ADVICE ON

Wind Turbines and Horses – Guidance for Planners and Developers

The British Horse Society

The UK is committed to producing 15 percent of energy from renewable sources by 2020 and government strategies incorporate the use of wind energy towards this target. The BHS does not express an opinion on the use of wind energy as its concern is for equestrian safety, however:

The potential effect of turbines on horses should be considered on any route used by them – this includes bridleways, byways, roads and permissive routes – and on businesses where horses are kept or trained.

Horses are most likely to react to the noise made by wind turbines, the movement of the blades, or movement of shadows cast by the blades. Placement of turbines must take account of existing equestrian access in minimising these effects of turbines close to routes used by horses or businesses where horses are kept.

Even though some horses are untroubled by turbines – photographs and film of horses grazing or being ridden near turbines are easily available – there are plenty of reports of horses whose reaction to a turbine has been adverse. There will be many unreported incidents and records of them are much harder to find because they were unexpected.

It cannot be assumed that it is safe to introduce turbines near equestrian routes because there are fewer reports of adverse reactions than of horses accepting turbines.

Most wind farms until recently have been in less populated areas with alternative equestrian routes and many riders have been able to choose to avoid going near turbines if they wish.

Proposals for wind energy projects are now increasing in more populated areas where there is a much higher density of traffic and urbanisation, and a much lower number of off-road routes and quiet roads. Riders may not have a choice of routes, commonly only one off-road route is available – none at all in many areas – so many riders and most carriage-drivers are reliant on quiet roads.

Wind farms can have a very severe and wide-reaching effect on the continued rights of equestrians to use off-road routes, pushing them onto busy roads or causing them to transport horses to less hostile environments for daily exercise, or to give up. All of these responses affect other traffic, the environment and the economy. It is estimated that an owner contributes more than £3,000[1] to the local economy for every horse, and horse riding

[1] British Equestrian Trade Association Survey 2011 found that direct expenditure on upkeep and care was £3,105 per horse per annum

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is an activity and sport undertaken by mature women, for whom exercise opportunities should not be reduced.

There have been no formal trials to establish horses' responses to turbines so there is no evidence as such, only anecdotal reports. Funding for such a trial would be difficult to acquire, even if it was considered humane to put animals into a situation that was known to be potentially unsafe or distressing. Reliance has to be on reported experience, which demonstrates, even in a very limited survey[2], that more than 20 percent of riders had experienced an adverse reaction from horses to wind turbines. It is important to note that the horses affected included placid, experienced and well-trained horses accustomed to all sorts of situations, and such as would often be partnered by a particularly vulnerable rider (young, inexperienced or with limited ability to cope) who may be reliant on off-road routes. A high proportion of riders would not risk taking their horses near turbines due to the bad experience of others or their own caution.

It may be argued that the evidence of the survey is poor because of the many variables such as other things the horse could be reacting to and that people's perceptions cannot be taken into account. However, in the absence of trials or surveys to the contrary, it remains that some horses and riders will be affected and the fewer alternatives there are for those people to continue to ride in safety, the less appropriate it is that their right of use of

[2] British Horse Society survey of Wind Turbine Experiences 2012

any route should be jeopardised.

BHS guidance in the 1990s recommended a minimum of 200m separation distance from bridleways, when the maximum height of turbines was around 65m. The distance was soon revised to three times tip height as turbines quickly became larger, although this was too late to include in government planning guidance.

BHS Policy Statement

The BHS strongly recommends that the views and concerns of local equestrians should be recognised and taken into account when determining separation distances and that normally a

> **minimum separation distance of 200m[3] or three times blade tip height (whichever is greater) will be required between a turbine and any route used by horses or a business with horses.**

This minimum separation distance may not be appropriate in all situations. Every site should be considered independently because there are likely to be many interdependent factors involved. A holistic approach is required that considers all of those factors, common ones of which are listed below, although less usual ones may occur in any location and require individual consideration.

The BHS is aware that every site is different and a blanket policy to cover all situations may be excessively restrictive for some sites. Emphasis is therefore placed on consideration of all factors with consultation and negotiation with local riders and carriage-drivers.

A single microgeneration unit, for which three times tip height is less than 200m, will be accepted at the lesser distance provided that there are no other factors that increase the separation distance required.

Factors which affect the separation distance required are:

- Availability of alternative routes and their desirability compared with the affected route. An assessment of routes and use patterns in the location may be needed. The fewer alternatives available, the more the impact on the affected route should be mitigated by increasing separation distances.
- The number of turbines and their location relative to the route:

[3] Includes all classes of highway available to horses – bridleway, restricted byway, byway open to all traffic, general purpose road (surfaced or unsurfaced) – and permissive routes

- One turbine is much easier to cope with than many; the more machines, the greater the threat.
- Turbines to one side only may create an easier situation than to both sides.
- Several turbines to both sides of a route; the longer the corridor, the greater the risk.
- Clear ahead or clear behind is better than turbines visible both in front and behind at the same time. A horse has nearly 350° vision and may react to a threat from behind that a rider cannot see.
- Location north of a route is better than south as it will not cast shadows across the route – turbines east and west of a north-south route is the worst scenario for incidence of shadow cast at any time of day. However, on some sites this instance may be occasional and it may be feasible for a turbine to be turned off in such circumstances but able to generate at all other times.

- Other hazards on the route so that the addition of turbines to existing

hazards creates an unreasonable situation, examples would be a deep ditch, reduced width, barbed wire fence, gate, blind bend or ruts. This is also true for turbines near a road, where an equestrian on the road already has motor vehicular traffic to consider and a horse's reactions may have immediate impact on other road users.

- Undulating ground which alters the height at which moving blades are in view is different from flat ground where all movement is well above eye level from any approach.
- Encountering a moving turbine at close quarters because it was obscured on approach by a hill, wood or building is a greater risk than approaching a turbine clearly in view from several hundred metres.

