

Wind farms cumulative impact assessment

ETSU-R-97 requires that noise from all wind farms cumulatively shall not exceed the limits derived in accordance with that document. As more wind farms and individual turbines are applied for and consented, the assessment procedures become more complex and the planning conditions required to take this into account become more difficult to formulate.

Whilst detailed guidance is needed, this would take some time and this article sets out our agreed view, or range of views, on some of the factors surrounding the issue in the hope that it might assist consultants and planning authorities in dealing with cumulative noise in the interim.

We emphasise that this article represents the views of the authors and has no “official” status.

When should a cumulative assessment be done?

For reasons of consistency with the IOA GPG¹ (1.2.1) we will relate this to developments with a total power output rating of more than 50 kW. Where we refer to wind farms that includes single turbines.

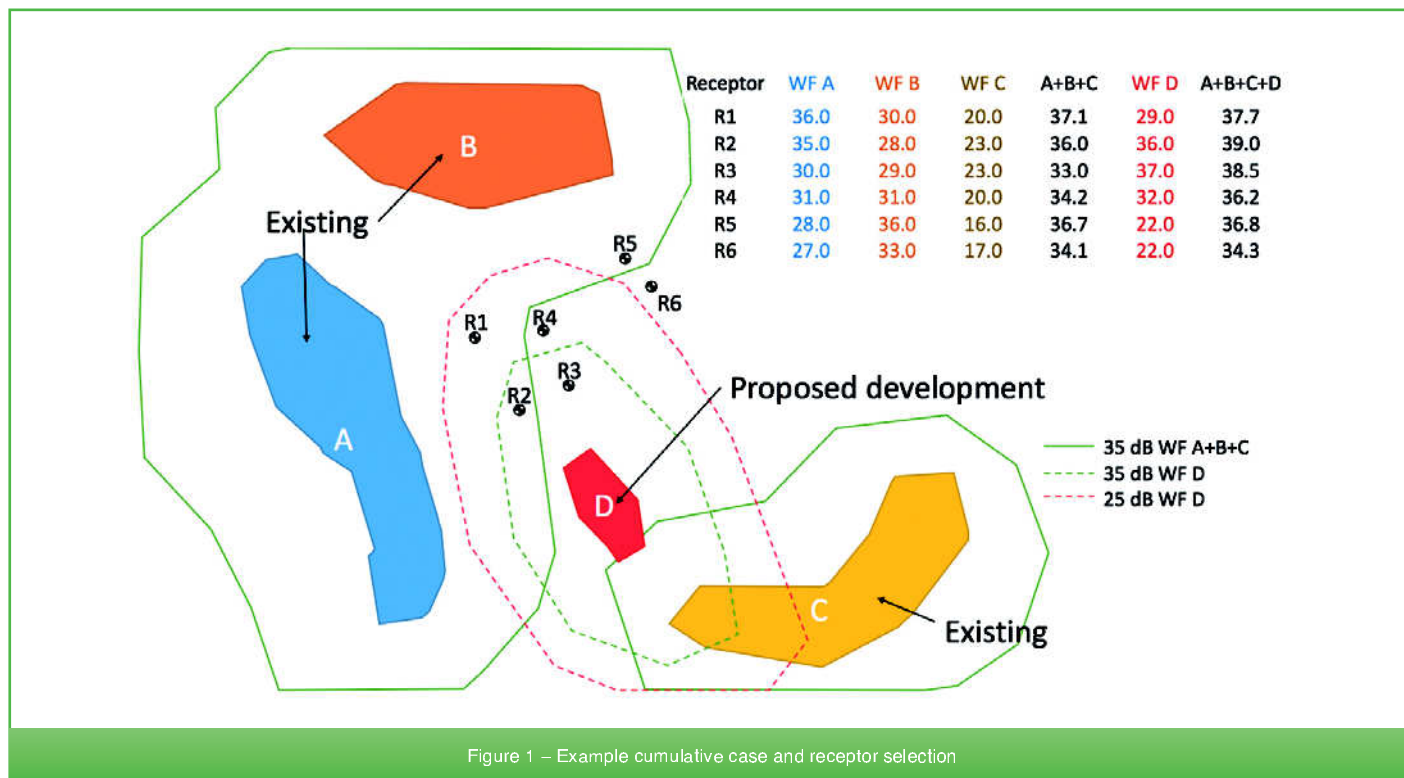
The first question which arises is “at which stage of its development should a neighbouring wind farm be included in a cumulative assessment”. It is generally agreed amongst us that all neighbouring wind farms that are operational or consented and all developments “ahead” of the application development in the planning queue should initially be considered. We also agree that generally other sites that are at a pre-application stage, e.g. scoping, should not be included. This may mean that further/supplementary information may be required for planning applications that entered the planning queue before the application but after the assessment was prepared. Wind farms that have been refused by the planning authority but are at appeal might also need to be considered but the status of these is a planning matter and needs to be discussed with the planning authority. It is always

