CHAPTER 8 – SHADOW FLICKER ANALYSIS

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8 SHADOW FLICKER ANALYSIS

Introduction

8.1 This assessment identifies and outlines the potential effects of shadow flicker on surrounding residential properties (receptors) as a result of the operation of the Proposed Development.

8.2 Wind turbines are large structures, which can cast long shadows when the sun is low in the sky. Wind turbines can cause 'shadow flicker' under certain circumstances. This happens when the sun passes behind a moving blade and casts a shadow on the window of a neighbouring property. The likelihood of this occurring and the duration of such an effect depends upon the following:

- The direction of the residence relative to the turbine(s);
- The distance from the turbine(s);
- The turbine hub height and rotor diameter;
- The time of year;
- The proportion of daylight hours in which the turbine operates;
- The frequency of bright sunshine and cloudless skies (particularly at low elevations above the horizon); and
- The prevailing wind direction.

8.3 Research by Clarke[1] has demonstrated that shadow flicked only occurs inside buildings when flicker appears through a narrow opening, particularly if the window is the sole source of light. As a general rule of thumb, the residential property must also be within ten rotor diameters of the wind turbine, and in Britain properties must lie within 130 degrees either side of north, relative to the wind turbines.

8.4 Potential disturbance from shadow flicker only occurs at frequencies between 2.5Hz and 40Hz. It is also important to note that the proposed wind turbines are variable speed and the blades rotate between 13 and 19 rpm, giving blade passing frequency of less than 3Hz, well below the frequencies of 5-30Hz

[1] Clarke, A case of Shadow Flicker/ Flashing: Assessment and Solution, Open University. Milton Keynes. 2001

associated with photosensitive epilepsy[2]. No epidemiological effects as a result of operation of the wind turbines are therefore predicted.

8.5 Modern turbines turn slower than earlier models making shadow flicker less of an issue, however, shadow flicker can still occur as a result of the sweep of the blades through the rays of sun which could be noticeable to affected properties.

8.6 The shadow flicker methodology utilised for this assessment presents a worse-case prediction of potential effects. In practice, shadow flicker effects would occur for considerably less time than the worst-case predictions as calculated by the shadow flicker model. There are two principal reasons for this; firstly, in the UK sunshine typically occurs for approximately 30% of daylight hours. At other times, the wind turbines are unlikely to cast shadows sufficiently pronounced to cause shadow flicker effects to occur. Secondly, during those times when wind turbine rotors are not orientated directly towards receptors, i.e. the nacelle and blades are not face on to the receptors, the duration of the shadow flicker effects would be reduced due to the elliptical shape of the shadow cast. Therefore, the widths of the shadow cast would range from the thickness of the blade when the blades are in line with the sun and receptor to a width equal to the rotor diameter, at those times when the rotor is perpendicular to the sun and receptor.

8.7 Consequently, for the purposes of this assessment, the duration of the shadow flicker effects has been calculated for worst-case conditions in which the software ('Windpro' see para 8.15) assumes that the turbines will be perpendicular to the sun at all times.

8.8 Within this section, the following has been undertaken:

- Methodology for the shadow flicker assessment has been detailed;
- Existing receptors (residential properties) within an identified study area have been described;
- Effects of shadow flicker as a result of the movement of the wind turbine blades on the surrounding receptors have been identified and described;

[2] (b) Publisher Unknown, Wind Energy - the Facts, paragraph 5.1.7, Flickering, p185, July 2004

- Mitigation measures which aim to avoid, reduce or compensate for the identified effects has been presented, if appropriate; and
- A conclusion of the significance of the shadow flicker effect has been given.

Assessment Methodology and Significance Criteria

8.9 TAN8[3] provides some guidance on shadow flicker effects from wind turbines. Annex 3, paragraphs 2.32 - 3.33 state the following:

Shadow Flicker and Reflected Light

2.32 Under particular circumstances the sun may pass behind the rotors of a wind turbine and cast a shadow over neighbouring properties. The shadow flicks on and off as the blades rotate. This can be disturbing for the affected residents or even have the potential of being a health problem for people who are photo-sensitive epileptics. The problem is seasonal and only lasts for a few hours per day, but needs to be investigated where any potential exists. Developers should provide an analysis of the potential for shadow flicker impacting upon any nearby properties.