Depending on local variation caused by prevailing wind and day length, the separation distance to avoid shadow cast will be greater where a route lies north of a turbine between west south west and east south east. Figure 1 roughly shows the area which will be affected by shadows and where the separation distance between route and turbine should be greater. The shaded area also reflects where noise is likely to be more of a problem because the route is downwind of prevailing wind in much of England and Wales.

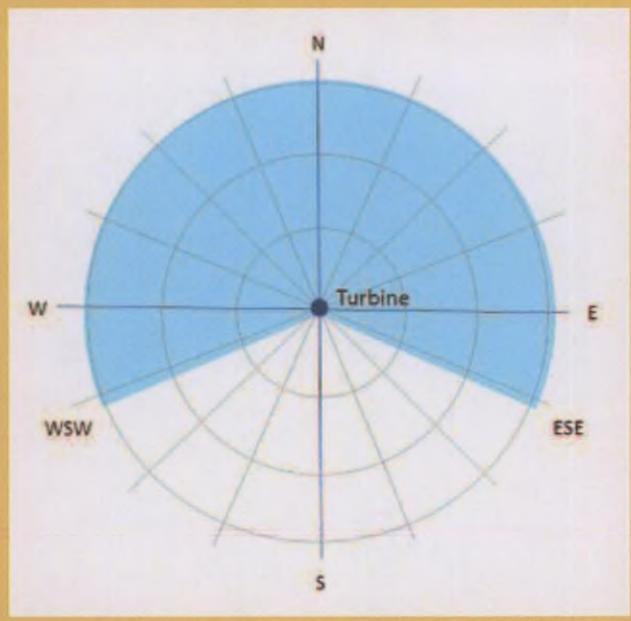


Figure 1: Separation distance between the turbine and route should be greater for routes in the blue area

Provision of alternative routes or improvement of existing facilities may reduce the impact of a wind farm, for example if a path can be provided off-road so that riders are not coping with traffic and tarmac as well as the wind turbines. Even if the separation distance between the turbines and the alternative route is less than to the road, it may be a preferable and safer option for some users.

Anemometers should be located at a distance greater than their overall height from an equestrian route. Cables must not cross an equestrian route,

including during erection of the mast. Their ground points should be at least 3m from an unfenced equestrian route and cables should be wrapped or sleeved to a height of 2m to increase their visibility.

Some anenometers have been found to produce a high pitched bleeping which is evidently distressing to horses. Models emitting noises should be avoided.

Access for construction purposes should avoid bridleways or byways as it is incompatible with equestrian use and routes should not be closed to equestrians so as to facilitate construction. Alternative construction traffic routes may be required.

Why horse riders are concerned

There are reports of horses being frightened by turbines, and equally there are reports of horses being undisturbed by them or quickly becoming accustomed to them. Horse owners are naturally concerned about the possible effect of turbines on their horses and may view them as a very high risk to their safety. Horses are flight animals and if frightened, they may make abrupt unexpected movements or bolt (run out of control), both of which may cause a rider to fall at speed and risk injury to him or herself, the horse, and to anyone in the horse's path.

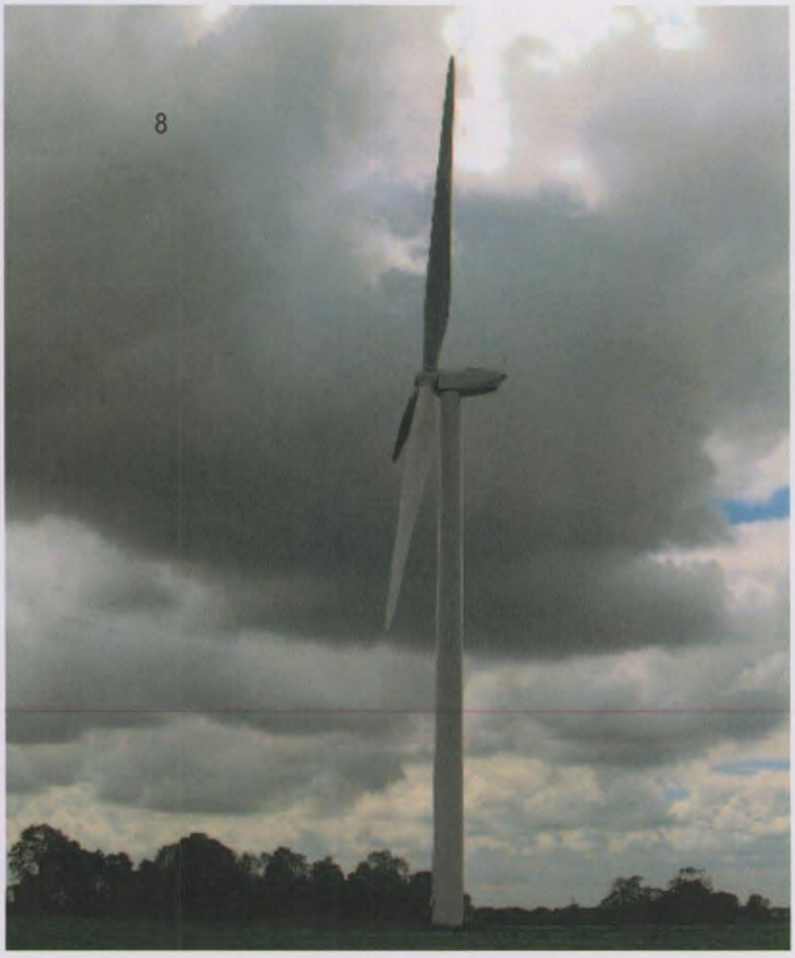
Equestrians have very few off-road riding opportunities – less than a quarter of paths available to walkers and even fewer to carriage-drivers – so the potential loss of any route is understandably of grave concern. Any route that was previously available to all should not be rendered unsafe for some. In the majority of cases where riders and carriage-drivers are displaced from off-road routes their only alternative will be greater use of roads, with an increased risk to themselves and other road users.