advisable that the exact extent of the cumulative assessment is agreed between the applicant and the planning authority.

Once this is agreed, the next stage in the assessment process is to decide which existing, consented and proposed wind farms should be included because they are close enough to the application development to contribute to the cumulative impact. The IOA GPG defines whether a wind farm is close enough by saying that a cumulative assessment should be made “if the proposed wind farm produces noise levels within 10 dB of any existing wind farm/s” (at 5.1.4) but not “where noise from the proposed wind farm is predicted to be 10 dB greater than that from the existing wind farm” (at 5.1.5). In this article we have used the term “existing” to mean the constructed, consented and proposed wind farms that have been included in the cumulative assessment other than the application development.

Depending on the number of developments in the area it might be appropriate to carry out an initial filter based on some sample calculations or on fixed distances based on experience. The consensus is that, since it is becoming increasingly common to identify receptors by taking those within the 35 dB contour for single wind farms, the 35 dB cumulative contour would be appropriate for a cumulative assessment. Our first suggestion is shown in Figure 1 where the 35 dB cumulative contour for all the existing wind farms is drawn and the 35 and 25 dB contours for the application wind farm. Those to be included are all receptors 1) inside the 35 dB application contour, plus 2) all those lying inside BOTH the 25 dB application contour AND the 35 dB cumulative contour for the existing wind farms. So, in Figure 1, R1 and R2 fulfil test 2 and R3 fulfils Test 1, so they are all included. R5 and R6 fail both tests so they are excluded. However, as shown in the numerical table, R4 fails both tests but should be included because the

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overall cumulative level is more than 35dB and the difference is less than 10dB. So some manual inclusions may be necessary in practice if this method is used.

An alternative method is shown in Figure 2. The red line is the 35 dB cumulative level for BOTH wind farms. The orange zone is where the difference between the total sound pressure level of the application turbines and that of the existing turbines is less than 10 dB. The receptors to be considered are thus those within both the orange zone and the red line.

Whichever of these two methods is used, there are details to be considered in calculating the noise levels used to form the contour lines. Some of us would like to see consented limits rather than predicted sound pressure levels, concave ground correction and valley correction included at this stage. However, the process of

