Glenurquhart & Strathglass Wind Energy Project

Section 6

Noise & Shadow Flicker
Roads & Transportation
Carbon Balance Calculations

Glenurquhart & Strathglass Wind Energy Project

Environmental Health Studies: Noise and Shadow Flicker Assessment

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Client:

Mike Girvan

Corrimony Energy Ltd

Assessment:

Richard Gauld

BSc(Hons) IEng MInstMC Dip DesInn Dip.GeoSci

Orkney Sustainable Energy Ltd

6 North End Road

Stromness

Orkney KW16 3AG

1 Summary results

1.1 Wind turbines can create two types of environmental health nuisance; disturbance from noise and the potential for shadow or flicker affects. This study considers the impact that these possible nuisances could have in the Glen Urquhart and Strath Glass area and concludes that these impacts are negligible for the wind turbines at Corrimony.

1.2 Wind turbine noise is normally generated by the turbine blades along with mechanical noise from the gearbox and generator. Modern wind turbines have minimal tonal content, and in some cases no longer have gearboxes, completely eliminating gear meshing tones. In the case of the project at Corrimony there are very long distances between the windfarm and any neighbour, thus the impact of noise from the wind turbines is insignificant and accordingly a simplified assessment has been carried out.

1.3 The distances to the neighbours to the west and north were measured then calculations performed to show the impact of the turbines at these properties. The windfarm at Corrimony has been designed to minimise impact and achieves the recommended sound levels at neighbours of 35dB(A) by a large margin.

1.4 Shadow flicker can occur under certain combinations of turbine position, time of day and time of year, when the sun may pass behind the rotor and cast a shadow over neighbouring properties; this can cause a nuisance when the shadow appears in narrow window openings. PAN45[1] recommends 10 rotor diameter separation between wind turbines and dwellings to avoid this nuisance, in this instance 820m. This has been fully achieved by the project at Corrimony; the nearest neighbours are 4200m away from the nearest turbine and accordingly there is no risk of shadow flicker impact whatsoever.

2 Potential disturbance from noise

2.1 Sound is generated by wind turbines when they operate and generate power, and occurs over the operational windspeed range. Below the cut-in wind speed there is insufficient strength in the wind to turn the blades and in extreme conditions turbines enter a storm control mode, with the rotor turning only very slowly as a safety measure. The production wind speed range for wind turbines is from 4 to 25 ms^{-1} and the principal source of noise is from the blades rotating in the air.

2.2 Noise levels are normally expressed in decibels. Noise in the environment is measured using the dB(A) scale which includes a correction for the response of the human ear to noises with different frequency content. A 1dB change in noise level is just perceptible, a 3dB change in noise level is clearly perceptible and a 10dB change in noise level is heard as a doubling or halving of the perceived level. The maximum sound levels from an Enercon E70 or a RE Power MM82 wind turbine is 104 dB(A) at a wind speed of 10 ms^{-1}, with this value decreasing with distance from the turbines and with atmospheric absorption. Table 1 shows the predicted impact at neighbours to the windfarm at Corrimony, along with other environmental noise levels.

Source/Activity	Indicative noise level dB (A)
Threshold of hearing	0
Corrimony wind energy project	**<10**
Rural night-time background	20-40
Quiet bedroom	35
Busy road at *5km*	35-45
Car at 65 km/h at *100m*	55
Busy general office	60
Conversation	60
Truck at 50 km/h at *100m*	65
City traffic	90
Pneumatic drill at *7m*	95
Jet aircraft at *250m*	105
Threshold of pain	140

Table 1 – Noise levels in the environment

2.3 The Planning Advice Note on Renewable Energy Technologies, PAN 45 provides information on noise from wind turbines in paragraphs 65-69 within the general section on Wind Power. Paragraph 65 states: "Well designed wind turbines are generally quiet in operation". The document goes on to discuss the sources of noise and the effects of increasing wind speed on wind turbine noise and background noise. It notes that the report "*The Assessment and Rating of Noise from Wind Farms*", ETSU-R-97[2], describes a framework for the measurement of wind farm noise and gives indicative noise levels thought to offer a degree of protection to wind farm neighbours.

2.4 These planning guidelines suggest that noise limits should be applied to locations where a quiet environment is desirable. Where a windfarm is relatively near to neighbouring properties, noise limits can be set relative to background noise and should reflect the variation in both turbine source noise and background noise with wind speed. Separate noise limits should apply for day-time and for night-time as the protection of the external amenity becomes less important in the evening and the emphasis should be on preventing sleep disturbance.

2.5 For day-time, the suggested noise limits are 35-40 dB(A) or 5dB(A) above the prevailing background, whichever is the greater. For night-time periods the recommended noise limit is 43 dB(A) or 5dB(A) above the prevailing background, again whichever is the greater. The 43 dB(A) lower limit is based on a sleep disturbance criteria of 35 dB(A) with an allowance of 10dB(A) for attenuation through an open window and 2dB(A) subtracted to account for the use of L_{A90} rather the $L_{Aeq.}$ Quiet day-time periods are defined as evenings from 1800-1900 plus Saturday afternoons from 1300-1800 and Sundays from 0700-1800. Night-time is defined as 1900-0700.

2.6 Where predicted noise levels are low at the nearest residential properties, due to large distances from wind turbines or if a small scale development is planned, a simplified noise limit is permitted by the planning guidelines, such that noise is restricted to a maximum L_{A90} level of 35 dB(A) for wind speeds up to 10 ms^{-1} at 10m height. This recognises that extensive background noise measurements should not be necessary for single turbines or low density schemes well away from neighbours.