How horses react to turbines

Some horses appear very fearful of wind turbines, others are unconcerned. This does not seem to be related to the ability of the rider or handler, or to the temperament of the horse – bomb-proof veterans have been known to react badly and spooky thoroughbreds to appear oblivious. There are also reports of horses that have previously encountered turbines calmly but on another occasion, with no apparent difference in conditions, have reacted adversely.

From reports of experiences, horses are most likely to be reacting to noise, movement of the blades or movement of shadows cast by the blades.

During the design stage, a wind energy project developer should



communicate with the authority's access officers to ensure that equestrian routes are taken into account and turbines located with maximum separation from horses to reduce the effect of noise, movement or shadows. This applies equally to a microgeneration system as a large commercial wind farm. Businesses with horses should be considered in the same way.

Movement is most likely to have an adverse effect on horses if it starts or changes direction suddenly, or if it is seen suddenly at close quarters, rather than having been visible from several hundred metres. Although sudden movement is very unlikely with commercial turbines, microgeneration units[4] can react quite abruptly to gusts and changes in wind direction and the movement and noise seem much greater because they are closer to the horse. They should be of a design that minimises 'yawing' of the head with changing wind direction.

A turbine's blades sailing over a right of way is found threatening by many people, but may be agreed with the planning authority if it reduces impact on another part of the site. It should be avoided on an equestrian route.

The BHS has received reports of turbines subject to annual testing producing sudden unusual high noise levels, which may be very frightening to horses. This should be avoided and, if it is required, then notification at least five days in advance should be clearly signed on approaches to the site at a distance that will be out of range of the noise. Websites for wind farms should also show the information prominently.

Moving shadows cast by blades are likely to be found more threatening by some horses when they fall on a hard surface than on vegetation. Shadow

[4] Microgeneration is the small-scale generation of heat and electric power by individuals, small businesses and communities to meet their own needs

cast can be predicted and turbines must be sited to avoid casting shadows on equestrian routes. Strategic hedge or tree planting or hedge management may shield an equestrian route from the effect.

Local horses may become accustomed to turbines, but this may not be feasible for businesses which horses visit for short periods. Some horses away from their home environment and accustomed handler may be more sensitive than in a familiar environment. Several planning authorities have taken account of the effect on horses and business in turning down applications for turbines in close proximity to stud farms dealing mainly with highly strung blood horses and other equestrian related businesses dependent on visiting horses. However, many horses do not react to turbines at all and the number of microgeneration projects for rural businesses or at competition venues[5] is rising, which over time is likely to help horses habituate to turbines.

Inclusion of information about turbine locations along with other potential hazards in promotional material for riding routes will help riders consider the risks in advance. Where possible, it may be pragmatic to suggest alternative routes.

Developers, local authority planning officers and the Planning Inspectorate (hearing public inquiries on wind projects) are dependent on evidence for their decisions on whether turbines are appropriate in a certain location. To date, relatively few dangerous incidents involving horses have been reported. As the number of turbines in the country increases and more riders encounter them, there may be more incidents but as turbines become commonplace and people accept them, so too will horses. If the number of incidents reported to the BHS increases and indicates that the safety of horses and riders or carriage-drivers is at risk, then the situation and policies will be reviewed.

Mitigation

There are a number of actions which may benefit riders and carriage-drivers or reduce the effect of turbines on them. They include:

- Provision of new definitive or permissive routes or improvement of existing routes in the locality to provide alternatives for those at risk for the life of the wind energy project.
- Diversion of routes to a greater distance or with increased sightlines to

[5] A demonstration turbine close to the equestrian area at the Pembrokeshire County Show in 2012 caused at least four incidents of horses reacting out of control, presumably to the turbine, and on investigation the Show decided not to permit demonstration turbines near equestrian areas at future events

avoid suddenly coming upon turbines within 500m.

- Consideration of potential impact on riders and/or carriage drivers should they be unable to continue using a route because of turbines, such as availability of alternative routes in the immediate vicinity.
- On many developments it can be identified that a limited number of turbines will affect an equestrian route with over-sail or shadow cast only under certain conditions. It is possible to model those conditions and to programme specific turbines to switch off as required to abate the nuisance.
- Consideration of the nature of the route in terms of space for a horse to shy, spin, jump or be manoeuvred on firm level ground; proximity of and access to roads if a horse was to bolt out of control.
- Notification to equestrians of certain days during construction most likely to be a hazard; for instance, concrete pouring creates many vehicle movements during a short period of time.
- Restriction of construction and construction traffic to 8am-6pm week days only so that routes can still be used during the construction period at the times of highest demand for equestrians.
- Restriction of construction traffic to roads or new tracks. Bridleways or byways must not become access roads. If this is unavoidable, alternative equestrian routes should be provided and the surface of the bridleway or byway restored to one suitable for horses.
- Notification of when turbine blades will be static, prior to commissioning, so that riders can familiarise horses by degrees.
- Notification after commissioning of test days throughout the life of the turbine(s) which may produce increased or unusual noise or speed.
- Familiarisation days organised on site.
- Using microgeneration machines of a design that minimises 'yawing' of the head with the changing wind direction as sudden movements are those most likely to frighten horses and risk an accident.
- Strategic hedge or tree planting or hedge management to shield an equestrian route from the effect of moving shadows on a path or blades at eye level.

This guidance does not apply in Scotland, for which the BHS produces separate guidance. Variation in the two documents arises from very different law relating to access and to patterns of land use between the countries.

If this advice note is a printed copy, please check for the latest version on www.bhs.org.uk/access-and-bridleways

For more information on The British Horse Society's rights of way work contact:

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The British Horse Society

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APPENDIX 5-2

WIND FARMS & HEALTH LITERATURE REVIEW, CHAPMAN 2015

Summary of main conclusions reached in 25 reviews of the research literature on wind farms and health.

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Updated 10 April 2015.