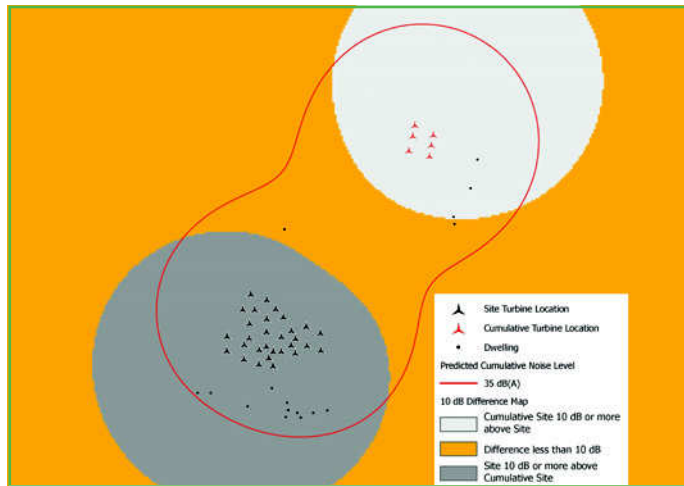


Figure 2 – Alternative example

carrying out this part of the assessment is not easy and the final method may depend, amongst other things, on what software is used. Moreover, some wind farms may adopt sector management where the sound output of the turbines is varied according to wind speed and direction in order to meet limits. This means that, if the details of the management scheme are known, there will be different contour plots for different wind conditions but, if they are not, it may not be possible to draw an accurate contour plot at all. In the latter case the assumption has to be made that there are no reduced modes operating.

How a cumulative assessment may be done

At this stage we should have a list of potential receptors and wind farms for which a cumulative assessment is required, though the list may be refined as the assessment progresses. It is important to note that the assessment is receptor based – that is to say each receptor has to be considered individually. There are several ways that the assessment might be done but there are two that are commonly used. Method one is to calculate the noise levels from the application site plus noise from existing wind farms and demonstrate whether or not this meets the appropriately derived ETSU-R-97 limits. Method two is to calculate noise levels from the existing wind farms, (except those on the application site), and then subtract this figure (logarithmically) from the appropriately derived ETSU-R-97 cumulative limits and compare the result with the predicted noise levels for the application. This has been called the “remaining noise budget” (RNB) method by Hayes McKenzie. The two methods may amount to the same thing but the second may provide clearer individual noise limits for the application development.

In either case all turbine noise calculations should be carried out using the procedure in IOA GPG. SWL in this article shall be taken to mean the sound power level plus appropriate addition for uncertainty of a particular turbine or turbines as set out in IOA GPG as the starting point for the propagation calculations.