2.7 The wind energy project at Corrimony has five turbines, and as they are located significantly further than 1km from any neighbour, it is felt that the simplified 35 dB(A) limit is appropriate, and as no other windfarm is located within 5km of the site; cumulative noise assessment is neither necessary nor required by planning guidance.

2.8 The process used to determine the sound levels was to identify a range of neighbours in different geographical positions, then to measure the distances from these properties to the turbines, considering both the straight line distance and any vertical variation. These measurements revealed that Tomich is over 4.5km to the west of the site, with Corrimony 5.5km to the north. The reduction in sound level that occurs over these distances is then calculated, along with any attenuation factors

2.9 This assessment has used 104 dB(A) as the source sound level within the turbines, and in this instance has considered the worst case result of the neighbour being down wind of the project. The noise calculations take into account reductions in sound pressure level due to geometric wave divergence and also includes a reduction due to atmospheric absorption:

Geometric Wave Divergence:	10 log 2 πr^2, where r is the distance to the neighbouring property.
Air Absorption Attenuation:	0.005 dB/m

2.10 The open moorland nature of the countryside and the long distances between the turbines and neighbours are important considerations, and at these distances the noise calculation revealed that sound levels are predicted to be less than 10dB(A). This is negligible impact and is significantly less than the recommended level of 35 dB(A) at neighbours, and well below the 45dB(A) maximum limit recommended for dwellings belonging to project owners.

2.11 Measurements of low frequency and infra-sonic noise around modern windfarms have shown that levels of such noise are below accepted thresholds of perception even on the wind farm itself[5]. There is no evidence that there are any effects of low frequency sounds at levels below perceptibility. The World Health Organisation has also stated that "there is no reliable evidence that infrasound below the thresholds of hearing produce physiological or psychological effects"[6].

3 Potential disturbance from shadow flicker

3.1 Under certain combinations of geographical position, time of day and time of year, the sun may pass behind the rotor of a turbine and cast a shadow over neighbouring properties. For the properties surrounding the turbines at Corrimony this would normally occur in early morning or late evening when the sun is at low elevations.

3.2 Regarding the issue of potential shadow impact, PAN45 states the following:

"When the blades rotate, the shadow flicks on an off; the effect is known as 'shadow flicker'. It occurs only within buildings where the flicker appears within a narrow window opening. The seasonal duration of this effect can be calculated from the geometry of the machine and the latitude of the potential site. Where this could be a problem, developers should provide calculations to quantify the effect. In most cases however, where separation is provided between the turbines and nearby dwellings (as a general rule 10 rotor diameters), 'shadow flicker' should not be a problem." [1]

3.3 The windfarm at Corrimony has been designed in conjunction with the software programme WindFarm. This programme uses Ordnance Survey 'Panorama' gridded topographic data at a scale of 1:50,000 to create a virtual landscape for assistance in designing layouts. As well as producing photomontage images and calculating zones of visual influence, the programme calculates of the risk of shadow flicker impact, based on the relative geometry of the turbine and any nearby properties. The project design has used a clearance of 820m, 10 rotor diameters, and as the nearest neighbour is 4.2km to the west there appears to be little risk of impact from shadow effects.

3.4 All neighbours are further away from the turbine than ten rotor diameters, nevertheless the risk of shadow impact has been calculated for all the properties to the north and west, regardless of the distance involved. This calculation confirmed that there is no impact whatsoever, at any time of the year, at all neighbours.

3.5 It has been suggested that shadow flicker from wind turbines can have an influence upon individuals susceptible to photosensitive epilepsy. Epilepsy Scotland indicate that television is the most commonly reported trigger of seizures in photosensitive people, and that flickering sunlight through trees or strobe lighting are also triggers. The flash rates reported to produce seizures are between 12 and 24 flashes per second (Hz) [7].

3.6 The flash rate which triggers epilepsy in photosensitive people is at a much higher frequency that the shadows produced by rotating wind turbines. To achieve a rate of 12 to 24 Hz from a three bladed wind turbine would require a rotational speed of 240 to 480 rpm, far greater than any grid-connected wind turbine speed, and approaching the rotational speed of helicopter blades. The shadow flicker from a wind turbine of the scale proposed for Corrimony has a frequency of 0 to 0.95 Hz, compared with the much higher frequencies of 12 to 24 Hz reported to induce seizures in individuals susceptible to photosensitive epilepsy.

4 References and bibliography

1 Planning Advice Note PAN 45 (2002). *Renewable Energy Technologies*. Scottish Executive Development Department; ISBN 0 7559 0372 2

2 ETSU-R-97 (1996). *The Assessment and Rating of Noise from Windfarms*. DTI Noise Working Group

3 Orkney Sustainable Energy Ltd. *Wind turbine noise*. http://www.orkneywind.co.uk

4 ETSU W/13/00385/REP (2000). *A critical appraisal of wind farm noise propagation.* ETSU for the DTI.

5 ETSU W/13/00392/REP (1997). *Low frequency noise and vibrations at a modern windfarm.* ETSU for the DTI.

6 Community Noise (1995). *Archives of the Centre of Sensory Research Vol.2(1),* eds. Bergland and Lindvall. World Health Organisation.

7 Epilepsy Scotland. *Factsheet* http://www.epilepsyscotland.org.uk/images/pdf/photosensitve.pdf