1. Council of Canadian Academies (2015). Understanding the evidence. Wind Turbine Noise.
2. **Schmidt JH, Klokker M (2014) Health effects related to wind turbine noise exposure: a systematic review. PLoS ONE 9(12): e114183. doi:10.1371/journal.pone.0114183**
3. 2014: McCunney RJ, Mundt KA, Colby WD, Dobie R, Kaliski K, Blais M. Wind turbines and health: a critical review of the scientific literature. Journal of Occupational & Environmental Medicine 2014; 56(11):pe108-130.
4. 2014: Knopper LD, Olson CA, McCallum LC, Whitfield Aslund ML, Berger RG, Souweine K, McDaniel M. Wind turbines and human health. Frontiers in Public Health 2014; 19 June
5. 2014: Arra I, Lynn H, Barker K, Ogbuneke C, Regalado S. Systematic review 2013: association between wind turbines and human distress. Cureus 6(5): e183. doi:10.7759/cureus.183 [Note: this review is a very poor quality paper published in a non-indexed, pay-to-publish journal. A detailed critique of it can be found at the end of this file.]
6. 2014: National Health and Medical Research Council (Australia). University of Adelaide full report (296pp) and draft consultation report (26pp). Final Report (Feb 15 2015)
7. 2013: VTT Technical Research Centre of Finland. (in Finnish) – summary at end of document
8. 2013: Department of Health, Victoria (Australia) Wind farms, sound and health.
9. 2012: Massachusetts Department of Environmental Protection. Independent Expert Science Panel Releases Report on Potential Health Effects of Wind Turbines
10. 2012: Oregon Wind Energy Health Impact Assessment.
11. 2011: Fiumicelli D. Windfarm noise dose-response: a literature review. Acoustics Bulletin 2011; Nov/Dec:26-34 [copies available from simon.chapman@sydney.edu.au]
12. 2011: Bolin K et al. Infrasound and low frequency noise from wind turbines: exposure and health effects. Environmental Res Let 2011;
13. 2010: Knopper LD, Ollsen CA. Health effects and wind turbines: a review of the literature. Environmental Health 2010; 10:78
14. 2010: UK Health Protection Agency Report on the health effects of infrasound
15. 2010: NHMRC (Australia) Rapid Review of the evidence
16. 2010: Chief Medical Officer of Health in Ontario
17. 2010: UK Health Protection Agency. Environmental noise and health in the UK. A report by the Ad Hoc Expert Group on Noise and Health. (this report is about all environmental noise)

18. 2009: Minnesota Department of Health. Environmental Health Division. Public Health Impacts of Wind Turbines.
19. 2009: Colby et al. Wind Turbine Sound and Health Effects: An Expert Panel Review.
20. 2008: Chatham-Kent Public Health Unit.
21. 2007: National Research Council (USA): Impact of wind energy development on humans (Chapter 4: pp97-120) of: Environmental Impacts of Wind-Energy Projects.
22. 2006: Context and Opinion Related to the Health Effects of Noise Generated by Wind Turbines, Agence Française de Sécurité Sanitaire de l'Environnement et du Travail(Affset), 2006. (in French only)
23. 2005: Jakobsen J. Infrasound emission from wind turbines. *J Low Frequency Noise, Vibration and Active Control* 2005; 24(3):145-155
24. 2004: Leventhall G. Low frequency noise and annoyance. *Noise & Health 2004;*.6(23):59-72
25. 2003: Eja Pedersen's Review for the Swedish EPA

Reviews of the evidence - extracted highlights

Direct health effects from noise and WTS

- "There is no consistent evidence that noise from wind turbines—whether estimated in models or using distance as a proxy—is associated with self-reported human health effects. Isolated associations may be due to confounding, bias or chance." NHMRC (2014) full report

- "There are no direct pathological effects from wind farms and that any potential impact on humans can be minimised by following existing planning guidelines." *Source: NHMRC 2010*
http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/new0048_evidence_review_wind_turbines_and_health.pdf

- "There is no evidence that the audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects." *Source: Colby 2009 review*
http://199.88.77.35/EFiles/docs/CD/PlanCom/10_0426_IT_100416160206.pdf

- "... surveys of peer-reviewed scientific literature have consistently found no evidence linking wind turbines to human health concerns." *Source: CanWEA*
http://www.canwea.ca/pdf/CanWEA%20-%20Addressing%20concerns%20with%20wind%20turbines%20and%20human%20health.pdf

- "There is insufficient evidence that the noise from wind turbines is directly... causing health problems or disease." *Source: Massachusetts review*
http://www.mass.gov/dep/energy/wind/turbine_impact_study.pdf

- "There is no reason to believe, based on the levels and frequencies of the sounds and... sound exposures in occupational settings, that the sounds from wind turbines could plausibly have direct adverse health consequences." *Source: Colby 2009 review* http://199.88.77.35/EFiles/docs/CD/PlanCom/10_0426_IT_100416160206.pdf

- "... while some people living near wind turbines report symptoms such as dizziness, headaches, and sleep disturbance, the scientific evidence available to date does not demonstrate a direct causal link between wind turbine noise and adverse health effects. The sound level from wind turbines at common residential setbacks is not sufficient to cause hearing impairment or other direct health effects..." *Source: Ontario CMOH Report* http://www.health.gov.on.ca/en/public/publications/ministry_reports/wind_turbine/wind_turbine.pdf

- "... the audible noise created by a wind turbine, constructed at the approved setback distance does not pose a health impact concern."*Source: Chatham-Kent Public Health Unit* http://www.harvestingwindsupport.com/blog/wp-content/uploads/2011/03/Chatham-KentHealth-and-Wind-.pdf

- There is no evidence for a set of health effects, from exposure to wind turbines that could be characterized as a "Wind Turbine Syndrome." *Source: Massachusetts review* http://www.mass.gov/dep/energy/wind/turbine_impact_study.pdf

- "... there is not an association between noise from wind turbines and measures of psychological distress or mental health problems." *Source: Massachusetts review* http://www.mass.gov/dep/energy/wind/turbine_impact_study.pdf

