90%) / 2 = 5%.

$$92.24 + (1.645 \times 2.55) = 96.4 \text{ dB(A) LA(5),8m/s}$$

N.B. this figure is not compatible with ETSU-R-97 calculations and is provided for information only, to help reference back to the MCS Noise Report.

For ETSU-R-97 we need the LA(90), 10m/s. From our original data, a plot of LA (90) referred to the hub using spherical propagation gives the plot shown in Figure 1.

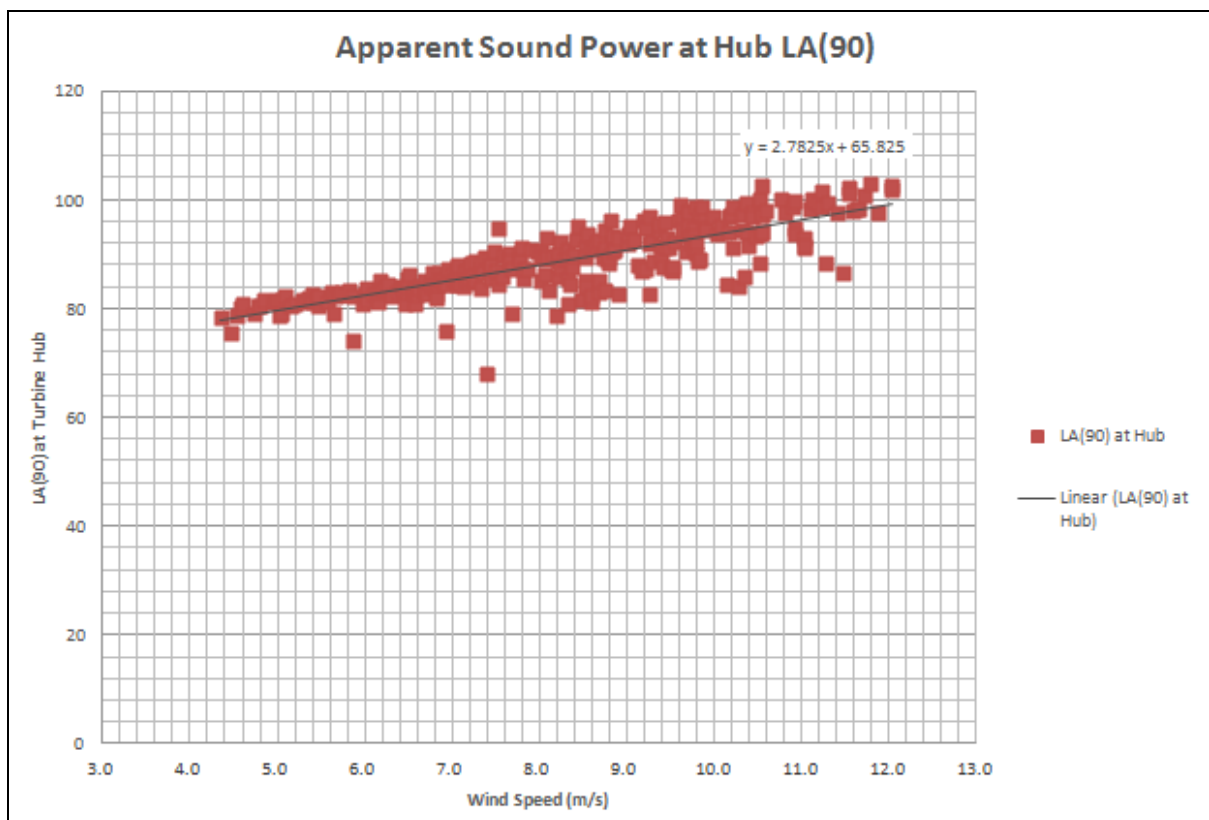


Figure 1: Plot of Apparent Sound Power Level at Hub based on LA(90) measured values

This gives us a level **93.65 dB(A) LA(90), 10m/s**

N.B. this is the relevant hub sound power which must be used for ETSU-R-97 considerations.

