Comment on 'shadow flicker' and photosensitive epilepsy

Issued : November 2008
Revision : '0'

DEFINITIONS

Flicker: A term used to describe inconsistent or wavering light.

Shadow flicker: An effect that occurs when the sun is viewed through the rotating blades of a wind turbine

INTRODUCTION

quiet**revolution** are regularly asked to comment on 'shadow flicker'. However when we are asked to comment, there is rarely any definition of shadow flicker provided, **nor** is there any attempt to provide assessment criteria against which a reasonable evaluation could be made.

This commentary attempts to summarise the potential issues and dispel the myths. The assumption is that the affect of shadow flicker is experienced within a building, whether a dwelling, office or other building type.

HORIZONTAL VERSUS VERTICAL WIND TURBINES

At this stage the issue of reflected light for quiet**revolution** turbines is not considered to be a problem as the twisted helix shape of the blades and the curved shape of other surfaces will disperse light rather than focusing it toward the viewer. The same may not be true of the majority of land based horizontal axis wind turbines, which have three or five blades; are often larger in scale; and commonly have flatter more linear faces which would have more of a potential to reflect light in a single direction causing a flickering affect to the viewer.

STANDARDS AND CASE STUDIES

There are as yet no British, European or International Standards for shadow flicker levels. This is because the perceived risk is too small and difficult to measure and the subject is complex with a large number of variables.

Despite the growing number of wind turbines installed worldwide, evidence of flicker effects is hard to find. Even in countries such as Germany, which is renowned for setting rigorous, demanding and thoroughly researched standards, there are no published standards and we can find NO examples of turbines causing photosensitivity related fits.

A rule of thumb, however, has been adopted [*and upheld by the German legal system*] that 30 hours of shadow flicker per year is acceptable[2]. This is based on those 30 hours being when:

i. The sun is shining

quiet**revolution** ltd. 1.11 Clerkenwell Workshops, 31 Clerkenwell Close, London EC1R 0AT
Tel: +44 20 7014 3399 **Fax**: +44 20 7014 3388 **Email**: info@quietrevolution.com

Registered in England No. 5405104
VAT No. 918 5666 85

ii. The building affected is occupied
iii. The occupants are awake
iv. The turbine is spinning

Other European countries such as Denmark and Holland with large wind industries follow similar guidelines to Germany, and there are no reported cases in any of these countries.

SUMMARY OF RISK

Based on the above rule of thumb, for shadow flicker to be an issue the following must all occur:

1. The sun must be shining [not behind cloud] *

2. The wind must be blowing at a speed sufficient for the wind turbine to be operational [for a quietrevolution turbine this is 4.5 to 16m/s] *

3. The flickering light must fill the majority of the field of vision.

4. There must be a person in the room and the person must be awake
   - For a bedroom this might only be, at most, 1 hour per day during the morning. Individual habits will vary but the hour is most likely to fall between 6.30-10am
   - For a living room the hours of occupation might be daylight hours [assuming that the occupants are not out at work
   - For a work environment, the hours of occurrence might typically be, between 8.30am and 6.00pm

5. There must be no curtains or blinds

* **Note:** *To estimate the number of hours where both the wind is blowing and the sun is shining a calculation is made. This calculation is termed "the de-rating factor". To determine the de-rating factor, historical meteorological data is used, In the UK the number of hours where both the wind is blowing and the sun shining is typically only 30% of daylight hours.*

PHOTOSENSITIVE EPILEPSY

The primary (and only real) cause for concern in relation to 'shadow flicker' is the risk of stimulating an epileptic fit in those who are susceptible to photosensitive epilepsy.

About 1% of the population suffer one or more epileptic fits during their lifetime. Of those who suffer from epilepsy only about 4% suffer with epileptic fits that are triggered by photosensitivity. This equates to approx. 23,200 people in the UK, or 0.04% of the population. In addition the specific trigger for any particular individual will vary.

The causes of a photosensitive epileptic fit are numerous [1], it is much more complex than simply flickering light. The factors include:

- DISTANCE: for wind turbines typically 10x rotor diameter is considered the limit of any potential problem, [the qr5 is equivalent of a ø4.2m HAWT] therefore a 42m limit is reasonable

  [PAN 45 (Revised 2002) Renewable energy technologies, paragraph 64. '…where separation is provided between wind turbines and nearby dwellings (as a general rule 10 rotor diameters), 'shadow flicker' should not be a problem.