- "Evidence that environmental noise damages mental health is... inconclusive." *Source: Ad Hoc Expert Group on Noise and Health* http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1279888026747

- "...no association was found between road traffic noise and overall psychological distress..."*Source: Ad Hoc Expert Group on Noise and Health* http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1279888026747

- "To date, no peer reviewed scientific journal articles demonstrate a causal link between people living in proximity to modern wind turbines, the noise (audible, low frequency noise, or infrasound) they emit and resulting physiological health effects." *Source: Knopper&Ollson review* http://www.ehjournal.net/content/pdf/1476-069X-10-78.pdf
  "... there is no scientific evidence that noise at levels created by wind turbines could cause health problems other than annoyance..." *Source: Eja Pedersen 2003 Review* http://www.naturvardsverket.se/Documents/publikationer/620-5308-6.pdf

  "None of the... evidence reviewed suggests an association between noise from wind turbines and pain and stiffness, diabetes, high blood pressure, tinnitus, hearing

impairment, cardiovascular disease, and headache/migraine." *Source: Massachusetts review* http://www.mass.gov/dep/energy/wind/turbine_impact_study.pdf

"...there are no evidences that noise from wind turbines could cause cardiovascular and psycho-physiological effects." *Source: Eja Pedersen 2003 Review* http://www.naturvardsverket.se/Documents/publikationer/620-5308-6.pdf

"...there was no evidence that environmental noise was related to raised blood pressure..."*Source: Ad Hoc Expert Group on Noise and Health* http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1279888026747

- "The health impact of the noise created by wind turbines has been studied and debated for decades with no definitive evidence supporting harm to the human ear." *Source: Chatham-Kent Public Health Unit* http://www.harvestingwindsupport.com/blog/wp-content/uploads/2011/03/Chatham-KentHealth-and-Wind-.pdf

- "The electromagnetic fields produced by the generation and export of electricity from a wind farm do not pose a threat to public health..."*Source: NHMRC 2010* http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/new0048_evidence_review_wind_turbines_and_health.pdf

- "... no consistent associations were found between wind turbine noise exposure and symptom reporting, e.g. chronic disease, headaches, tinnitus and undue tiredness." *Source: Bolin et al 2011 Review* http://iopscience.iop.org/1748-9326/6/3/035103/pdf/1748-9326_6_3_035103.pdf

- "... low level frequency noise or infrasound emitted by wind turbines is minimal and of no consequence... Further, numerous reports have concluded that there is no evidence of health effects arising from infrasound or low frequency noise generated by wind turbines." *Source: NHMRC 2010* http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/new0048_evidence_review_wind_turbines_and_health.pdf

- "... renewable energy generation is associated with few adverse health effects compared with the well documented health burdens of polluting forms of electricity generation..." *Source: NHMRC 2010* http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/new0048_evidence_review_wind_turbines_and_health.pdf

- "Although opposition to wind farms on aesthetic grounds is a legitimate point of view, opposition to wind farms on the basis of potential adverse health consequences is not justified by the evidence." *Source: Chatham-Kent Public Health Unit* http://www.harvestingwindsupport.com/blog/wp-content/uploads/2011/03/Chatham-KentHealth-and-Wind-.pdf

- "What is apparent is that numerous websites have been constructed by individuals or groups to support or oppose the development of wind turbine projects, or media sites

reporting on the debate. Often these websites state the perceived impacts on, or benefits to, human health to support the position of the individual or group hosting the website. The majority of information posted on these websites cannot be traced back to a scientific, peer-reviewed source and is typically anecdotal in nature. In some cases, the information contained on and propagated by internet websites and the media is not supported, or is even refuted, by scientific research. This serves to spread misconceptions about the potential impacts of wind energy on human health..." *Source: Knopper&Ollson review* http://www.ehjournal.net/content/pdf/1476-069X-10-78.pdf

- Afsset was mandated by the Ministries responsible for health and the environment to conduct a critical analysis of a report issued by the *Académie nationale de medicine* that advocated the use of a minimum 1,500 metre setback distance for 2.5 MW wind turbines or more. The Affset report concluded that "It appears that the noise emitted by wind turbines is not sufficient to result in direct health consequences as far as auditory effects are concerned. [...] A review of the data on noise measured in proximity to wind turbines, sound propagation simulations and field surveys demonstrates that a permanent definition of a minimum 1,500 m setback distance from homes, even when limited to windmills of more than 2.5 MW, does not reflect the reality of exposure to noise and does not seem relevant."

Annoyance

- "... wind turbine noise is comparatively lower than road traffic, trains, construction activities, and industrial noise."*Source: Chatham-Kent Public Health Unit* http://www.harvestingwindsupport.com/blog/wp-content/uploads/2011/03/Chatham-KentHealth-and-Wind-.pdf

- "There is consistent evidence that noise from wind turbines—whether estimated in models or using distance as a proxy—is associated with annoyance, and reasonable consistency that it is associated with sleep disturbance and poorer sleep quality and quality of life. However, it is unclear whether the observed associations are due to wind turbine noise or plausible confounders" NHMRC (2014) full report

- "The perception of noise depends in part on the individual - on a person's hearing acuity and upon his or her subjective tolerance for or dislike of a particular type of noise. For example, a persistent "whoosh" might be a soothing sound to some people even as it annoys others."*Source: NRC 2007* http://www.vawind.org/assets/nrc/nrc_wind_report_050307.pdf

- "... some people might find [wind turbine noise annoying. It has been suggested that annoyance may be a reaction to the characteristic "swishing" or fluctuating nature of wind turbine sound rather than to the intensity of sound." *Source: Ontario CMOH Report*

http://www.health.gov.on.ca/en/public/publications/ministry_reports/wind_turbine/wind_turbine.pdf

- "... being annoyed can lead to increasing feelings of powerlessness and frustration, which is widely believed to be at least potentially associated with adverse health effects over the longer term."*Source: Ad Hoc Expert Group on Noise and Health* http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1279888026747