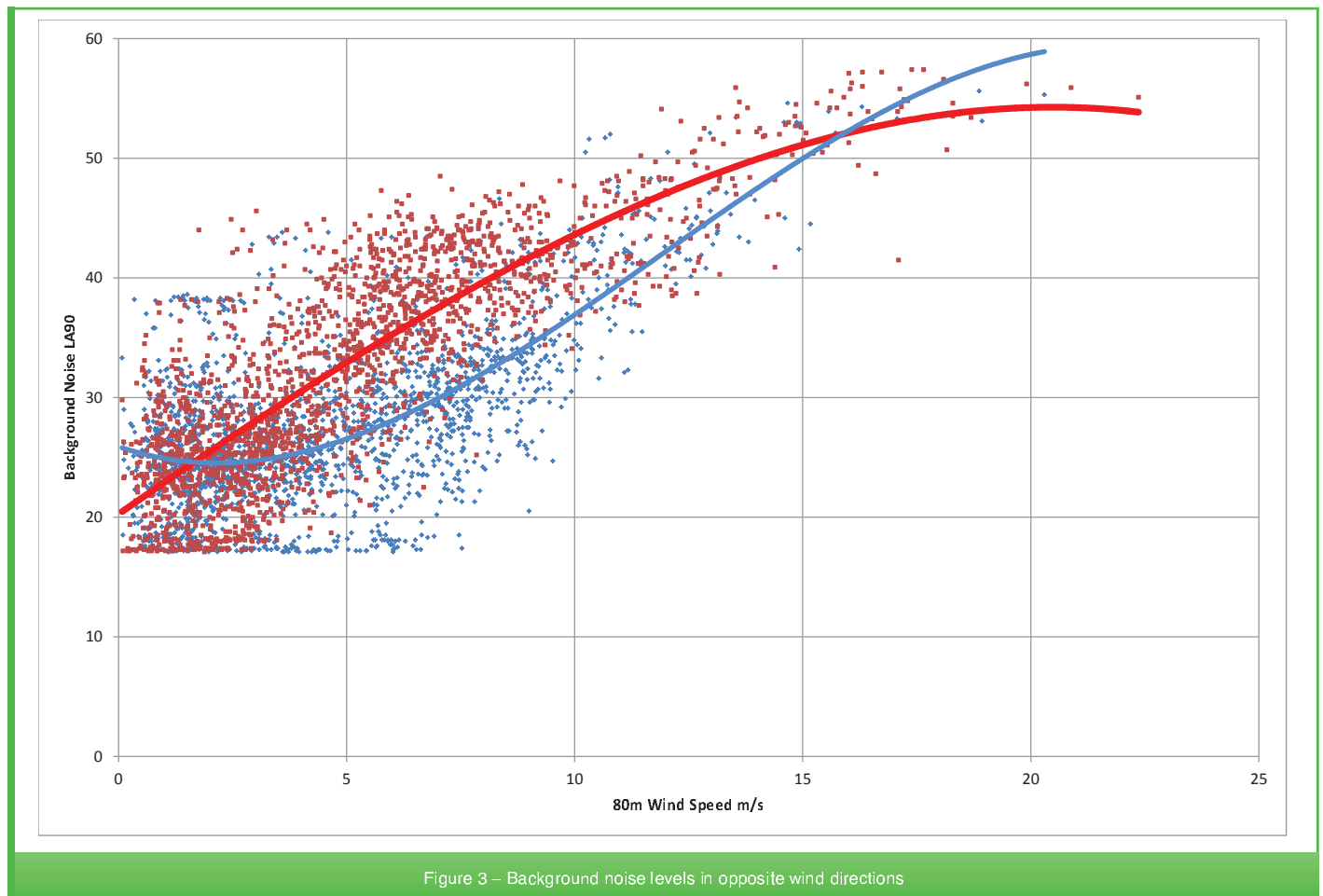


Figure 3 – Background noise levels in opposite wind directions

However, the IOA GPG requires that consented limits are used instead of predicted noise levels as input to the assessment except in cases where there is significant headroom. In order to deal with these conflicting requirements in a structured manner, we can calculate the noise at an affected receptor from an existing wind farm by using the SWL of the candidate turbine (or actual turbine if known) plus an additional uplift of **X dB** at all wind speeds.

This sound power level is capped, if necessary, for all the turbines at each operating or consented wind farm (that is to say those wind farms that have been assigned planning conditions) so as to avoid a breach of that wind farm's individual noise limits at the "controlling" property. Alternatively, where, in order to meet existing noise limits, not all the turbines on an individual existing site are being operated in the same way for all wind conditions it may be preferable to apply this cap to the predicted sound pressure levels at one or more of the assessment locations. For both methods, this capping should take account of any tones that incurred a penalty. Again it is advisable to consult with the planning authority to establish whether it has developed any policy in this respect.

It should be noted that the controlling receptor in any wind direction may not be the nearest receptor. The turbine noise level at a receptor further away may be higher (for example due to valley effect or lack of barrier effect) or the limits at a receptor further away may be lower. This can be due to either lower background noise levels at the further receptor or the application of "financially involved" limits at the closer receptor. Lower backgrounds at a further location can happen for example where the nearest receptor is at the bottom of a valley with water noise but the controlling receptor is up the hill on the opposite side of the valley to the wind farm.

There are various ways of assigning a value to "X". It could be determined by carrying out a risk assessment of the likelihood of an increase in noise level (or in tones requiring a penalty)

but some methodology would have to be adopted for this. Wind farms that have been operating for some time without apparently exceeding the limit might be considered for a low value of "X" if a compliance study has already been carried out for the scheme which indicates predicted levels are achieved. On the other hand unbuilt consented developments with significant headroom could use it all up by changing the candidate turbine. Alternatively, a blanket value of "X" can be agreed with the planning authority. Figures that have been suggested generally range from 2 dB to 5 dB. An example² of such guidance, as currently proposed in draft form by Cornwall Council, is shown for information in Table 1.

In the case of concurrent applications, the use of apportioned or shared noise limits can be useful, as discussed in IOA GPG 5.4.2.