- FREQUENCY: 7Hz to 20Hz are considered to be the frequencies, where those at risk of photo sensitive epilepsy, are more likely to suffer a seizure. The frequencies 5Hz to 30Hz have a substantially lower risk and for frequencies outside these ranges the risk is minute.
  For information, quiet**revolution**'s qr5 turbine CPS is 1.67Hz to 4.30Hz [100-260 RPM]

- COLOUR: The colour of the light is critical, deep red contrasted with other colours, especially blue, is known to have the worst affect. People who are susceptible to photosensitive epilepsy, due to colour contrast, often wear optical filters to dramatically reduce their risks.

- AGE: Photosensitive epileptic fits and far more common in the young than in adolescents and even less among adults.

- FIELD OF VISION: The amount of the individuals field of vision that is exposed to the light [e.g. A very large screen [or the viewer sitting close] with flashing lights is more likely to trigger a fit that a smaller screen [or the viewer at a greater distance]. If the field of vision is less than 25% flicker light it is not generally a problem. For this reason a turbine in an external environment is never likely to cause a photo sensitive epileptic fit as the percentage of the field of vision occupied by the flickering light is always likely to be far below 25%.

- INTENSITY: or brightness of the light

- CONTRAST: Between the light and shadow [the greater the contrast the greater the risk]. There will be far less contrast as the sun rises and sets than in the middle of the day.

- BACKGROUND LIGHT LEVELS. In a typical office environment the background light levels are normally high as large numbers of ceiling mounted fluorescent lights are usually permanently switched on during working hours. Offices also typically have blinds to filter and diffuse direct sunlight, as sunlight makes the viewing of monitors very difficult.

REPORTED OCCURRENCES

We have searched extensively in the UK and abroad for reported occurrences of shadow flicker actually causing a photosensitive epileptic fit or seizure, however we can find no reported occurrences anywhere and certainly no cases that have come to court or encouraged any legislative body to explore the possibility of writing a suitable standard.

There are pseudo-scientific papers that report on the potential risks, but these papers also do not site any examples where there have been photosensitive epileptic seizures or even reportable problems caused by shadow flicker from a wind turbine, these papers often include some fantastic quotable lines but do not back up their claims with evidence.

There are currently [Autumn 2008] approx. 9,000 small scale wind turbines installed in the UK, in locations from dwellings to schools, offices, factories etc., none of these turbines have to date caused a reportable incident of flicker induced epilepsy.

TO CONCLUDE

For a wind turbine to present a potential hazard to someone who is at risk from photosensitive epilepsy, **all** of the following must be true:

- The wind must be blowing.
- The sun must be shining.
- The observer must be close enough to the flickering light source to be affected
- The observer must be within in the flickering light field
- A large percentage of the individuals visual cortex must be stimulated [over 25%]
- The rotor must be spinning at a speed that affects the specific photosensitive range of the observer.
- The rotor spinning speed must stay in the specific range long enough to trigger a reaction.
- The background illumination must be low
- The contrast between shadow and light must be high
- The colour spectrum of the light must be in the correct range to affect the individual
- There is nothing blocking out the flicker light, such as blinds or a tree outside the window.
- The individual does nothing to remove themselves from the flicker light source before it begins to affect them.

Note: due to the constant movement of the sun through the sky, the amount of time a flickering source may fall on any particular place or window is likely to be less than 10-15 minutes on any particular day and if a location is susceptible in mid summer, it will almost certainly not be susceptible at other times of the year.

Therefore in the absence of any published standards or case studies, and on the basis of the above factors the risk is perceived to be very low and hard to measure, and therefore flicker or shadow flicker concerns should not be a reason for planning permission being refused for a wind turbine installation.

EXAMPLES

1 : A typical working office

Once the factors below are considered the risk of photosensitive epileptic fit occurring within an office environment has dropped well below the levels of other risks present in a typical workplace. Risks that are either highly unlikely or if occurring have only a minor impact can be managed in the same way as other minor office risks, such as, fire evacuation procedures, lifting and manual handling, first aid, trip hazards etc.

People in an office will be generally adults, the environment is likely to be low contrast, there are likely to be large windows [making the 25% field of vision occupied by a flickering source as unlikely]. There are likely to be blinds if direct sunlight is ever a problem and the sun is likely to be high in the sky and therefore the shadows short, limiting the impact to a smaller area There will also be only a limited amount of time with both wind and bright sun.

Once the above factors are considered, if quantified, the number of people who might be affected in this environment are very small, perhaps 3,000 people in the UK or perhaps 210 people working in offices in London.

SOURCES:

1. The National Society for Epilepsy, January 2007, [www.epilepsynse.org.uk]
2. http://www.windpower.org/en/tour/env/shadow/index.htm