2.33 Turbines can also cause flashes of reflected light, which can be visible for some distance. It is possible to ameliorate the flashing but it is not possible to eliminate it. Careful choice of blade colour and surface finish can help reduce the effect. See "The Influence of Colour on the Aesthetics of Wind Turbine Generators" - ETSU W/14/00533/00/00 for detailed advice.

8.10 Within Wales there is no standard for the assessment of shadow flicker and there are no guidelines on what exposure would be acceptable, therefore best practice guidance from the UK.

8.11 In Northern Ireland the equivalent planning guidance to TAN8 is the draft Best Practice Guidance to PPS 18 Renewable Energy (Northern Ireland Department of the Environment, 2009). This states that only properties within 130 degrees either side of north of the turbines can be affected at UK latitudes and the potential for shadow flicker at distances greater than ten rotor diameters from a turbine

[3] Technical Advice Note 8: Renewable Energy, 2005

position is very low. This shadow flicker assessment has been based on these principles.

8.12 PPS 18 Renewable Energy also provides an indication of what may be an acceptable duration of shadow flicker (page 29), stating that:

'It is recommended that shadow flicker at neighbouring offices and dwelling…should not exceed 30 hours per year or 30 minutes per day'.

8.13 For the purpose of this chapter, values greater than 30 hours per year or 30 minutes per day are considered significant.

8.14 An analysis has been performed to ascertain the potential shadowing effects to nearby properties and is described below. The study area for the shadow flicker assessment was defined as an area around each turbine, 10 times the rotor diameter (therefore in this case 1000m) and within 130° either side of north.

8.15 A specialised computer package called Windpro has been used to determine the maximum number of hours in the year when shadows may theoretically be cast from the wind turbines towards dwellings within ten rotor diameters of the site. This is based upon the worst-case conditions of:

- Assuming narrow window openings;
- No screening from buildings or vegetation;
- Full sun from sunrise to sunset (i.e. no cloud cover);
- The rotor planes always perpendicular to the line from the wind turbine to the sun i.e. the sun is low in the sky and directly behind the turbine when viewed from a property; and
- The wind turbine is always operating (i.e. correct wind speed).

8.16 There is no established guidance on the interpretation of the significance of the effects in the UK, as a result of shadow flicker receptors. The evaluation of effects will be based on the frequency, timing and duration of events, and whether these are considered likely to affect the amenity of the occupants.

Baseline Description

8.17 The wind turbine proposed for the development will have a rotor diameter of up to 100m. Therefore, the shadow flicker assessment has been carried out for

properties that lie within 1000m (10 x rotor diameter) of the wind turbines (see Table 8.1 below) and within 130 degrees either side of north, relative to the wind turbines location. Five dwellings were identified within 1000m of the wind turbines (Figure 8.1), however only two are orientated in a compass direction that may witness shadow flicker.

Table 8.1: Proposed Turbine Coordinates

Turbine Number	Easting	Northing
T1	256960	241001
T2	256950	241248

Results and Conclusions

8.18 Table 8.2 below provides a summary of worse case results from the Windpro shadow flicker modelling. Only two of the dwellings identified (A and E) are predicted to experience shadow flicker effects under a worst-case scenario. As expected, no effects are predicted for properties B, C and D, due to their orientation to the proposed turbines. Further detail from the Windpro shadow flicker modelling can be found in Appendix 8.1.

Table 8.2: Summary of Worst-case Shadow Flicker Results

Receptor	Name	Coordinates (Easting, Northing)	Distance from nearest Turbine (m)	Total hours per year when shadow flicker may occur	Max. minutes per day when shadow flicker may occur	Summary of effect
A	Cefnblaenau	257678, 241860	951	27:44	26	No significant effect
B	Caermalwas Fawr	256463, 240383	793	0	0	No effect
C	Esgairliving	257096, 240300	714	0	0	No effect
D	Tanrhiw	256617, 240415	679	0	0	No effect
E	Bwlch Caermalwas Fach	256158, 240512	939	2:12	11	No significant effect

8.19 Despite the predicted shadow flicker effects for properties A and E above, the frequency of potential occurrence would not be considered significant. In addition, the shadow flicker assessment was carried out on a worse-case scenario assuming the sun is always shining at times when shadow flicker could

theoretically occur. It is therefore unlikely that this level of shadow flicker occurrence would actually be realised.

8.20 Notwithstanding the fact that no significant effects are predicted, in order to protect the amenity of local residents, a condition could be attached to any permission that would allow any legitimate complaint to be investigated and appropriate mitigation applied, if necessary.