ETSU-R-97 Threshold Distances – Absolute (Where No Background Noise Data Available)

The spherical propagation equation rearranged to solve for threshold distance ignoring background noise is –

$$r = 10^{\left(\frac{L_p - L_w + 11}{-20}\right)}$$

where

L_p is the decibel level LA(90) at a slant distance from hub;

L_w is the decibel level LA(90) at hub;

r is the radius or slant distance from hub.

For the various values of L_p relevant to ETSU-R-97, acceptable noise threshold distances for the Evoco 10kW, in the absence of background noise data are summarised in the table below:

Threshold Criterion (Lp) <i>(Absolute, where background noise data unavailable)</i>	Minimum Separation Distance (r)
45 dB(A) - Appropriate level for a party with a financial interest in the turbine. (Daytime and night time)	76 metres
43 dB(A) – Night time limit for 3 rd parties	96 metres
40 dB(A) – Upper level of discretion for daytime threshold for 3 rd parties	136 metres
39 dB(A)	152 metres
38 dB(A)	171 metres
37 dB(A)	191 metres
<i>Evoco Recommended Separation Distance</i>	<i>200 metres</i>
36 dB(A)	215 metres
35 dB(A) - Lower level of discretion for daytime threshold for 3 rd parties	241 metres

Paragraph 22 of the ETSU-R-97 Executive Summary directs planners to choose an appropriate threshold in the range 40dB(A) to 35 dB(A) having regard to the impact of the decision on the financial viability of the wind turbine project. In this regard, it is instructive to consider a typical background noise scenario for a quiet rural site. The effect of background noise is covered below, but here, taking the rural background noise curve provided on page 64 of ETSU-R-97 as indicative of a typical site, background noise itself at 10m/s could be expected to be around 44 dB(A). Any threshold level chosen below that

44 dB(A) means turbine noise is likely to be below background noise. *So even the 40dB(A) end of the planner's discretion should normally be below background.*

Evoco Energy recommends a minimum threshold distance of 200 metres where no background data is available, although in some cases, especially with background noise measurement , a smaller threshold may be acceptable.

ETSU-R-97 Threshold Distances – Referenced to Background Noise

Both wind turbine noise emissions and ambient background noise have a clear wind speed dependence. Under ETSU-R-97, if background noise data is available, a comparison can be made and the acceptable level for turbine noise is taken to be 5 dB(A) above background.

The same spherical propagation equation can be used, substituting (background noise at 10m/s + 5 dB(A)) for L_p .

For example, the background noise from test data for the Evoco 10 MCS acoustic report, which was conducted on a typical quiet rural site, can be described by the equation:

$$y = 1.5987x + 28.683$$

where

x is wind speed in m/s, and

y is background noise in dB(A).

So at 10m/s, the ambient background noise level on this site is 44.67 dB(A). On this site, the daytime threshold noise level under ETSU-R-97 is therefore $(44.67 + 5) = 49.67$ dB(A).

Inserting this for L_p into the spherical propagation equation, the threshold radius can be calculated to be 44.3 metres. However, the night time absolute level of 43 dB(A) , 95.5 metres would prevail here.

N.B. at 44.3m, the turbine installation would comply with ETSU but would be clearly audible, being 5dB above background. Evoco Energy do not recommend such a close separation and in fact recommend a minimum separation distance of 200m, to maintain inaudibility of the turbine in the majority of operating conditions.

However it can be observed that generally, threshold distances calculated with reference to on site background noise data tend to be much closer than those using absolute decibel thresholds.

Appendix 1

Calculating the Sound Pressure levels of the Evoco 10 at Various Distances (Not including background Noise)

If we know the proposed separation distance but wish to solve the spherical propagation equation to discover the expected attenuated sound pressure level we can use the following rearrangement of the equation:

$$L_p = L_w - 20 \log(r) - 11$$

Where

L_p is the decibel level at a slant distance from hub;

L_w is the decibel level at hub;

r is the radius or slant distance from hub.

Example of use –

Proposed turbine site is 250m from the closest quiet amenity area in a neighbour's land. What is the predicted decibel level of the turbine (ignoring the effect of background noise) at 10m/s wind speed?

$$\begin{aligned} L_p &= L_w - 20 \log(r) - 11 \\ &= 93.6 - 20 \log(250) - 11 \\ &= 34.64 \text{ dB(A)} \end{aligned}$$