- "Wind turbine annoyance has been statistically associated with wind turbine noise, but found to be more strongly related to visual impact, attitude to wind turbines and sensitivity to noise." *Source: Knopper&Ollson review* http://www.ehjournal.net/content/pdf/1476-069X-10-78.pdf

- "... self reported health effects like feeling tense, stressed, and irritable, were associated with noise annoyance and not to noise itself..." *Source: Knopper&Ollson review* http://www.ehjournal.net/content/pdf/1476-069X-10-78.pdf

- "... many of the self reported health effects are associated with numerous issues, many of which can be attributed to anxiety and annoyance." *Source: Knopper&Ollson review* http://www.ehjournal.net/content/pdf/1476-069X-10-78.pdf

- "To date, no peer reviewed articles demonstrate a direct causal link between people living in proximity to modern wind turbines, the noise they emit and resulting physiological health effects. If anything, reported health effects are likely attributed to a number of environmental stressors that result in an annoyed/stressed state in a segment of the population." *Source: Knopper&Ollson review* http://www.ehjournal.net/content/pdf/1476-069X-10-78.pdf

- "... some community studies are biased towards over-reporting of symptoms because of an explicit link between...noise and symptoms in the questions inviting people to remember and report more symptoms because of concern about noise." *Source: Ad Hoc Expert Group on Noise and Health* http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1279888026747

- "... it is probable that some persons will inevitably exhibit negative responses to turbine noise wherever and whenever it is audible, no matter what the noise level." *Source: Fiumicelli review abstract*

- "The major source of uncertainty in our assessment is related to the subjective nature of response to sound, and variability in how people perceive, respond to, and cope with sound." *Source: Oregon review* http://public.health.oregon.gov/HealthyEnvironments/TrackingAssessment/HealthImpactAssessment/Documents/Oregon%20Wind%20Energy%20HIA%20Public%20comment.pdf

- "... sleep difficulties, as well as feelings of uneasiness, associated with noise annoyance could be an effect of the exposure to noise, although it could just as well be that

respondents with sleeping difficulties more easily appraised the noise as annoying." *Source: NHMRC 2010* http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/new0048_evidence_review_wind_turbines_and_health.pdf

- "Even noise that falls within known safety limits is subjective to the recipient and will be received and subsequently perceived positively or negatively."*Source: Chatham-Kent Public Health Unit* http://www.harvestingwindsupport.com/blog/wp-content/uploads/2011/03/Chatham-KentHealth-and-Wind-.pdf

- "... annoyance was strongly correlated with a negative attitude toward the visual impact of wind turbines on the landscape..." *Source: NHMRC 2010* http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/new0048_evidence_review_wind_turbines_and_health.pdf

- "Respondents tended to report more annoyance when they also noted a negative effect on landscape, and ability to see the turbines was strongly related to the probability of annoyance."*Source: Minnesota Health Dept 2009* http://www.health.state.mn.us/divs/eh/hazardous/topics/windturbines.pdf

- "[It is proposed that annoyance is not a direct health effect but an indication that a person's capacity to cope is under threat. The person has to resolve the threat or their coping capacity is undermined, leading to stress related health effects... Some people are very annoyed at quite low levels of noise, whilst other are not annoyed by high levels." *Source: NHMRC 2010* http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/new0048_evidence_review_wind_turbines_and_health.pdf

- "Further, sounds, such as repetitive but low intensity noise, can evoke different responses from individuals... Some people can dismiss and ignore the signal, while for others, the signal will grow and become more apparent and unpleasant over time... These reactions may have little relationship to will or intent, and more to do with previous exposure history and personality." *Source: Minnesota Health Dept 2009* http://www.health.state.mn.us/divs/eh/hazardous/topics/windturbines.pdf

- "Stress and annoyance from noise often do not correlate with loudness. This may suggest [that other factors impact an individual's reaction to noise... individuals with an interest in a project and individuals who have some control over an environmental noise are less likely to find a noise annoying or stressful." *Source: Minnesota Health Dept 2009* http://www.health.state.mn.us/divs/eh/hazardous/topics/windturbines.pdf

- "There is a possibility of learned aversion to low frequency noise, leading to annoyance and stress..." *Source: Leventhall 2005 review* http://www.noiseandhealth.org/article.asp?issn=1463-1741;year=2004;volume=6;issue=23;spage=59;epage=72;aulast=Leventhall

- "Noise produced by wind turbines generally is not a major concern for humans beyond a half mile or so because various measures to reduce noise have been implemented in the design of modern turbines."*Source: NRC 2007*
http://www.vawind.org/assets/nrc/nrc_wind_report_050307.pdf

- "Noise... levels from an onshore wind project are typically in the 35-45 dB(A) range at a distance of about 300 meters... These are relatively low noise or sound-pressure levels compared with other common sources such as a busy office (~60 dB(A)), and with nighttime ambient noise levels in the countryside (~20-40 dB(A))." *Source: NRC 2007*
http://www.vawind.org/assets/nrc/nrc_wind_report_050307.pdf

- "Complaints about low frequency noise come from a small number of people but the degree of distress can be quite high. There is no firm evidence that exposure to this type of sound causes damage to health, in the physical sense, but some people are certainly very sensitive to it." *Source: Ad Hoc Expert Group on Noise and Health*
http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1279888026747

- "... there is the theoretical possibility that annoyance may lead to stress responses and then to illness. If there is no annoyance then there can be no mechanism for any increase in stress hormones by this pathway... if stress-related adverse health effects are mediated solely through annoyance then any mitigation plan which reduces annoyance would be equally effective in reducing any consequent adverse health effects. It would make no difference whether annoyance reduction was achieved through actual reductions in sound levels, or by changes in attitude brought about by some other means." *Source: Ad Hoc Expert Group on Noise and Health*
http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1279888026747