At each receptor, the sound pressure level needs to be calculated for each of the turbines in each of the developments. This may be done without applying any attenuation for wind direction or by taking wind direction into account and we suggest the choice is left to the applicant, though ignoring wind direction will tend to over-state the turbine noise levels. General calculation methods are set out in the IOA GPG in Section 5 and directivity calculations in the IOA GPG at 4.4. It should be noted that the additional attenuation due to direction depends on the distance of the receptor from each turbine.

Combining tonal and non-tonal contributions from individual wind farms to give a cumulative result can be problematic. Different results can be obtained depending on whether the tonal penalty is included in the individual contributions that are summed or whether the individual contributions are added without the penalty and the appropriate penalty added to the cumulative sum. The latter is mathematically correct but, particularly if the tonal wind farm is quieter than others, the presence of the other wind turbines may reduce the audibility of tones meaning that if the whole individual penalty is added to the cumulative noise the effect of the tone will be exaggerated. A common sense approach may need to be adopted and the method used to calculate cumulative totals with tonal noise should be stated.

All methods also require that an appropriate notional cumulative noise limit is established. This should be done in accordance with ETSU-R-97 taking into account that some planning authorities have alternative limits. Note that the cumulative limit need not however be specified as a planning condition - this is discussed further below.

Some planning authorities may adopt a policy of permitting turbines without a cumulative assessment if more stringent limits are applied than normal ETSU-R-97 limits. Denbighshire may allow this provided that the noise level from a single turbine does not exceed 32 dB (L_{A90}) or a large wind farm 35 dB or 3 dB above background noise level at any receptor, other than those which are financially involved.

Background noise levels

One of the other issues that can be problematic is what background noise measurements should be used in formulating the limits. This arises because it is often difficult or even impossible to measure background noise for a later application without the influence of existing wind turbine noise. The fact that existing

Controlling property	Correction factor
Predicted sound level is more than the consented sound level ^a	The <i>consented</i> sound level should be used in the cumulative sound assessment
Predicted sound level is equal to consented sound level	0.0 dB(A)
Predicted sound level is less than the consented sound level by:	The correction factor is the difference between the predicted and the consented.
1 dB(A) ^b	1 dB(A)
2 dB(A) ^b	2 dB(A)
3 dB(A) ^b	3 dB(A)
Predicted sound level is less than the consented sound level by 4 dB(A) ^b or more ^c .	4 dB(A)

Notes

- a any difference are likely to be due to a new turbine sound power data, or changes in recommended prediction methodology, such as inclusion of valley penalty or use of uncertainty.
- b the usual rounding convention applies, e.g. a difference of 4.4 dB(A) would be rounded to 4dB(A), and a difference of 4.5dB(A) would be rounded to 5dB(A)
- c the correction factor is limited to a maximum of 4dB(A) eg where the difference is 7 dB(A), the correction factor will still be 4 dB(A)

Table 1 - Correction factor to be applied in a cumulative noise assessment to predicted sound levels of consented turbines

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turbines cannot be heard when the consultant sets up the equipment is not necessarily an indication that there will be no influence from turbine noise!

If the background noise has been appropriately assessed for an earlier development, measurements may have already been taken at the required receptor or suitable proxy. It may be possible to use these provided that it can be shown that they have been properly done in accordance with current practice and that there is no reason to expect a substantial change in background noise levels in the intervening period. However, it needs to be borne in mind that the background noise is plotted against wind speed and wind speeds on the two sites may not be similar. If sufficient information is available it may be that data can be adjusted to allow for any differences.

Measuring total noise and deducting calculated noise from existing turbines is a methodology which is sometimes used but this needs to be treated with caution because it can produce anomalous results. For example, it is not uncommon for the total noise including turbines to be less than the calculated turbine noise. In addition, the consultant would need to know whether all the turbines were operating or what modes they were operating in during the measurements. An alternative is to measure background noise levels and filter out wind directions likely to be influenced by existing turbines, provided that such filtering does not in itself result in elevated background noise levels which are likely to be atypical of background noise levels when downwind of the proposed development.

For example Figure 3 shows background noise levels on a site filtered for winds in the western half and winds in the eastern half of the compass. The difference may be due to different shielding of the noise measurement location or to different shielding of the anemometer mast even if there is no difference in the types of noise sources in the two directions.

Planning conditions in cumulative situations

A cumulative condition is one that makes the operator of the application wind farm responsible for the noise level of their own wind farm cumulatively with other wind farms in the area – either all of them or specific named ones. The subject of cumulative conditions is still a matter of debate. Some of us consider that cumulative conditions should never be imposed and that they are not enforceable. Most of us consider that they are usually not desirable because of potential difficulties of enforcement. Each application has to be considered on its merits. Extensions to existing wind farms are a special case. The original noise conditions can be extended to the new wind farm as a whole without difficulty provided they are both under the control of the same operator. Wording for these conditions needs to be structured with care to avoid full limits being applied to both parts of the wind farm.

There is a move in some local authorities to limit turbine noise to the calculated turbine noise levels in the ES. This has the advantage that it does not leave “unused” capacity within the noise budget. However such an approach may be problematic if the noise limits can only be met by a single make/model of turbine. It also has a number of disadvantages when it comes to compliance testing because limits at low wind speeds may be below background noise and also because it makes it more likely that the first stage of compliance testing will be inconclusive and the second stage of turning turbines off need to be implemented. This makes the compliance assessment process protracted. One solution is to apply a margin over the calculated turbine noise of, say, 2 dB – provided that this does not result in a breach of either the individual or cumulative wind farm limits, however this may not remedy the problem of limits being below background. Alternatively, the whole ETSU-R-97 limit can be shifted up or down as illustrated in the IOA GPG Figure 7. However, there is far from a consensus in this area with many consultants strongly favouring a working margin over the sound pressure levels in the ES, and the retention of a fixed lower limit with local authorities and others concerned that limits are already used up in many cases.

Where a receptor has a financial involvement in one wind farm it is entitled to the higher financially involved (FI) limit only for that wind farm. Cumulatively the receptor should also be given the notional higher FI limit where the cumulative assessment includes the wind farm which the receptor is involved with.

What have we left out?

What we have set out here only scratches the surface of the problem. There are other issues that arise from the assessment of cumulative impact that we have not covered or only referred to in passing. These may all have to be borne in mind in a cumulative assessment.

- Wind speeds may be different on the different sites.
- Some sites may have limits based on measured 10m height wind speeds and some using standardised wind speeds. There may also be smaller differences in noise limits due to background noise measurements being related to 10m wind standardised from different hub heights.
- Some existing turbines may be constrained to various noise modes depending on wind conditions. This means that if a margin over calculated turbine noise is used, then this may vary according to such conditions. This fact may not be appreciated by the assessor of the new wind farm.
- As alluded to earlier, cumulative assessments often end up with limits giving the operator little or no margin. This may make compliance testing more difficult, take longer and be more controversial.
- Mitigation of noise levels by sector management – the use of low noise modes in certain wind directions and speeds to meet limits – is increasingly used for cumulative assessments. Although this may result in a compliant maximum noise level, that maximum may be present for a wider range of conditions. In addition, levels may be higher in other conditions than they would have been had there been no sector management but quieter turbines were used. There may therefore be a higher “noise dose” at the receptor than otherwise.
- The assessment of cumulative noise can be very complex and is it unreasonable to expect a developer of a 70 kW single turbine to carry out the same degree of work as the developer of a 70 MW wind farm? On the other hand is it reasonable since the impact on residential amenity might be the same?
- Following the Gorsedd Bran decision³ the planning authority may also have a policy that receptors are entitled to the reduction in noise that a change in wind direction brings rather than seeking to encourage development to surround the receptor, albeit within ETSU-derived noise limits. This is a contentious point and may not be accepted by some consultants. ◻

References

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2. <http://www.cornwall.gov.uk/environment-and-planning/environmental-protection/wind-turbines/> (Feb 2015)
3. Appeal Ref: APP/R6830/A/08/2074921

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