Infrasound

- "Infrasound is audible when the sound levels are high enough. The hearing threshold for infrasound is much higher than other frequencies. Infrasound from wind farms is at levels well below the hearing threshold and is therefore inaudible to neighbouring residents. There is no evidence that sound which is at inaudible levels can have a physiological effect on the human body . This is the case for sound at any frequency, including infrasound."
http://docs.health.vic.gov.au/docs/doc/5593AE74A5B486F2CA257B5E0014E33C/$FILE/Wind%20farms,%20sound%20and%20%20health%20-%20Technical%20information%20WEB.pdf

- "Claims that infrasound from wind turbines directly impacts the vestibular system have not been demonstrated scientifically... evidence shows that the infrasound levels near wind turbines cannot impact the vestibular system."
http://www.mass.gov/dep/public/press/0112wind.htm
- "There is no evidence that infrasound ... [from wind turbines ... contributes to perceived annoyance or other health effects." *Source: Bolin et al 2011 Review*
http://iopscience.iop.org/1748-9326/6/3/035103/pdf/1748-9326_6_3_035103.pdf

- "There is no consistent evidence of any physiological or behavioural effect of acute exposure to infrasound in humans." *Source: UK HPA Report* http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1265028759369

- "... self reported health effects of people living near wind turbines are more likely attributed to physical manifestation from an annoyed state than from infrasound." *Source: Knopper&Ollson review* http://www.ehjournal.net/content/pdf/1476-069X-10-78.pdf

- "... infrasound from current generation upwind model turbines [is well below the pressure sound levels at which known health effects occur. Further, there is no scientific evidence to date that vibration from low frequency wind turbine noise causes adverse health effects." *Source: Ontario CMOH Report* http://www.health.gov.on.ca/en/public/publications/ministry_reports/wind_turbine/wind_turbine.pdf

- "It would appear... that infrasound alone is hardly responsible for the complaints... from people living up to two km from the large downwind turbines." *Source: Jakobsen 2005 review* http://multi-science.metapress.com/content/w6r4226247q6p416/

- "From a critical survey of all known published measurement results of infrasoundfrom wind turbines it is found that wind turbines of contemporary design with therotor placed upwind produce very low levels of infrasound. Even quite close to theseturbines the infrasound level is far below relevant assessment criteria, including thelimit of perception."*Source: Jakobsen 2005 review* http://multi-science.metapress.com/content/w6r4226247q6p416/

- "With older downwind turbines, some infrasound also is emitted each time a rotor blade interacts with the disturbed wind behind the tower, but it is believed that the energy at these low frequencies is insufficient to pose a health hazard." *Source: NRC 2007* http://www.vawind.org/assets/nrc/nrc_wind_report_050307.pdf

Shadow flicker

- "Scientific evidence suggests that shadow flicker [from the rotating blades of wind turbines does not pose a risk for eliciting seizures as a result of photic stimulation." *Source: Massachusetts review* http://www.mass.gov/dep/energy/wind/turbine_impact_study.pdf

- Shadow flicker from wind turbines... is unlikely to cause adverse health impacts in the general population. The low flicker rate from wind turbines is unlikely to trigger seizures in people with photosensitive epilepsy. Further, the available scientific evidence suggests that very few individuals will be annoyed by the low flicker frequencies expected from most modern wind turbines." *Source: Oregon review* http://public.health.oregon.gov/HealthyEnvironments/TrackingAssessment/HealthImpa

ctAssessment/Documents/Oregon%20Wind%20Energy%20HIA%20Public%20comment.pdf

- "Flicker frequency due to a turbine is on the order of the rotor frequency (i.e., 0.6-1.0 Hz), which is harmless to humans. According to the Epilepsy Foundation, only frequencies above 10 Hz are likely to cause epileptic seizures." *Source: NRC 2007* http://www.vawind.org/assets/nrc/nrc_wind_report_050307.pdf

Community & social response to wind turbines

- The perception of sound as noise is a subjective response that is influenced by factors related to the sound, the person, and the social/environmental setting. These factors result in considerable variability in how people perceive and respond to sound... Factors that are consistently associated with negative community response are fear of a noise source... [and noise sensitivity..." *Source: Oregon review* http://public.health.oregon.gov/HealthyEnvironments/TrackingAssessment/HealthImpactAssessment/Documents/Oregon%20Wind%20Energy%20HIA%20Public%20comment.pdf

- "Wind energy developments could indirectly result in positive health impacts... if they increase local employment, personal income, and community-wide income and revenue. However, these positive effects may be diminished if there are real or perceived increases in income inequality within a community." *Source: Oregon review* http://public.health.oregon.gov/HealthyEnvironments/TrackingAssessment/HealthImpactAssessment/Documents/Oregon%20Wind%20Energy%20HIA%20Public%20comment.pdf

- "Effective public participation in and direct benefits from wind energy projects (such as receiving electricity from the neighboring wind turbines) have been shown to result in less annoyance in general and better public acceptance overall." *Source: Massachusetts review* http://www.mass.gov/dep/energy/wind/turbine_impact_study.pdf

- "... people who benefit economically from wind turbines [are less likely to report noise annoyance, despite exposure to similar sound levels as those people who [are not economically benefiting." *Source: NHMRC 2010* http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/new0048_evidence_review_wind_turbines_and_health.pdf

- "Landowners... may perceive and respond differently (potentially more favorably) to increased sound levels from a wind turbine facility, particularly if they benefit from the facility or have good relations with the developer..." *Source: Oregon review* http://public.health.oregon.gov/HealthyEnvironments/TrackingAssessment/HealthImpactAssessment/Documents/Oregon%20Wind%20Energy%20HIA%20Public%20comment.pdf

- "The level of annoyance or disturbance experienced by those hearing wind turbine sound is influenced by individuals' perceptions of other aspects of wind energy facilities,

such as turbine visibility, visual impacts, trust, fairness and equity, and the level of community engagement during the planning process." *Source: Oregon review* http://public.health.oregon.gov/HealthyEnvironments/TrackingAssessment/HealthImpactAssessment/Documents/Oregon%20Wind%20Energy%20HIA%20Public%20comment.pdf

- "Wind energy facilities... can indirectly result in positive health impacts by reducing emissions of [green house gases and harmful air pollutants, and... Communities near fossil-fuel based power plants that are displaced by wind energy could experience reduced risks for respiratory illness, cardiovascular diseases, cancer, and premature death." *Source: Oregon review* http://public.health.oregon.gov/HealthyEnvironments/TrackingAssessment/HealthImpactAssessment/Documents/Oregon%20Wind%20Energy%20HIA%20Public%20comment.pdf

- "The environmental and human-health risk reduction benefits of wind-powered electricity generation accrue through its displacement of electricity generation using other energy sources (e.g., fossil fuels), thus displacing the adverse effects of those other generators." *Source: NRC 2007* http://www.vawind.org/assets/nrc/nrc_wind_report_050307.pdf

- "Community engagement at the outset of planning for wind turbines is important and may alleviate health concerns about wind farms. Concerns about fairness and equity may also influence attitudes towards wind farms and allegationsabout effects on health. These factors deserve greater attention in future developments." *Source: Ontario CMOH Report* http://www.health.gov.on.ca/en/public/publications/ministry_reports/wind_turbine/wind_turbine.pdf

Summary of 2013 VTA Finnish report

VTT Technical Research Centre of Finland has published a new study with a conclusion that wind turbines do not cause any adverse health effects. The study consisted of a review of nearly 50 scientific research articles conducted in Europe, USA, Australia and New Zealand over the past 10 years.

Due to the increased number of wind power projects in Finland, a growing concern has arisen among the public regarding the possible negative impacts wind energy production may have on human health. VTT Technical Research Centre of Finland conducted a comprehensive literature review covering nearly 50 scientific research articles. The review concluded that in the light of current scientific research, there is no evidence to show that the infrasound produced by modern wind turbines is anything but harmless.

The sound of a nearby wind farm is does not possess such qualities or volume that it would cause physical symptoms to humans. The study also concluded that the infra sounds below the auditory threshold does not constitute a health hazard. Additionally, most of the infra sound caused by a wind farm is mixed with other infra sound from the environment and

does therefore not cause any additional exposure. According to the research articles reviewed, the low frequency sound with potential hazardous health impacts would have to be of a higher volume than that caused by wind farms, in order to have an impact on our health. Also, concern that shadow flicker may cause epileptic seizures are overruled in the research material. Such seizures cannot be caused by the type of flicker the slow rotation speed of the wind turbine blades produce.

Commentary: Major problems with recent systematic review on wind farms and distress.

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At least 20 reviews of the evidence on whether wind turbines cause health problems including stress have been published since 2003 (1). Cureus recently published another (2) where the authors referenced none of these.

Highlights of the findings of these reviews may be found here (1). The most recent (2014) review by Australia's peak health and medical agency, The National Health and Medical Research Council (3) concluded:

"There is no consistent evidence that noise from wind turbines... is associated with self reported human health effects. Isolated associations may be due to confounding, bias or chance. There is consistent evidence that noise from wind turbines—whether estimated in models or using distance as a proxy—is associated with annoyance, and reasonable consistency that it is associated with sleep disturbance and poorer sleep quality and quality of life. However, it is unclear whether the observed associations are due to wind turbine noise or plausible confounders."

and

"The association between estimated noise level and annoyance was significantly affected by the visual attitude of the individual (i.e. whether they found wind farms beautiful, or ugly and unnatural) in the three studies that assessed this as a potential confounding factor. Residents in [one] study with a negative attitude to the visual impact of wind farms on the landscape had over 14 times the odds of being annoyed compared with those people without a negative visual attitude. ...This means that factors other than the noise produced by wind turbines contribute to the annoyance experienced by survey respondents."

Against this background, I was curious to see what a new systematic review would conclude. According to the Cureus website, the new paper was peer reviewed. This is difficult to understand because of the sheer volume of major and minor problems it contains. Together, these make its contribution valueless to scholarly understanding of the

phenomenon of noise and health complaints about wind farms. The paper shows many signs of poor understanding of the subject matter of their review, of critical appraisal methods, of some basic conventions in systematic reviewing, of structuring in scientific writing, and much more besides.

The problems commence in the first line of the abstract where the confusing statement is made that "the proximity of wind turbines to residential areas has been associated with a higher level of complaints compared to the general population." I assume here that they are trying to say that those living near turbines have a higher prevalence of health complaints like sleep disturbance and general "human distress" than in the wider population. The prevalence of sleeping problems in general populations is as high as 33% (4) and reference material exists that quantifies the prevalence of many health problems in general populations (5, 6). Instead, the authors support their statement with a reference to a small qualitative study of 15 people both affected and unaffected by turbines (7). No conclusions about the prevalence of health problems in communities near turbines or in matched comparison populations can be drawn from that paper. I know of no published evidence that would allow such a statement to be made.

The authors state that their search strategy located 18 eligible papers but that these were based on six original studies. They explain that the 12 non-original "studies" (several of which were reviews or commentaries) were then excluded. Yet in their "key results" they proceed to describe the characteristics of all 18 papers and thus act as if these were not excluded ("All 18 peer-reviewed studies captured in our review found an association...").

The authors do not appear to understand what an "outcome" is. The abstract lists "outcome" variables that are not outcomes at all (such as study quality and journal name). These are independent variables, not dependent ones.

Their eligibility criteria for study selection are perplexing. What for example, is the difference between "peer-reviewed studies" and "studies published in peer-reviewed journals"? So too, is their noting that they searched the Cochrane Library for relevant studies. The Cochrane Library is a repository of reviews of evidence for health interventions, not for data on the prevalence of health complaints.

The authors seem not to understand the difference between studies and trials. For obvious reasons, there have been no trials conducted in this area.

Their main conclusions are that: