# Wind Turbines and Proximity to Homes:

# The Impact of Wind Turbine Noise on Health

## a review of the literature & discussion of the issues

by

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&

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*Health is a state of complete physical, mental, and social well-being, and not merely the absence of disease and infirmity.*

~ The World Health Organization Charter

*The objective of science is not agreement on a course of action, but the pursuit of truth.*

~ John Kay (2007)

*First, Do No Harm.*

~ The Hippocratic Oath

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# *Preface*

In 2007, we published *Noise Radiation from Wind Turbines Installed Near Homes: Effects on Health*, a paper that examined the intersection of the science of acoustics and medicine in order to better understand why people experienced adverse health effects as a result of long-term exposure to wind turbine noise. The paper reviewed already published studies and reports, revealing a serious disparity between acousticians' predicted effects of wind turbine noise and the actual effects experienced by those living near wind turbines, even when developers adhered to government guidance. Internationally, there was evidence of sleep disturbance when industrial wind turbines were sited near people's homes, other sensitive living and working environments, and in some cases, broader communities.

We anticipated that these complaints and problems would escalate if more wind turbines were built near homes and communities, unless governments addressed the failure of wind energy policy to protect the public's health. Unfortunately, the worst-case scenario has unfolded, even as acousticians realise that predicting and controlling wind turbine noise is more complex than anticipated. As more wind turbines are sited without exercising due care and attention to the noise pollution and consequent health effects, more people are experiencing the negative effects of wind turbine noise. Moreover, the science of sleep and the adverse effects of noise on sleep and health continue to reveal just how damaging sleep disturbances and sleep deprivation are to health, learning, and quality of life.

Yet, governments have focused their policies on achieving wind energy targets while opting to ignore evidence demonstrating that when wind turbines are located too close to family homes, the prolonged exposure to the audible and inaudible range of acoustic characteristics of wind turbine noise adversely affects people's health.

As we and many others noted years ago, all these problems and discord, along with the expense of appeals and public inquiries, might have been avoided with the simplest of solutions: locate wind turbines at a distance from homes, sensitive facilities, and communities, at a distance that protects the occupants from prejudicial health consequences. Although this paper primarily reviews the policies in Britain, the unwanted health effects are universal.

Governments continue to rely on acoustic engineers to prepare official guidance both on exposure to wind turbine noise, including the upper limits of dosage and duration, and on the separation distances of wind turbines from homes. It is ironic that several experts on noise and health are on faculty at British universities -- yet perplexingly, Britain continues to rely upon acoustic engineers to advise on the complex problem of noise and health. Moreover, although the problem of wind turbine noise is well known to Government, there is no evidence that Government has planned or seeks to organise an independent academic, epidemiologic clinical study of these issues, even though it has been urged to do so.

The British and other governments aspire to human rights ideals, yet they indirectly endorse the inhuman treatment suffered by some families, stemming directly from Government policy that allows construction of wind turbines in close proximity to family homes. This illustrates also that the protection of family life and its amenity and health are less important to Government and its policy-makers than the protection of commercial development, landscape interests, and birds and bats.

We did not receive nor will we receive any remuneration by writing this paper. By reviewing the evidence from research by those with relevant expertise, we hope this paper helps those who seek to protect people's health and basic human rights and to prevent inappropriate, environmentally polluting, industrial development near homes and communities. That is our reward.

# *Introduction*

Successive UK Energy Ministers have failed to acknowledge that the historic method of controlling the distance between people's homes and wind turbines, ETSU-R-97, published in 1997, is obsolete and no longer protects the amenity of those living near wind turbines. ETSU-R-97, written more than 15 years ago, is no longer 'fit for purpose' and does not provide adequate health protection to neighbouring families. When ETSU was published, wind turbines were maximally 60 metres tall. Today's wind turbines are 125 – 150 metres tall to blade tip, with massive spatial surface areas covered by the circumference of the blade swing, which creates significant vortices of air turbulence in back and in front of the blades. While there are improvements in the technology of wind turbine design, the sheer increase in size produces new dynamics in altitude wind turbulence and physical acoustic problems. By far the greatest problem for people is the increase in acoustic radiation, which pollutes the living and working environments of those who live near the wind turbine sites. [ETSU for the Department of Trade and Industry (Dti). ETSU-R-97: The Assessment & Rating of Noise from Wind Farms: Final Report. Dti (UK), September 1996 http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/energy/sources/renewables/explained/wind/onshore-offshore/page21743.html ]

This paper addresses not only the issues of wind energy policy where it violates the basic living environment of families and the adverse health effects of wind turbine noise, but also assesses the considerable number of anecdotal reports from people living with wind turbine noise. As noted in the authors' 2007 paper, although there are many who dismiss anecdotal reports as inconsequential or meaningless, these reports are from real people, living with real problems, often with no recourse: they put 'the human face on science'. The authors also examine how this translates into a human rights issue, as government policy assigns more credibility to acousticians' reports than to medical evidence, and assigns more importance to renewable energy policy than to the individual lives injured by that policy.

The paper begins with a review of the acoustic impact of wind turbine noise reported by families and communities in the UK as well as similar cases in Japan, Australasia, the United States, Canada, and throughout Europe. This first chapter collates and details some of the evidence of recent reported cases and the extent of discomfort, distress, and health problems suffered by those families with prolonged exposure to wind turbine noise.

Chapter 2 examines the views of leading acoustic experts on the reasons that the acoustic 'bombardment' impacts people physically. This chapter also reviews the problems and complexities in interpreting the UK ETSU-R-97 guidance and subsequent apparent difficulty enforcing noise conditions that emerge from ETSU.

Chapter 3 discusses peer-reviewed medical research and reports from internationally recognised authorities, e.g., the World Health Organization, supporting the anecdotal evidence of health problems experienced by families living near wind turbines; these families endure the pulsating noise as well as prolonged exposure. There is also a growing body of evidence-based research substantiating the adverse health impacts of environmental noise pollution, particularly with extended exposure, of which wind turbine noise is an example.

As with many public health issues, the problems with wind turbine noise started with anecdotal reports where turbines were built too close to homes. These complaints emerged in a scattered pattern, because often the people affected did not associate the sudden onset of their sleep disturbances, headaches, or inability to concentrate with the noise. Most people were confident when told by the wind energy companies and their local officials that wind turbines were not intrusive, that the noise produced is easily masked by background noise, and that the noise compared favourably with familiar sounds, e.g., a home fridge, or a quiet conversation in the library. Initially, each affected person thought his or her new symptoms were unique.

As more complaints emerged from those who lived near newly operational wind turbine sites, and those who pinpointed the start of their newly identified health problems with the movement of the blades, some of those affected -- and a few health professionals -- suspected that the source of their problems might be associated with the noise generated by the wind turbines. This association seemed more likely because the victims' symptoms were relieved when they were away from their homes or farms. Moreover, the symptoms recurred once they returned home. These patterns

emerged only over time, and across many wind turbine areas, internationally. Chapter 3 also reviews several pilot studies conducted by physicians in order to assess the anecdotal reports of health effects from those living near wind turbines.

Chapter 4 considers basic international human rights, apparently sidestepped by Britain, as its environmental policy appears to assign greater priority to the protection of landscape, bats, dormice, and water voles (though the authors certainly applaud those efforts). The State appears to accord more importance to, and enforces with more stringency, those issues to the detriment of policy that protects the health and dignity of families. As a result, in their ambition to achieve renewable energy targets, public officials authorise what amounts to the degrading and inhuman treatment of families.

The influential wind energy industry and its lobbyists, public agencies, environmental organisations, and many media sources often employ pejorative labels, such as NIMBY – Not In My Backyard, to decry or stigmatise those who complain, as insensitive to environmental pollution and global warming, in order to dismiss these anecdotal reports. Yet, it is essential to remember that many of those affected by wind turbine noise were those same people who welcomed the wind turbine schemes and were skeptical of those who complained about potential or actual noise interference. Many early wind turbine noise studies focused on annoyance and identified sleep disturbance as a frequent problem, but these studies did not collect data on health effects. Public health problems often evolve gradually and become more evident only with the passage of time as more people are affected (duration of exposure).

UK government renewable energy policy has focused more on expanding the role of industrial wind turbines rather than ensuring the protection of the health of those exposed to wind turbine noise, i.e., the protection of the public's health. Thus, the voices of those affected by wind turbine noise have grown more insistent as more wind turbine sites are located near homes and villages. The solution has always seemed transparently straightforward: locate wind turbines further from homes and other sensitive structures. Of course, one must then determine the optimum distance, and there lies the rub, with industry pushing for minimal distances, while many others seek a more precautionary stance, in an effort to protect health, well-being, dignity, and quality of life.

Wind turbine noise is a form of and another cause of environmental noise pollution. Recent studies, both medical and acoustic, offer data to assist with the decision on where to site and how to design wind turbine arrays. Notably, wind energy developers often assert that there are virtually no studies on wind turbine noise and no evidence of its ill effects. However, there are not only studies specifically on the adverse effects of wind turbine noise, there are also studies on noise with similar or shared acoustic characteristics. Wind turbine noise is especially complicated because of the 'cocktail' of physical acoustic characters that comprise the noise pollution. The pulsating noise, characteristic of wind turbines, can be more intrusive than other types of noise, and the pulsations include both audible and inaudible components, i.e., low frequency noise, infrasound, and vibration. Noise with these characteristics is more intrusive, and the World Health Organization (WHO) guidelines recommend lowering the permissible decibel levels when noise contains these characteristics. WHO makes these recommendations not merely to reduce annoyance or nuisance. WHO makes these recommendations because epidemiological studies indicate clearly that environmental noise is prejudicial and injurious to health. [WHO 1999, 2010, 2011]

WHO's impartial reports are particularly compelling because they undergo periodic review and updating by its international panel of experts from diverse, related fields. Moreover, the panel's findings and reports undergo a process of stringent review internally amongst the panelists, as well as externally, by reviewers not on the panel. Most recently WHO issued Night Noise Guidelines for Europe 2009, and the Burden of Disease from Environmental Noise 2011, which, with EU directives and guidelines on noise, offer policy-makers and other invested parties with descriptions of how health is adversely affected by noise, as well as with methodologies to ameliorate or to prevent injury to health from environmental noise.

Those affected by wind turbine noise could be your relatives, friends, neighbours, and even -- at some point -- you. Often these are people who know austerity intimately, who understand the dilemma of balancing environmental issues such as energy supply and global warming with current policy and future demands. Instead, they are marginalised and made to feel doltish and

selfish. They also feel disenfranchised and abandoned by those in whom they have placed their trust. This cynicism is not unfounded, as many are left financially impoverished as they seek advice and support in order to make their voices heard. The issue of wind turbine noise is about real people, who are genuinely suffering degrading and inhuman treatment.

Planning for industrial estates near dwellings is more restrictive on noise control, with those facilities rarely operating daily, 24/7, than the noise controls on wind turbines. Selecting a minimum distance of 2km as a buffer between homes and the placement of a wind turbine – though an even greater distance may be required – is not excessive when the lives and well-being of those affected are taken into account. There is still ample opportunity for developers to site their schemes more appropriately and for government to redress errors in policy that allow these untoward, unpredictable, and unacceptable effects.

# *Chapter 1*

## Wind Turbines built near Homes: the Effects on People

There are several hundred wind turbine arrays operating onshore in the UK. In March 2010, the UK Department of Trade and Industry (Dti) issued *Research into Aerodynamic Modulation of Wind Turbine Noise: Final Report*, which it commissioned from a team headed by Dr Andy Moorhouse at Salford University and Mr Malcolm Hayes, an acoustician who co-authored ETSU-R-97, *The Assessment & Rating of Noise from Wind Farms*, for the Dti. In its analysis of this report, the Daily Telegraph [UK] noted, "one in six wind farms have had complaints about noise". [Gray L. Noise Complaints about One in Six Wind Farms. Daily Telegraph, 6 March 2010]

The Salford Report included analysis of twenty-seven wind turbine arrays that had proved contentious because of noise complaints. The authors of the Salford Report did not interview any of those living near these wind turbine arrays, nor did they appear to use the most recent WHO guidance or other available research on the adverse impact of noise on people, nor did they include consultation with experts in clinical studies on these subjects. Therefore, it was no surprise that their report found no reason to alter current standards. [Moorhouse A; Hayes M; von Hünerbein; Piper B; and Adams M. *Research into Aerodynamic Modulation of Wind Turbine Noise: Final Report.* Report by University of Salford for Defra, BERR, DCLG, and Dti (UK), July 2007]

Yet, an *Analysis of Wind Farms with Noise Complaints based on the Salford Report* found at least 36 wind turbine arrays that caused noise problems for those living nearby. [Chart compiled anonymously from data retrieved via the Freedom of Information Act by the Renewable Energy Foundation (REF): Constable, J (Dr) and Moroney L (Dr). *Data obtained under the Freedom of Information Act: Wind Turbine Noise Complaint Survey Data Collected by the University of Salford under contract to the Department of Business, Enterprise and Regulatory Reform: Research into Aerodynamic Modulation of Wind Turbine Noise* URN 07/1235. Renewable Energy Foundation (REF), London, UK, 6 Februrary 2009 http://www.ref.org.uk/publications/151-ref-publishes-data-on-wind-farm-noise-obtained-under-the-freedom-of-information-act and http://www.ref.org.uk/attachments/article/151/jc.lm.salford.data.comment.07.02.09.c.pdf]

This translates into 16% of UK wind turbine sites causing significant noise problems, even after the extensive process of scoping reports, adherence to government and industry noise guidance and prediction models, and conditions set by local authorities. Moreover, if the Salford report had included only those wind turbine arrays located near homes, rather than also including those that were remotely sited, the percentage of sites with wind turbine noise complaints rises.

Complaints about wind turbine noise are international, found wherever wind turbines have been sited in proximity to homes: in the USA, Canada, Australia, New Zealand, Japan, Turkey, Denmark, The Netherlands, Germany, and other countries in Europe.

In 2009, the Maine Medical Association, a State chapter of the American Medical Association, passed a Resolution regarding *Wind Energy and Public Health*:

> "Whereas, assessing the potential health impact of wind turbines has been difficult to measure but if present would be of significant concern. This is especially apparent regarding the noise level and other noise characteristics specific to industrial wind turbines.
>
> Therefore be it resolved that the Maine Medical Association work with health organizations and regulatory agencies to bring to the publics attention the scientific information of known medical consequences of wind development.
>
> Further Resolved that the Maine Medical Association (1) encourage performance of studies on health effects of wind turbine generation by independent qualified researchers at qualified research institutions, (2) ensure that physicians and patients alike are informed of evidence-based research results." [Maine Medical Association. Resolution Re: Wind Energy and Public Health. MMA (USA), 2009]

The following examples represent the considerable intrusion of wind turbine noise into everyday life and the devastating consequences for ordinary people, regardless of their backgrounds, ages, and careers. They illustrate the casual dismissive approach of the wind energy industry as well as the reluctance of governments to undertake impartial and independent scientific research into the problems, or to adhere to stricter guidelines recommended by expert reports such as those issued by the World Health Organization.

In June 2005, Mrs Gwen Burkhardt of New Quay, Wales, UK, reported that the three 'massive' wind turbines that were built near her family home in 2001, had a significant and negative impact on her health:

> "Having been in the best of health for most of my life, I couldn't understand why I was suddenly feeling very unwell for no apparent reason. Racing pulse, heart palpitations, a strange churning in my head, a feeling of nausea, a terrible unease and a need to escape. Sleep became difficult too." [Burkhardt G. Wind Farm Illness (letter) WalesOnline, 6 June 2005 www.walesonline.co.uk]

In 2006, Gail Mair and her husband settled into their new home in Scansano, Italy. Within four weeks, the 10 newly erected 121m wind turbines, with the nearest approximately 900m from their home, started operating. Within a short time, both Mrs Mair and her husband experienced a series of health problems that were new to them both – with the onset not long after the wind turbines were switched on: insomnia; loss of concentration; nausea; and depression. During 2007, Mrs Mair kept a diary of the noise and the symptoms experienced. Characteristically, the symptoms disappeared when the family left the area for work, extended visits, and holidays. Coupled with the sleep disturbances, the family also detected a humming or buzzing noise inside the house, loud enough to distress them and visitors. Finally, in 2008, after spending ever more extended times away from their new home in order to recuperate, the couple left permanently –

> "abandoning the work of a lifetime. Our house is unsaleable, our old age 'pension' worthless."
> [Mair G. Italian Windfarm Diary, January 2007 to December 2007. http://docs.wind-watch.org/mair-diary.pdf]

Jane and Julian Davis live at Deeping St Nicholas, Spalding, Lincolnshire, UK. In 2006, a wind turbine array began operating, with the nearest turbine 930m from two homes: theirs and the home of Mr Davis' parents. As advocates of renewable energy, the Davis family did not object to the scheme, particularly as the developer assured the community that noise would not be problematic. The reality was quite different. The Davis family kept a record of the health problems suffered because of the noise from the wind turbines. Most significantly, the problems included severe sleep deprivation and disturbance, but also heart palpitations and arrhythmias, vertigo, depression, not to mention considerable distress. [Davis J. Personal Communication, 13 April 2009; MAS Environmental. Noise Monitoring Graph within first floor bedroom - Davis's House - Wind Farm Noise, 5 July 2007, in: Assessing Noise from Proposed Wind Turbine Developments. MAS Environmental, Cambridge, UK, May 2009; Davis J and Davis J. General Statement of Jane & Julian Davis, 16 April 2009; Davis J and Davis J. Letter to MP Re: Deeping St Nicholas Windfarm noise nuisance, 17 May 2010] Their family physician recorded these problems.

On 17 July 2008, a Valuation Tribunal reduced the Council Tax Banding on their home and the home of Mr Davis' parents. The judgment stated:

> "It was apparent from the evidence submitted that the construction of the wind farm 930 meters away from the appeal dwellings had had significant detrimental effect on the Appellants quiet enjoyment of their properties. The Tribunal therefore found that the nuisance caused by the wind farm was real and not imagined."
> [Valuation Tribunal Service. Council Tax Valuation List Appeal for The Farmhouse at Greys Farm, North Drove Bank, Spalding, Lincolnshire PE11 3JX. Appeal Number 2525475651/032C/20, 17 July 2008 www.valuation-tribunals.gov.uk]

In 2009, in Ontario, Canada, the *Barry's Bay This Week* reported that a retired pharmacist, Carmen Krogh, experienced the onset of unwelcome symptoms following the commissioning of a nearby wind turbine array:

> "Her symptoms came on quickly. She experienced bad headaches, dizziness, queasiness, a heart rhythm sensation and a vibration inside her body…"
> [Woman Tells a Tale of Turbine Torment: Retired Pharmacist Speaks to Killaloe, Hagarty and Richards about the Effects Industrial Wind Turbines had on her Health. *Barry's Bay This Week*, 11 February 2009]

> "It was just like the whole room was spinning says Lisa Michaud of Thamesville, Ontario, as she recalled the weeks after the Kent Breeze wind farm began operating in May. The noise at night keeps you awake. But its not just the noise that you hear. Its something else thats comining at you constantly that you don't hear, but you feel. It's just not right."
> [Seglins D and Nicol J. Wind Farm Health Risks Claimed in $1.5M Suit: Ontario Family Sues Suncor, Alleging Health Problems. CBC News, 21 September 2011 http://www.cbc.ca/news/canada/toronto/story/2011/09/21/seglins-windfarms.html; see also Seglins D and Nicol J. *Ontario Wind Farm Health Risks Downplayed: Documents*. CBC News, 22 September 2011 http://www.cbc.ca/news/health/story/2011/09/21/wind-turbines.html. See also Appendix 3.1 of this paper.]

In January 2010, Japan's Environment Ministry initiated a study of health complaints by families living near wind turbine arrays. At 30 of 376 wind turbine sites in Japan, people living nearby filed complaints about environmental noise problems and the consequent health issues: insomnia, headaches, dizziness, and tinnitus – a buzzing, ringing, and/or humming in the ears. With each of these 30 sites, several and as many as 60 residents living near the wind turbine arrays reported health problems. [Ito A and Takeda T. Sickness Claims Prompt Study of Wind Turbines. The Asahi Shimbun, 19 January 2010 http://www.asahi.com/english/Herald-asahi/TKY201001180410.html]

In March 2010, the *Wall Street Journal* reported on the experience of Charlie Porter and his family after a wind turbine array started operating within 550m of their home:

> "In 2007, a phalanx of wind turbines were built around Charlie Porter's property in rural northern Missouri. Soon Mr Porter began to have trouble sleeping. So did his wife and daughter. The noise, he told me, made sleeping almost impossible. 'We tried everything – earplugs, leaving the TV station on all night.' Nothing worked. Late last year he moved his family off their 20 acre farm... 'I've spoken to nine people in New York, Wisconsin, Ontario, New Zealand, Nova Scotia and England who live or lived near wind turbines. All complained of the noise with sleep deprivation being the most common complaint...' "
> [Bryce R. The Brewing Tempest over Wind Power: People Living near Turbines Increasingly Report Sleep Deprivation, Headaches and Vertigo. The Wind Lobby says There's No Proof. The Wall Street Journal, 1 March 2010]

In March 2010, the *Daily Telegraph* [UK] reported that:

> "Barry Moon and Gill Haythornthwaite's home is in the Cumbria fells on the outskirts of the village of Askam in Furness... The seven turbines have sparked the most complaints about wind farms in the country. Residents complain of a noise like someone is 'mixing cement in the sky' or a 'clay stuck in the tumble dryer', and they are not the only ones... New figures reveal that at least one in six wind farms have had complaints about noise causing a lack of sleep or just 'dreadfully irritating'." Ms Haythornthwaite concurred: 'It is a dreadfully irritating whoosh whoosh noise... It is unbearable to be outside in the garden when there is the noise.' "
> [Gray L. Noise Complaints about One in Six Wind Farms. Daily Telegraph, 6 March 2010]

As reported in the *Huron Daily Tribune* in May 2010, sixteen Huron residents filed a lawsuit that detailed several noise problems with a wind turbine array in proximity to their homes, including low frequency noise and infrasound, which though inaudible, can travel long distances from the source, and even penetrate buildings:

> "Intrusions detailed in the lawsuit include: LFN and subaudible infrasound and/or impulse noise created by and emitted from the wind turbines which range as close as 1,000ft (333 meters) and 1,700 feet (515 meters), away from each plaintiff's home."

The plaintiffs experienced *"actual physical discomforts"* of the kind that would cause physical discomfort to an 'ordinary' person.

> "Physical harm and negative health effects listed in the law suit included: inability to sleep, and repeated awakening during sleep, headaches, dizziness, stress and tension, extreme fatigue, diminished ability to concentrate, nausea, and other physiological and cognitive effects."

The lawsuit notes that at least one family, the Peplinskis, experienced adverse health effects so severe that they left their home and rented an apartment away from the wind turbines. [Hessling K. Residents Sue Wind Companies. Huron Daily Tribune (Michigan, USA), 29 May 2010; WNEM TV5 (Michigan) Investigates: Possible Conflict of Interest; Lawsuit against Wind Energy Cos: This Man's Family Can't Sleep, 29 May 2010]

In July 2010, Mr and Mrs Dean received a *Noise Impact Assessment Report* from Noise Measurement Services Pty Ltd, Brisbane, detailing the noise impact of the Waubra wind turbine array near their home and farm. The consultant's report stated:

> "Wind Farm activity appears to create a pulsating infrasound and low frequency pattern. These patterns are illustrated in sonograms... My hypothesis at this stage is that wind farm sound has an adverse effect on individuals due to this pulsating nature, as well as audible noise due to the wind turbine. These effects may be cumulative."

The report notes that the effects include sleep disturbance, anxiety, stress, and headaches:

> "I am of the opinion, based on my own research, that wind farm noise can and does create unreasonable noise within residences and consequential adverse effects in the sense of sleep disturbance, annoyance, and potential health effects to residents living within **2km** of large wind turbines set in a wind farm. These risks are quantifiable and the effect is significantly more than minor."
> [Executive Summary p 6, and S.7, p 64]

Moreover, the consultant's report observed similar consequences at two other wind turbine arrays, at Manawatu and Makara, noting that:

> "... wind farm sound can be heard within residences situated within 3.5km of large turbines."
> [Thorne B. Noise Impact Assessment Report: Waubra Wind Farm. Report No 1537. Noise Measurement Services Pty Ltd, South Brisbane, Australia, July 2010; see also Stateline Victoria. Claims of Wind Farm Illness, 19 February 2010 (available online only through 20 May 2010); White L. Wind Farms Can Cause Significant Health Problems. Weekly Times Now, 24 December 2009 http://www.weeklytimesnow.com.au/article/2009/12/24/144511_national-news.html; Rolfe P. Turbines Declared Nasty Neighbour as Secret Buyout is Revealed. Sunday Herald Sun, 30 January 2011 http://www.heraldsun.com.au/news/victoria/turbines-declared-a-nasty-neighbour/story-e6frf7kx-1225996775637; Waubra Resident Tells Court of Wind Farm "Hell". The Courier (Australia), 18 January 2011 http://www.thecourier.com.au/news/local/news/general/waubra-resident-tells-court-of-wind-farm-hell/2049825.aspx]

A Torrington, Devon, UK, couple are selling their home and business following the construction of three wind turbines in a field opposite their bungalow:

> "Pat and Arthur Poulton say they are being kept awake at night by the noise from a trio of giant turbines less than 500 metres from their home at Higher Darracott... 'I can hear the turbines through my pillow at night said Mrs Poulton'."
> [Keeble A. Our Sleepless Nights with the Wind Turbines. *North Devon Gazette*, 8 June 2011] (Note: The scheme was refused consent by the local Council but approved on appeal by an Inspector, even though the Official was advised during the Public Inquiry that the noise intrusion was likely to engage a Human Rights violation.)

According to Allen Haas of Malone, Wisconsin:

> "I have 3 wind turbines on my property and get $4,000 for each one. It's been 2 years... People are not really mad directly at the wind turbines or even know what they are mad about, they're just mad, aggressive. [The nearest wind turbine is] "3,000 feet away - way too close. You don't get sleep at night because they roar like an airport. I get shadow flicker in my house, but down in the village of Johnsburg where those are about another 1,500 feet away from the turbines – oh probably 4,500 feet total, those blades are throwing shadows right over all the house roofs."
>
> "I go to my doctor and now I'm on a lot of different medications. I've been to the hospital a couple of times in the past 2 years with chest pains. And they can't figure out what it is but now we're all being diagnosed with wind turbine syndrome... It definitely causes depression. Memory loss is the worse issue. I see it so bad in myself and especially my parents who are older... My dad is a totally different person since these things went up. He stays in bed all day now. Even if he does get up to eat, he just goes back to bed. There is no will anymore. I ask the doctor – how are they doing this to us?"
> [Haas A. To the PSC Commissioners. Malone, Wisconsin. August 2010 http://psc.wi.gov//apps35/erf_search/content/homesearch.aspx?part1=1&part2=AC&part3=231&type=Comments and http://www.wind-watch.org/documents/to-the-psc-commissioners/]

These examples represent only a small number of the large – and growing – number of families suffering, worldwide, wherever wind turbines are built in proximity to family homes. As mentioned earlier, but worthy of repetition because of the severity of the effect and the impunity with which it is allowed, the physical harm and negative health effects include preventing a person from falling asleep, repeated awakenings during sleep, difficulty returning to sleep, headaches, dizziness, stress and tension, extreme fatigue, diminished ability to concentrate, and other physiological and cognitive effects.

At the 16 August 2010 meeting of the Huron-Kinloss Township Council, Dr Hazel Lynn, the Grey-Bruce Medical Officer of Health in Ontario, Canada, said it is wrong that municipal councils do not have any jurisdiction over setbacks because:

> "...within buildings, Low Frequency Noise (LFN) which comes from wind turbines, could cause health effects, such as inner–ear problems. She said those effects would be less if the setbacks were longer than the provincial setback of 550 meters. She added that symptoms are the same around the world but the problem is that not much is known about wind turbines."

Dr Lynn also noted that just because people generally cannot hear LFN, this does not mean that it has no effect. Dr Lynn recommended a minimum setback of at least 1km to 1.5km. [PHE02] Asked to clarify this statement, Dr Lynn said:

> "... we should have longer setbacks, and if you can't have longer setbacks, well, then maybe we shouldn't be having them [more wind turbine developments] right now."
> [Bender S. Medical Officer of Health Believes Wind Turbine Setbacks should be Longer. *Lucknow Sentinel* 25 August 2010 www.lucknowsentinel.com]

In a letter dated March 2011, Dr Alan C Watts, New South Wales, Australia wrote,

> "Experience around the world, including Canada, USA and Europe, is raising questions that have yet to be fully answered and some countries are now sufficiently concerned to cease wind turbine construction in closely populated areas.
>
> Claims are being made that infrasound frequencies created by turbines are producing a suite of symptoms in people living in close proximity to wind turbines. These include but are not limited to headaches, insomnia, feelings of confusion, middle ear problems, nausea, tinnitus, tachycardia and panic attacks. The results

> of these small but indicative studies and surveys are sufficient to raise serious doubt about the continuation of turbine construction using current standards. Although it may be argued that these symptoms can be found in populations not subject to the effects of wind turbines, there is enough evidence to mandate formal research."
> [Watts, AC. Wind Turbines may represent a Health Hazard to Our Residents (letter). Blayney Chronicle (NSW, Australia), 21 March 2011]

Local physicians and health officers are observing at the grass roots level the effects of wind turbine noise on the health of those for whom they are responsible. Yet, misguided or poorly enforced policies and conditions fail to protect those people who are vulnerable to environmental noise pollution, through no fault of their own.

In order to assess the extent of reported problems with wind turbine noise in Ontario, in 2009, an independent group devised and conducted the self-funded WindVOiCe survey, which followed the principles of Health Canada's *Canada Vigilance Programs* for prescription and consumer products, vaccines, and other products. Results were reported on the Society for Wind Vigilance [SWV] website, an international organisation comprised of health professionals and acousticians who share concern about the adverse health effects of wind turbine noise. Of the 109 respondents to the WindVOiCe survey, 102 reported altered health and/or quality of life. In total, 72% of participants reported increased symptoms of anxiety, stress, or depression since the start of their local wind project, with sleep disturbance, excessive tiredness, and headaches the most common complaints, but other symptoms include inner ear problems, cardiovascular complaints such as arrhythmias and palpitations, acute hypertension, headaches, and cognitive and mood disturbances. Krogh *et al* have also reported their results in the peer-reviewed journal, *Bulletin of Science, Technology & Society*.
[Krogh CME, Gillis L, Kouwen N, and Aramini J. WindVOiCe, a Self-Reporting Survey: Adverse Health Effects, Industrial Wind Turbines, and the Need for Vigilance Monitoring. *Bulletin of Science, Technology & Society* 2011;31:334-345]

Victims report disturbed living conditions and loss of quality of life and enjoyment of their homes and property, as well as financial losses because of the negative impact to the health of their families. Some leave their homes for respite, in order to protect their health and well-being; typical responses included:

> "Not only we get flickering from the towers we cannot open any windows due to the constant noise of the blades... Biggest factor is the noise... Had to move out of my home, just come home now to feed the cattle... Our home can't be sold due to the problem per real estate agent... Family events can't take place at home... Financial problems due to keeping two homes."
> [Krogh C; Gillis L; and Kouwen N. A Self-Reporting Survey: Adverse Health Effects with Industrial Wind Turbines and the Need for Vigilance. WindVOiCe Wind Vigilance for Ontario Communities, Ontario, Canada, July 2010; see also Wind Concerns Ontario. A Self-Reporting Survey: Adverse Health Effects with Industrial Wind Turbines and the Need for Vigilance: Abstract and Participant Comments. Wind Concerns Ontario Community-based Health Survey, July 2009 – presented on April 22 2009 by Dr Robert McMurtry to the Ontario Government's Standing Committee re: Bill 150, the Green Energy Act]

In 2009, the American Wind Energy Association and the Canadian Wind Energy Association (A/CanWEA) issued its report, *Wind Turbine Sound and Health Effects, an Expert Panel Review*. The A/CanWEA Panel Review acknowledges that wind turbine noise may cause annoyance, stress, and sleep disturbance, and that people may experience adverse physiological and psychological symptoms. The panel then concludes that there are no serious health effects for those living with wind turbine noise, even though the adverse conditions will persist for at least 20 to 25 years, the predicted 'life' of a wind turbine.

The SWV analysed and responded to the A/CanWEA report, concluding that:

> "The conclusions of the A/CanWEA Panel Review are not supported by its own contents nor does it have convergent validity with relevant literature. It then ignores the serious consequences. The World Health Organization identifies annoyance and sleep disturbance as adverse health effects.[1]

In 2009, the World Health Organization released a peer-reviewed summary of research regarding the risks to human health from noise induced sleep disturbance. Some of the adverse health effects documented include fatigue, memory difficulties, concentration problems, mood disorders, cardiovascular, respiratory, renal, gastrointestinal, musculoskeletal disorders, impaired immune system function and a reported increased risk of mortality to name a few.[2]

Health Canada acknowledges the health consequences of stress and considers it a to be a risk factor in a great many diseases, such as heart disease, some types of bowel disease, herpes, mental illness and difficulty for diabetics to control blood sugar. It states severe stress can cause biochemical changes in the body, affecting the immune system, which leaves the body vulnerable to disease.[3]

Despite the acknowledgement that wind turbine noise may cause annoyance, stress and sleep disturbance the A/CanWEA Panel Review fails to offer any science based guidelines that would mitigate these health risks.

On the contrary, the A/CanWEA Panel Review concludes by suggesting that the authoritative health based noise guidelines of the World Health Organization should be ignored and that wind turbine noise limits be based on public policy.[4]

The A/CanWEA Panel Review concludes by stating that it does not "advocate for funding further studies." [5]

Others do not agree.

In November 2009, the Japanese Ministry of Environment announced a four-year study into the effects of wind farms on health.[6]

In September 2009 members of the Maine Medical Association passed a resolution which among other things calls for independent study and authoritative guidelines.[7]

Preliminary findings of a controlled study (Mars Hill, Maine) conducted by Dr. Michael Nissenbaum to investigate potential negative health effects concludes that adults living within 1100 meters of industrial wind turbines suffer high incidences of chronic sleep disturbances and headaches, among other somatic complaints, and high incidences of dysphoric psychiatric symptomology, compared to a control group living 5000-6000 meters away. This controlled study is a work in progress.[8]

The A/CanWEA Panel Review can only be viewed for what it is. It is an industry association convened and sponsored attempt to deny the adverse health effects being reported.

1 World Health Organization, Guidelines for Community Noise, 1999
http://www.euro.who.int/mediacentre/PR/2009/20091008_1
2 Night Noise Guidelines for Europe, World Health Organization (2009)
www.euro.who.int/document/e92845.pdf
3 Health Canada http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/life-vie/stress-eng.php
4 W. David Colby, M.D. et al., Wind Turbine Sound and Health Effects, An Expert Panel Review 2009,
Prepared for American Wind Energy Association and Canadian Wind Energy Association
5 W. David Colby, M.D. et al., Wind Turbine Sound and Health Effects, An Expert Panel Review 2009,
Prepared for American Wind Energy Association and Canadian Wind Energy Association
6 http://www.yomiuri.co.jp/dy/national/20091129TDY02309.htm
7 Maine Medical Association Resolution re Wind Energy and Public Health September 2009
8 http://windvigilance.com/mars_hill.aspx"

[Society for Wind Vigilance. Wind Energy Industry Acknowledgement of Adverse Health Effects: Part 1 Conclusion and Executive Summary of an Analysis of the American/Canadian Wind Energy Association sponsored "Wind Turbine Sound and Health Effects". Society for Wind Vigilance, Ontario, CA: January 2010 http://www.windvigilance.com/news/analysis-of-a-canwea-panel-review. See also Society for Wind Vigilance. Wind Energy Industry Acknowledgement of Adverse Health Effects: Part 2 Detailed Analysis of an Analysis of the American/Canadian Wind Energy Association sponsored "Wind Turbine Sound and Health Effects". Society for Wind Vigilance, January 2010]

These reports and study results are replicated elsewhere. In a 2010 lecture, Nina Pierpont, MD, PhD, reported on the findings of her study on the effects of wind turbine noise on health, including this finding on learning and cognition in children:

> "In my wind turbine study, 7 out of 10 school-age children and teens did worse in school during exposure to turbines, compared to before or after, including unexpected problems in reading, math, concentration, and test performance, noticed by both teachers and parents. Teachers sent notes home asking what was wrong with the children".
> [Pierpont N, MD, PhD. Wind Turbine Syndrome and the Brain. First International Symposium on the Global Wind Industry and Adverse Health Effects: Loss of Social Justice? Picton, Ontario, Canada, 30 October 2010, p5]

A report issued by the UK Noise Association (UKNA) concluded that: "noise generated by wind turbines can cause significant health problems, including stress, anxiety and depression." [Fitzpatrick K. 'Noise from Windfarm is Affecting My Health. Manchester Evening News, 22 January 2011]

Some journalists and an increasing number of MPs have observed the effects of wind turbine noise on those in their communities and constituencies. As a result, there has been more news coverage about those untoward effects. Yet, one of the more distressing articles, published in *The Sunday Times* [UK], revealed that:

> "Civil servants have suppressed warnings that wind turbines can generate noise damaging people's health for several square miles around. The guidance from consultants indicated that the sound level permitted from spinning blades and gearboxes had been set so high -- 43 decibels -- that local people could be disturbed whenever the wind blew hard. The noise was also thought likely to disrupt sleep."
> [Leake J and Byford H. Officials Cover up Wind Farm Noise Report. *The Sunday Times* (UK) 13 December 2009; see also Leslie K. *Ontario Unable to Tell if Wind Farms Exceed Noise Limits, Activists Say.* The Globe and Mail (Toronto, Canada), 15/16 June 2011.]

Civil servants -- public employees in the public's service -- suppressed critical information, needed by decision and policy makers, that posed a direct challenge and threat to the concept of a "fair democratic society". [Leake J and Byford H. Officials Cover up Wind Farm Noise Report. *The Sunday Times* (UK) 13 December 2009]

Among those MPs who are alarmed by their observations of the effects of wind turbine noise, Chris Heaton–Harris (Conservative, Daventry), in the House of Commons, asked the Secretary of State for Energy:

> "If he will review the implementation of recommendations made to the Government by the Hayes McKenzie Partnership in respect of wind turbine noise nuisance and aerodynamic modulation, with a view to reducing permitted noise levels."

Gregory Barker (Bexhill and Battle, Conservative), Minister of State (Climate Change), replied:

> "The work being carried out by Hayes McKenzie Partnership is a review of how current noise guidance is implemented in consideration of planning decisions, and is not concerned with the guidance itself or issues such as permitted noise limits. Hayes McKenzie are now working up their draft report which will then be independently peer reviewed... publication."
> [House of Commons Debate: Wind Power: Noise. Hansard, 18 October 2010, c482w] (See also: Heaton-Harris C. Onshore Wind Turbines (Proximity of Habitation). House of Commons Debates, HC Deb 17 November 2010, c900. (Second reading rescheduled for 20 January 2012.)
> http://services.parliament.uk/bills/2010-11/onshorewindturbinesproximityofhabitation.html]

This is cold comfort, because the Hayes McKenzie Partnership participated in preparing and writing ETSU-R-97, and represents wind energy clients during the process of wind turbine applications and appeals.

As *The Sunday Times* revealed, civil servants suppressed the nature and extent of problems with wind turbine noise. In order to rebuild public credibility, the government should have sought wider consultation, independent of the wind industry, and should have exercised more care when awarding a consultation regarding wind turbine noise. While one may acknowledge that the appointed firms are capable of undertaking this work, as a simple exercise of prudence to ensure a second and impartial assessment, certainly the government agency responsible should seek an acoustic engineering analysis from a firm without direct ties to the wind energy industry. Because of this oversight, the UK public and Parliament cannot have confidence in the impartiality of the reports issued by the department responsible for wind turbine noise guidance.

In April 2010, Plaid Cymru called on Carmarthenshire County Council (Wales, UK) to formally adopt a 2km buffer zone policy for large-scale commercial wind farm developments, creating a buffer of 2km (1.5 miles) between wind turbines and homes, unless residents consented otherwise. Plaid's Westminster candidate Jonathan Edwards, MP (Carmarthen East and Dinefwr), said:

> "Having spoken to people that have come under a lot of strain as a result of wind farm developments being situated very near to their homes I am left with little doubt that some protection must be offered. I am supportive of wind energy, as part of a holistic approach to tackling climate change, but I do believe that for the green agenda to work we need to take people with us. Any developments should fully take into account the impact they will have on the lives and individuals and communities in which they are built. I hope Council recognise that and take this proposal under serious consideration."
> [Edwards J. Plaid Call for 2km Wind Farm Buffer Zone. 9 April 2010 http://www.jonathanedwards.org.uk/plaid-call-for-2km-wind-farm-buffer-zone]

In the House of Commons on 27 July 2010, Mr Edwards, MP, asked the Secretary of State for Climate Change "... whether he plans to revise the noise assessment guidance for wind turbines (ETSUR97) (c893w).

In response, Gregory Barker, MP, said that:

> "Noise is a key issue to be taken into account in considering proposals for wind farm development. There is no reason to believe that the protection from noise provided for by ETSUR97 guidance does not remain acceptable, and we have no plans to change this..."
> [Hansard. Edwards J and Barker G. Wind Power. 27 July 2010, c893W]

In August 2010, the 14th Lord Reay, Hugh William Mackay, a former Member of the European Parliament, set down a Bill in the House of Lords proposing a minimum distance between wind turbines and homes based on the height of the wind turbine:

> "If the height of the wind turbine generator is
> a) greater than 25m, but does not exceed 50m, the minimum distance requirement is 1,000m
> b) greater than 50m, but does not exceed 100m, the minimum distance requirement is 1,500m
> c) greater than 100m, but does not exceed 150m, the minimum distance requirement is 2,000m
> d) greater than 150m, the minimum distance requirement is 3,000m.
>
> The height of the wind turbine generator is measured from the ground to the end of the blade tip at its highest point."

However, a reduced distance would be allowed with the express agreement of every family homeowner within the restricted zone. [Lord Proposes Controversial 2km Residential Distance Ruling on Wind Farms. *Western Morning News*, 9 August 2010]

In Nov 2010, Chris Heaton–Harris, MP, sought to bring a similar Bill to the House of Commons, giving local people and communities more control over development proposals in their area, such as wind farms and the right for local authorities to set minimum distances from homes. (However, Liberal Democrat MP for Cheltenham, Martin Horwood, opposed this motion.) [Heaton-Harris C. Onshore Wind Turbines (Proximity of Habitation). House of Commons Debates, HC Deb 17 November 2010, c900. This bill was scheduled for a second reading during 2011; after postponements, it is now expected to have its second reading debate on 20 January 2012.]

Karen Whitefield (Airdrie & Shotts, Scottish Labour) submitted a written question to the Scottish Parliament on 6 December 2010:

> "To ask Scottish Executive what the legal set-back distances are for the construction of wind farms from (a) individual properties & (b) settlements (Question S3W-38080).

In his written response, Keith Brown said:

> "There are no legal set-back distances. **Scottish Planning Policy recommends a 2km separation distance between areas of search for wind farms and the edge of cities, towns, and villages.** The Scottish Parliament Public Petitions Committee has supported this position as a guide rather than a rule in closing petition."
> [Scottish Parliament Written Answers, Question S3W-38080, 15 Dec 2010]
> [Emphasis added.]

An article in *The Northern Times* (Scotland) reported that:

> "The local authority has forced Scottish and Southern Energy to shut down a Sutherland wind farm after the company breached planning controls by failing to deal with excessive noise from the development. People living close to the Achany wind farm near Roehall are claiming their lives are being made a misery by the constant noise, and are angry that their complaints are ignored."
> [McMorran C. Exasperated Planners Shut Wind Farm Down. The Northern Times, 9 June 2011]

These few examples illustrate the difficulty that families and communities face as they attempt to wrestle with wind turbine noise or with efforts to prevent inappropriate wind turbine development. Although noise problems are extant and acknowledged, and the current guidance offers little or no protection, government is content to continue with the status quo. Although several MPs and Peers have offered realistic potential solutions, government has not shown any interest in pursuing these.

Often families cannot escape this industrial intrusion into their lives because they do not have the financial resources to seek respite in a 'safe' house. Some families, driven to abandon their homes, seek rented or other accommodation if their family budget allows – and sometimes even if it does not. (See also Hessling K. Residents Sue Wind Companies. *Huron Daily Tribune* May 29, 2010 http://www.michigansthumb.com/articles/2010/05/29/news/local_news/doc4c0117f48d12c257748685.txt.) Often, families seek the help of the developer or wind farm operator, local government and other agencies, in order to enforce noise conditions. Regularly, this proves futile, inadequate, time-consuming, and expensive. The process may take years. In the UK, because the Guidance on wind turbine noise does not provide adequate protection, the developer or owner may actually meet the limits imposed by ETSU or the planning noise conditions. Yet, neighbouring families suffer injury to their health, compromised quality of life, and loss of the amenity of their homes. Thus, not even the planning conditions protect those living nearby. Those families suffering from the adverse health effects of wind turbine noise may be considered victims of degrading and inhuman treatment, authorised by the State.

According to Dr Aitken [2010] of the University of Edinburgh, in the research paper *Why We Still Don't Understand the Social Aspects of Wind Power*:

> "The literature on public attitudes to wind power is underpinned by key assumptions which limit its scope and restrict the findings it can present.

Five key assumptions are that:
1. The majority of the public supports wind power.
2. Opposition to wind power is therefore deviant.
3. Opponents are ignorant or misinformed.
4. The reason for understanding opposition is to overcome it.
5. Trust is key."

Aitken contends that opposition to wind power:

> "cannot be dismissed as ignorant or misinformed, instead it must be acknowledge that objectors are often very knowledgeable. Public attitudes and responses to wind power should not be examined in order to mitigate potential future opposition, but rather in order to understand the social context of renewable energy. Trust is identified as a key issue, however great trust must be placed in members of the public and in their knowledge. In sum, the literature must abandon the assumption that it knows who is 'right' and instead must engage with the possibility that objectors to wind power are not always 'wrong'."
> [Aitken M. Why We Still Don't Understand the Social Aspects of Wind Power: A Critique of Key Assumptions within the Literature. *Energy Policy* 2010; 38: 1834-1841]

Ellis et al [2009] similarly observed that applications for wind turbine arrays:

> "often arouse controversy, particularly if proposals are poorly located. The available evidence does not support the claim that planning causes undue delays in relation to major wind energy schemes. Rather, planning should be seen as an essential part of the democratic process -- which needs time if it is to work effectively."
> [Ellis G; Cowell R; Warren C; Strachan P; Szarka J; Hadwin R; Miner P; Wolsink M; Nadal A. Wind Power: Is there a "Planning Problem"? *Planning Theory & Practice* Dec 2009; 10(4): 521-547]

Although public attitudes to wind farms have been studied, the research has emphasised

> "understanding the 'problem' of objection, to the neglect of exploring the basis of support. The ideological (i.e. unreflectively pro-wind) and epistemological (i.e. unreflectively positivist) bias has led to poor explanatory findings, which in turn has resulted in ineffective policy."
> [Ellis G; Barry J; Robinson C. Many ways to say 'no', different ways to say 'yes': Applying Q-Methodology to understand public acceptance of wind farm proposals. *Journal of Environmental Planning and Management* July 2007; 50(4): 517-551]

Ellis et al [2007] also note that the research into public attitudes and objections to wind farm developments highlights

> "the inadequacy of the NIMBY explanation of objection, which overlooks the complexity of why people may object to a wind farm proposal..." This "fuels conflict because of its derogatory implications and contributes to poor responses to such disputes. There is a tendency to marginalise and denigrate oppositional voices to schemes that are portrayed as being environmentally progressive, failing to acknowledge that each individual's position is informed by personal and collective values that are deeply held, aspirational and often well intentioned. This suggests that even some of the more sophisticated explorations of objection to wind farms may be conceptually flawed." Indeed, the authors suggest, "the most popularly deployed methodology, the opinion poll, has contributed to the impasse in understanding public perception of wind farms..."

Yet, even the planning process suggests that lay knowledge plays a limited role:

> "Local objectors were able to influence the early planning application stage. However, this resulted in an appeals process (public inquiry), which was beyond the influence of lay people, and within which lay knowledge played only a marginal role... Witnesses who could not back up their evidence with 'reliable' data or scientific reasoning were discredited as illegitimate and as having little to contribute to the inquiry process. Thus the inquiry constructed boundaries

> between expert and lay knowledge, in ways which diminished the role that lay knowledge might play."
> [Aitken M. Wind Power Planning Controversies and the Construction of 'Expert' and 'Lay' Knowledges. *Science as Culture* March 2009; 18(1): 47-64]

Aitken [2009] reflects on one particular planning application, observing that:

> "Much of the evidence put forward at the inquiry was generaliseable -- that is, equally applicable to other potential wind farm sites around the UK. It did not therefore reflect the particular issues relating to the single application of this case study. Far less did it reflect the real concerns and worries of the local community whose protest generated the public inquiry. While the local opponents may have hoped that the inquiry would provide an impartial forum focussed on the issues which were pressing for this particular community, they ended up as little more than a passive audience for expert disagreements."

This scenario is re-enacted throughout the UK during many Public Inquiries, further reinforcing the sense of disenfranchisement by the communities who must then capitulate to policy decisions that negatively influence their daily lives. Certainly there is a disconnect between the experiences and voices of local groups and the effectiveness of government and industrial wind energy standards to protect people from the untoward and often unanticipated negative consequences of industrial development.

Indeed, Aitken [2009] states that the appeals process **"was beyond the influence of lay people, and within which lay knowledge played only a marginal role…** Lay voices merely represented supplementary and even superfluous actors on a stage dominated by specialist and highly experienced experts (and lawyers). Although the stage was nominally local, the events being acted out were anything but." [Emphasis added.]

Certainly, without the input of local people and their local knowledge, the people are unrepresented in the 'democratic' decision-making process, which is in the hands of one inspector. Yet, local communities accept a model that relies on expert knowledge at the expense of local knowledge. Ironically, expert knowledge "has secured a hegemonic position within technical decision-making... its central role is therefore not questioned or challenged, even by those who might suffer as a result." [Aitken 2009]

Still, Aitken observes that policy- and decision-makers and the wind energy industry have worked primarily to identify ways in which to secure the public's greater acceptance of wind power. However, as long as they presume:

> "that opposition is misinformed, ignorant, or deviant it can never fully understand individual or community experiences with wind power. Moreover, by presuming that that opposition needs to be avoided or overcome it fails to acknowledge the potential value of objectors' points of view. Objectors are not necessarily ignorant, but rather may be very well informed about wind power or local issues relating to particular developments. As such, their views should not be overlooked and participation should not be viewed as a means to overcome or mitigate opposition but instead as valuable opportunities to incorporate multiple viewpoints and knowledge resources. This would at times lead to the conclusion that particular proposed developments are inappropriate or socially unacceptable...
>
> This paper points to the irony of repeated calls for engendering greater trust within planning processes when the literature appears so clearly wedded to a managerial intention of overcoming opposition..."

However, planners, developers, and commentators must also place more trust in the public:

> "They should trust the public to have valid opinions and legitimate knowledge and therefore should trust that open participation can produce positive outcomes whether or not these are in favour of particular developments." They "must engage with the possibility that objectors to wind power are not always 'wrong'."
> [Aitken 2010]

Furthermore, and most critically, these assumptions have found their way "into policy and practitioner debates as well as planning debates around particular proposed wind power developments (as highlighted above in relation to NIMBYism)." [Aitken 2010]

Thus, the experiences related in this chapter serve an important role as a cautionary tale for others who are embroiled in efforts to ensure that wind turbine developers do not site turbines near homes and communities. Together, policy, the planning process, and the wind energy industry offer little in the way of ameliorating the inadequate standards or even providing noise conditions that are reasonable and enforceable. Efforts now by developers and government to engage people and their communities – often with financial or other incentives offered to the community – are now seen as cynical attempts to evade responsible planning that protects families from wind turbine arrays built too close to homes.

Families with limited financial resources are informing their public officials and decision makers as best they can, by submitting evidence in papers and reports that describe the suffering experienced by families elsewhere. [Wetterer R. Statement Presented to the State of New Hampshire Site Evaluation Committee, re: Docket No. 2010-01, New Hampshire, USA, 31 August 2010]

# *Appendix 1*

## People's Health Experiences: Additional References

Alteri B.
**Does Wind Turbine Noise Affect Your Sleep or Health?**
*WLBZ Channel 2*, Bangor Maine, USA, 14 May 2009.
http://www.wlbz2.com/news/local/story.aspx?storyid=104717&catid=3

Glen Dhu Power – Wind Project (Shear Wind Inc.).
**Environmental Assessment: Proximity and Noise.**
Nova Scotia, Canada, February 2008; February 2009.
http://www.gov.ns.ca/nse/ea/glen.dhu.wind.farm/glen.dhu.wind.farm.Addendum.Section02.Proximity.and.Noise.pdf

Todd W.
**Living with Turbines – a Personal Account, 16 February 2009.**
http://www.windaction.org/documents/15113

Todd W.
**Testimony to Maine Legislature, 30 April 2007.**
http://www.maine.gov/dep/ftp/bep/ch375citizen_petition/pre-hearing/AR-70%20Wendy%20Todd%20testimony.pdf or
http://www.wind-watch.org/documents/testimony-of-wendy-todd-to-the-maine-legislature-april-30-2007/

**Waubra Resident on 24-hour Check.**
The Courier (Australia), 31 December 2010.
http://www.thecourier.com.au/news/local/news/general/waubra-resident-on-24hour-check/2037606.aspx

Webster B.
**Helicopter Noise Court Challenge for Wind Farms.**
*The Times* (UK), 4 July 2011.
http://www.thetimes.co.uk/tto/environment/article3082809.ece

# *Chapter 2*

## Wind Turbine Noise and Guidance

### 2.1 WIND TURBINE NOISE

Chapter 1 illustrates that wind turbines located in close proximity to family homes create environmental noise pollution that people may perceive not merely as annoying or a nuisance, but also experience as injurious to health. There are many reported health responses, but the primary responses and the trigger for other consequences, such as fatigue and inability to concentrate on tasks, are long-term sleep disturbance and sleep deprivation.

According to a recent article in *Audiology Today*, a publication of the American Academy of Audiologists, the authors express concern that as wind turbines are allowed in proximity to homes and communities, their noise may generate health issues among patients, to which audiologists should remain alert:

> "Noise from modern wind turbines is not known to cause hearing loss, but the low-frequency noise and vibration emitted by wind turbines may have adverse health effects on humans and may become an important community noise concern.
>
> Evidence has been mounting over the past decade, however, that these utility scale wind turbines produce significant levels of low frequency noise and vibration that can be highly disturbing to nearby residents. None of these unwanted emissions, whether audible or inaudible, are believed to cause hearing loss, but they are widely known to cause sleep disturbances.
>
> Inaudible components can induce resonant vibration in solids, liquids, and gases – including the ground, houses, and other building structures, spaces within those structures, and bodily tissues and cavities – that is potentially harmful to humans. The most extreme of these low frequency (infrasonic) emissions, at frequencies under about 16Hz, can easily penetrate homes.
>
> Some residents perceive the energy as sound, others experience it as vibration, and others are not aware of it at all. Research is beginning to show that, in addition to sleep disturbances, these emissions may have other deleterious consequences on health. It is for these reasons that wind turbines are becoming an important community health issue, especially when hosted in quiet rural communities that have no prior experience with industrial noise or urban hum."
> [Punch J, James R, and Pabst D. Wind Turbine Noise: What Audiologists Should Know. *Audiology Today* July/August 2010]

Yet, as recently as 27 July 2010, in response to a question in the House of Commons, Charles Hendry acknowledged:

> "Noise is an issue."

Then he added:

> "There is no reason to believe that the protection from noise provided by the ETSU-R-97 guidance does not remain acceptable and we have no plans to change this."
> [Hansard. Davies P and Hendry C. Noise: Wind Farms. HC Deb, 27 July 2010, c888w]

On the one hand it is quite understandable that a property developer will seek to maximise the economic potential of a site by shoehorning wind turbines onto a site up to the margin that the developers' acoustic consultant thinks might be negotiated with the authorising public officials. This is all part of the commercial world. On the other hand, it is the responsibility of government and delegated agencies of government to ensure that effective guidance provides the maximum level of protection to families for their health, amenity, and human rights, which the Government has contracted to honour in international conventions. Current regulation is unreliable and inadequate for protecting the health of families living near wind turbines. Where family homes are

located within a minimal 2km buffer zone from the periphery of a proposed wind turbine array, one must ask: Is the national need for onshore industrial wind turbines so critical that it is justifiable to dispense with the basic human rights, dignity, and health of families, and instead sanction priority for wind turbines near homes, and thus sentence families to degrading and inhuman treatment? If the answer to this question is 'yes', then it is for the Government to provide sufficient compensation to the families allowing them to move to a comparable home away from the wind turbines. If however, the answer is 'no', then it is incumbent upon the authorising agency to set enforceable controls on the level of noise that respects the family's amenity, dignity, and privacy; that protects their basic human rights; and that prevents injury to their health.

In a recent article, Harrison (Queens University, Ontario) carefully delineates the principal problems:

> "The characteristics of turbine noise that contribute to annoyance and sleep disturbance are as follows: The sound from turbines is amplitude modulated at the blade passage frequency. The modulation level is typically 3 to 5 dBA (Van den Berg 2005) but higher levels have been measured (Moorhouse, Hayes, von Hunerbein, Piper & Adam, 2007).
>
> Two things arise: The peak sound is higher than the average used for noise regulation and the modulation enhances the audibility of the sound to such an extent that the turbine noise can be detected even when the sound is below ambient. The noise emitted by a turbine is broadband; however, at a distance of 500 meters and more, the higher frequencies have been absorbed by the atmosphere so that it is predominantly low-frequency noise that reaches a receptor.
>
> This low frequency noise enhances annoyance and is more readily able to penetrate walls and resonate inside rooms. Many people report a thumping, rumbling, or impulsive character to the turbine noise…."
> [Harrison JP. Wind Turbine Noise. *Bulletin of Science, Technology and Society* 2011;31:256-261]

In other words, current guidance averages the 'peaks' and the 'troughs', which makes the emitted sound appear level (on paper). Yet, that is not how a person perceives the sound. The human ear would hear the 'peak' as distinctive and intermittent. It is the 'peak' noise that creates the 'thumping' characteristic of wind turbine noise, and which people find disruptive and intrusive. Moreover, the 'peak' sound might actually exceed the allowable noise limit, but when averaged with the 'trough', the averaging makes it appear (on paper) that the noise is compliant with guidance and conditions. [Bray W and James R. Dynamic Measurements of Wind Turbine Acoustic Signals, Employing Sound Quality Engineering Methods Considering the Time and Frequency Sensitivities of Human Perception. Noise-Con (Portland, Oregon, USA), July 25 – 27, 2011]

## *What is an acceptable level of noise?*

The World Health Organization, the European Union, and many environmental and health organisations have identified environmental noise pollution as a major and worsening public health problem. In 2009, the World Health Organization published *Night Noise Guidelines for Europe*, issued by the WHO Regional Office, the European Centre for Environmental Health, and co-sponsored by the European Commission. One goal of the WHO Night Noise Guidelines (WHO NNG) is to provide impartial expertise and scientific advice to the European Commission and its Member States in developing legislation for limiting people's exposure to night noise. A key objective was to provide guideline values for night noise in order to protect the public from prejudicial health effects. The recommendations for health protection state:

> **"Sleep is an essential part of human function and is recognised as a fundamental right under the European Convention on Human Rights. (Article 8.1, Everyone has the right to respect for his private and family life, his home and his correspondence.) Based on the evidence of the health effects of night noise, an overall summary of the relation between night noise levels and health effects, and stepwise guideline values are presented as shown in Table 5.4 and 5.5 respectively."**

> **"For the primary prevention of subclinical adverse health effects in the population related to night noise, it is recommended that the population should not be exposed to night noise levels greater than 30 dB of L night, outside during the night when most people are in bed. Therefore L night, outside 30 dB is the ultimate target of Night Noise Guideline (WHO NNGL) to protect the public, including the most vulnerable groups such as children, the chronically ill and the elderly, from the adverse health effects of night noise."**
> [WHO NNG 2009, p 109]

Note that the WHO NNG are based largely on non-impulsive noise, e.g., road and rail, and is therefore not strictly applicable to wind turbine noise, which has the peaks and troughs of pulsation and intermittency. Noise with pulsation and/or intermittency can be more intrusive than non-impulsive noise, substantiated in many studies and recently confirmed by yet another study in a detailed meta-analysis by Szalma and Hancock:

> "... intermittent noise is more disruptive than a continuous schedule."
> [Szalma JL and Hancock PA. Noise Effects on Human Performance: A Meta-Analytic Synthesis. *Psychological Bulletin* 2011, Vol. 137, No. 4, 682–707]

WHO NNG recommendations for health protection refer to the relationship with the earlier WHO Guidelines for Community Noise, issued in 2000:

> "If negative effects on sleep are to be avoided the equivalent sound pressure level should not exceed 30 dBA indoors for **continuous** noise. If the noise is not continuous, sleep disturbance correlates best with LAmax and effects have been observed at 45 dB or less. This is particularly true if the background level is low. Noise events exceeding 45 dBA should therefore be limited if possible. For sensitive people an even lower limit would be preferred. It should be noted that it should be possible to sleep with a bedroom window slightly open (a reduction from outside to inside of 15 dB)... The thresholds for a number of effects are now known, and much lower than an L Amax of 45. The last 3 sentences still stand: there are good reasons for people to sleep at night with their window open, and to prevent sleep disturbances one should consider the equivalent sound pressure level and the number of sound events. **The present guidelines allow responsible authorities and stakeholders to do this.**"
> [WHO NNG 2009, pp 110—111]

In 2011, WHO issued *The Burden of Disease from Environmental Noise* (WHO BDEN), an exhaustive study of current knowledge of the relationship between disease and noise, and the known best guidance to avoid adverse impacts on health from environmental noise:

> "The health impacts of environmental noise are a growing concern among both the general public and policy-makers in Europe... The chapters contain the summary of synthesized reviews of evidence on the relationships between environmental noise and specific health effects, including cardiovascular disease, cognitive impairment, sleep disturbance and tinnitus."
> [WHO Burden of Disease from Environmental Noise (WHO BDEN), 2011, Abstract http://www.euro.who.int/__data/assets/pdf_file/0008/136466/e94888.pdf]
>
> **"Thus, noise pollution is considered not only an environmental nuisance but also a threat to public health."**
> [WHO BDEN, 2011, Forward]

In the UK, the wind energy industry was and remains largely responsible for devising the wind turbine noise guidelines used by government since 1997. At that time, the Dti [then BERR, now DECC] convened a Noise Working Group [NWG], whose 14 members were comprised primarily by acousticians consulting to or working for the wind energy industry. [See Frey BJ and Hadden PJ, *Noise Radiation from Wind Turbines Installed Near Homes: Effects on Health*, June 2007.] Although the NWG had access to the WHO 1995 report on *Community Noise*, it included reference only to the much older 1980 (and superseded) WHO report on community noise. WHO regularly updates its noise and health guidance because there are advances in the science and the understanding of the issues involved, and because it is a responsibility to ensure that policy- and decision- makers have the most current knowledge and data. Decisions often have long-term consequences – as

demonstrated by the wind turbine noise policy in the UK. Whereas the WHO reports are researched and reviewed by a panel with multidisciplinary, international expertise, in the UK, ETSU was devised solely by those without medical or clinical expertise; nor, apparently, did the panel consult with or include anyone with clinical or epidemiological expertise. [World Health Organization. Community Noise. WHO, 1995 http://www.nonoise.org/library/whonoise/whonoise.htm]

Most telling, ETSU is transparent in its purpose, as stated quite definitively in its *Executive Summary*, that is, to devise a guidance for allowable audible noise

> **"without placing unreasonable restrictions on wind farm development or adding unduly to the costs and administration burdens on wind farm developers or local authorities."**
> [ETSU-R-97 Executive Summary S.1] [Emphasis added.]

Note also that ETSU addresses audible noise only, to the exclusion of low frequency noise, a significant component of wind turbine noise that is largely inaudible but often perceptible.

The NWG – with its panel of 14 members and the chair (drawn mainly from the wind energy industry) – proceeded to design a guidance that – with the assent of the Department of Trade and Industry -- continues to blight the lives of those who have wind turbine arrays built near their homes and communities. As the ETSU *Executive Summary* also states:

> "We have considered whether the low noise limits which this could imply in particularly quiet areas are appropriate and have concluded that it is not necessary to use a margin above background approach in such low-noise environments. This would be unduly restrictive on developments..."
> [ETSU-R-97 Executive Summary S.11]

When the regulators are among those regulated, there is no control over standards and their enforcement.

> "Where regulatory actions are exposed to public view, regulators are more likely to engage in careful and reflective decision-making."
> [ICT (Information and Communications Technologies) Regulation Toolkit. *Decision-making Process and Consultation Framework*. S.7.2. 16 June 2011 www.ictregulationtoolkit.org]

When ETSU was published, wind turbines were approximately 30m high, whereas many wind turbines now measure 125m and higher. Yet, as wind turbine noise persisted in causing problems even after the implementation of ETSU, the government continues to rely on the same cadre of consultants for subsequent evaluations of reported problems with wind turbine noise.

In August 2006, the UK Government published *Measurement of Low Frequency Noise at Three UK Wind Farms*, written by Hayes McKenzie Partnership Ltd (HMP), on consultation to the Dti. (Mr Hayes was a member of the NWG that produced ETSU-R-97). Their Report measured low frequency noise at three wind farm sites in the UK. The HMP Conclusions quote WHO's 1995 report on *Community Noise*, which stated that:

> **" 'There is no reliable evidence that infrasound below the hearing threshold produces physiological or psychological effects.' "**
> [Hayes McKenzie Partnership. Measurement of Low Frequency Noise at Three UK Wind Farms, August 2006, p66]

This HMP Report – published in **2006** – repeats the same quotation on pages 2, 10, 46 as well as on page 66. However, this quotation, taken from the WHO *Community Noise* paper **1995**, does not appear in the **1999** WHO *Guidelines for Community Noise*, which superseded the earlier report. WHO's 1999 report is freely available on the web to download and was available to the authors of the HMP report, as WHO reports are generally freely available on the web. [World Health Organization. Guidelines for Community Noise. WHO 1999 http://whqlibdoc.who.int/hq/1999/a68672.pdf]

Moreover, the WHO *Guidelines for Community Noise 1999* clearly states in Section 3.8:

> **"The evidence on low frequency noise is sufficiently strong to warrant immediate concern... Health effects due to low frequency components in noise are estimated to be more severe than for community noises in general."**

**Rather than quote from the most current WHO report with the most reliable research and evidence-based observations, HMP quoted from superseded WHO documents that supported its own contention that low frequency noise has no adverse effects on people.**

Contrast the HMP conclusion with the data produced by consultant acousticians from MAS Environmental (Cambridge, UK), at the home of the Davis family on 5 July 2007**, *Wind Farm Amplitude Modulation showing significant low frequency content*.** [MAS Environmental. Noise Monitoring Graph within first floor bedroom - Davis's House - Wind Farm noise, 5 July 2007, in Assessing Noise from Proposed Wind Turbine Developments. MAS Environmental, Cambridge, UK, May 2009] The measurement inside a bedroom at night with the window partly open, using LA eq 125ms, indicated modulation between 38dBA and 30dBA at one per second, and the modulation fluctuated over time. Whereas, LA90 (which averages readings over a period of time, flattening the peaks and troughs) shows a much lower dBA reading at 31dBA as a continuous flat noise.

A second measurement by MAS Environmental, taken at the Davis's House:

> **"... clearly shows wind farm Amplitude Modulation showing significant low frequency content."**

MAS Environmental commented that:

> **"Wind turbine noise contains considerable low frequency content (LFN). Work funded to date by DEFRA in this area is completely inadequate and not scientifically robust. The use of 'A' weighting alone for investigating LFN is an indication of the lack of technical expertise applied to this area. As lower frequency wave bands are analysed, as in this graph, the extent of the modulation becomes worse, more than 10dB.**
>
> **Due to the governments preferred measure for assessing the noise from wind turbines, known as ETSU-R-97, which has the effect of averaging noise peaks out over a period of time, there is no recourse to justice under existing British law to assist us. We now know that although we were initially told that less than 5% of wind farms have this problem, the reality is likely to be in excess of 10%..."**
> [MAS Environmental. Assessing Noise from Proposed Wind Turbine Developments. MAS Environmental, Cambridge, UK, May 2009] [Emphasis added.]

In testimony to the Wisconsin Public Service Commission, October 2009, Richard James, a certified acoustician, addressed the issue of low frequency noise:

> "Dr Leventhall testifies that 'any effect from wind turbine noise, or any other low level of noise, which might be produced within the body is lost in the existing background noise and vibration.' Human beings have adapted to disregard normal bodily noises. It is, therefore, seriously wrong of Dr Leventhall to compare external, imposed, and unnatural fluctuating sounds with pressure levels of 40 – 70 decibels to physiologic noises within the body.
>
> Dr Leventhall testifies that 'higher frequency noise from wind turbines, if it is audible, can cause disturbance to some residents, but this effect is no different from that of noise from another source.' On the contrary, wind turbine noise, by virtue of its constant presence (over hours or days), dynamic modulation of ILFN and audible frequencies, and frequent nocturnal exacerbation, is unlike other sources of community and industrial noise. Moreover, other sources of industrial noise are regulated in manners suitable to their nature. Given the demonstrated increased annoyance of turbine noise, regulations must be specially formulated to address their unique qualities and potentials for annoyance."

> [James R. Surrebuttal Testimony of Richard R James on Behalf of the Coalition for Wisconsin Environmental Stewardship. Wisconsin Public Service Commission, docket 6630-CD-302: Wisconsin Electric Power Company (WEPCO), 28 October 2009, pp SR9.16 – SR9.22] (N.B.: Dr Leventhall is an acoustician who has acted as a consultant to Defra and other UK government agencies.)

Regarding low frequency noise, Dr Swinbanks (MAS Research Ltd – Mathematical & Scientific Research), corroborates James' assessment of LFN:

> "The opinions of two UK acousticians relating to wind turbine noise differ.
>
> Professor Ffowcs-Williams has stated, "It is known that modern, very tall turbines, do cause problems, and many think current guidelines fail adequately to protect the public."
>
> While Dr Geoff Leventhall has commented, "I can state quite categorically that there is no significant infrasound from current designs of wind turbines. Infrasound is not a problem, low frequency noise may be audible under certain conditions, the regular swish is not low frequency noise."
>
> In practice, the transition from infrasound to low frequency sound may be blurred. Based on my experience, the consistent reports of physical discomfort resulting from wind turbine noise reinforce my perception that low frequency noise can indeed be a problem. The reported effects are entirely consistent with those that I have experienced at first hand 20-30 years ago.
>
> Low frequency noise can induce feelings of discomfort and nausea, not unlike seasickness. Like seasickness, the sensitivity of different individuals varies enormously, some being immediately sensitive, while others can barely detect anything…"
> [Swinbanks MA (Dr). Submission to the Michigan Public Service Commission (MPSC) re: Case No U-15899, 8 December 2009. MAS Environmental, Cambridge, UK, 9 December 2009]

Low frequency noise emissions from wind turbines was a central topic at the 2011 Fourth International Conference on Wind Turbine Noise in Rome. One study by Møller and Pederson found:

> "The noise emission from 48 wind turbines with nominal electric power up to 3.6mw is analyzed and discussed. The relative amount of LFN is higher for large turbines (2.3 – 3.6mw) than for small turbines (≤2mw), and the difference is statistically significant."
> [Møller H and Pedersen CS. Low Frequency Noise from Large Wind Turbines. JASA Journal of the Acoustical Society of America June 2011;129(6): 3727-3744]
> (See further discussion of LFN at S.2.4, p 54.)

However, although wind turbine noise problems, both audible and inaudible (LFN) were known about long before the Dti Noise Working group convened, as noted by Swinbanks, the NWG's ETSU-R-97 instead recommends:

> "Noise from the wind farm will be limited to 5 dB(A) above background for both day-and night-time (with the exception of the lower limits and simplified method described below), remembering that the background level of each period may be different. It should be noted that this limit applies to the noise from the wind farm only and not the total ambient noise with the wind farm operating... On balance it is considered that a margin of 5dB(A) will offer a reasonable degree of protection to both the internal and external environment without unduly restricting the development of wind energy which itself has other environmental benefits."
> [Note: Low Frequency Noise, LFN, is discussed further in S.2.4, p 54.]

Regarding a *Lower Limit,* the NWG added that:

> "Applying the margin above background approach to some of the very quiet areas in the UK would imply setting noise limits down to say 25-30 dB(A) based upon background levels perhaps as low as 20-25dB(A**). Limits of this level would**

> **prove very restrictive on the development of wind energy.** As demonstrated below, it is not necessary to restrict wind turbine noise below certain lower fixed limits in order to provide a reasonable degree of protection to the amenity."
> [ETSU-R-97, p 60] [Emphasis added.]

In November 2008, Michael Stigwood, an acoustic engineer and environmental health engineer with MAS Environmental, Impington, Cambridge, UK, presented a seminar at the University Centre, Cambridge. During the *"Windfarm Nuisance Investigation and Assessment Seminar",* Stigwood pointed out that in 1996, at the time of ETSU, the height of wind turbines was 30 – 60 metres to blade tip, 250 – 500kw of power, with a blade sweep of 300 – 1250 square metres. Today wind turbines are considerably larger, with a height of 100 – 150 metres to blade tip, 1.5 – 3 MW of power, with a blade sweep of 2,800 – 11,000 square metres. Stigwood also made these points:

> "There are assumptions in ETSU that do not hold true. There are inherent defects in the methodology developed for ETSU where the problem and errors are greater the larger the turbines. Controls proposed in ETSU fail to address the differences between medium and large wind turbines and thus permit greater impact the larger the turbines."
> [Stigwood M. Windfarm Nuisance Investigation & Assessment Seminar. MAS Environmental, University Centre, Cambridge, UK, 20 November 2008]

In gathering evidence at the Deeping St Nicholas wind farm, with turbines 100 metres to blade tip, MAS found the larger turbines generated

> "low frequency noise impact which may dominate within dwellings even at substantial distances. (Can modulate over a considerable range in the region of 15 – 20 dB). (This research concurs with research by Van den Berg.) Excess Amplitude Modulation (AM) arises when measured within dwellings especially at certain times where certain atmospheric conditions appear to prevail (up to 8dB measured inside)...
>
> Free field background noise level measurements as proposed in ETSU R 97 commonly will not represent background noise levels experienced immediately outside dwellings...
>
> The procedures and methods contained within ETSU R 97 are incapable of identifying the range of impacts from noise generated by large wind turbines, within nearby dwellings."
> [Stigwood M. Windfarm Nuisance Investigation & Assessment Seminar. MAS Environmental, University Centre, Cambridge, UK, 20 November 2008]

In considering Excessive Amplitude Modulation with large wind turbines, Stigwood noted:

> "In ETSU the difference between LAeq and LA90 of wind turbine noise is assumed to be 2dB over a 10 minute period. The suggested relationship arises because of the limited variation between peak to trough sound energy levels for medium turbines does not apply in the case of large turbines where a far greater peak to trough ratio can clearly occur."

And in measurements taken by MAS at Deeping St Nicholas, 930 metres from nearest wind turbine, Stigwood observed that:

> "The lowest to the highest point exceeds 10dB just in one minute. Max variation for individual thump or whoosh is 8dB(A)."

Regarding the onsite measurements at Deeping St Nicholas, the MAS report noted that:

> "We have repeatedly measured low frequency noise internally at different times of the day and night. Externally the wind turbine noise can be almost completely masked and unrecognizable. Internally the masking noise is almost completely removed, revealing serious intrusion from the modulating noise. Significant differences arise between the attenuation of the turbine noise and the attenuation of nearby sources of masking noise such as trees."

MAS further commented on Amplitude Modulation (AM) at the Deeping St Nicholas site:

> "Equates to the modulation or cyclic variation of sound energy emitted by wind turbines. It is relatively broadband in character and changes or pulsates at the frequency of the blade passage frequency, giving rise to a characteristic 'swishing' or 'whooshing' sound. At times the sound can be more pronounced as a thumping noise. It is characterised by a regular rise and fall in sound energy denoted by the peak to trough range. Amplitude Modulation is far greater in certain individual sound energy third octave bands. It can be up to and exceeding 20dB – (See variation in 160 Hz 1/3$^{rd}$ octave band which exceeds 20dB)."
> [Note: Amplitude Modulation (AM) is discussed further in S.2.5, p 60.]

In discussing *Wind Shear Issues*, MAS made the following observations:

> "In practice the wind speed at different heights will vary most of the time and can sometimes reverse (Inversion conditions). All methods are approximate but the Power method is the most accurate. During background noise measurements, wind speed measurements should be made at: (1) 10m, (2) hub height, (3) one other height to confirm validity of the relationship. (Ideally above hub height to confirm any 'Nocturnal Jet'). (The latter would probably require equipment measuring air speed using Doppler shift technology)."

The MAS seminar also addressed wind conditions at night:

> "Clear sky and low wind gives stable atmosphere due to radiative cooling. In these circumstances the wind profile changes and the standard formulas are no longer relevant...
>
> "At night there can be little or no wind generated noise at ground level or even in the trees up to 10 meters or so but at heights of increasingly above 10 meters the predicted relationship fails. For example: For wind at 10 meters height, the speed is 3 m/s, then at 60 meters hub predicted is 3.7m/s. BUT under stable conditions at night, for wind at 10 meters = 3m/s, then at 60 m hub height = 6m/s."

In its assessment of the ETSU control methods, the MAS report observed that:

> "Measurements of the LA90 are relied upon in ETSU. This is a statistical measure of the **quietest 10% of the time.** It cannot reflect the potential peaks of sound energy likely to arise." (MAS 126)
>
> The effect of this is that because ETSU was designed on the basis of medium size turbines, it assumes the same laws relate to large turbines. This is not the case. "If the same LA90 limit was placed on both it can be seen the larger turbine would be permitted to create noise peaks almost 6 – 7dB higher than the medium ones."
> [Stigwood M. Windfarm Nuisance Investigation & Assessment Seminar. MAS Environmental, University Centre, Cambridge, UK, 20 November 2008]
> [See also Stigwood M. Public Inquiry into Proposed Construction of wind Farm at North Dover wind park by Ecotricity: Proof of Evidence of Mike Stigwood, MAS Environmental, for Langdon Action Group. (UK) PINS Ref: APP/X2220/A/08/2071880/NWF, 16 December 2008, pp 43-39.]

A structural engineer may calculate with confidence the exact size of a concrete beam to span an opening. However, as the MAS report so clearly illustrates, no such exact science is available to the acoustic engineer in calculating the noise levels expected at homes neighbouring wind turbines. There are many unpredictable variables and estimates at each step, each presenting numerous permutations: the same model wind turbine, even as part of the same array, may differ in its performance than its nearest counterpart. The variables include wind direction, wind speed, wind gusts, and wind and temperature fluctuations from ground level to hub height and blade tips, the variations in landscape, the time of year, humid v dry conditions, to name a few confounding factors. Therefore, it is not surprising that noise-modeling techniques are imprecise, even when acousticians are assisted by computer modeling applications.

As noted above, ETSU methodology assumes a noise source from a single point, the nacelle, which for a small wind turbine might be 20m at hub height with a blade swept area of 300 sq m, and a larger wind turbine may have a hub height of 100m, with blades reaching 160m high and with a swept area of 11,000 square metres of noise emission. [Makarewicz R. Is a Wind Turbine a Point Source? *JASA Journal of the Acoustical Society of America* Feb 2011;129(2): 579-581] This in itself is justification for introducing a generous 'factor of safety' adjustment applied to any wind turbine noise predictions. Yet, there is no evidence of a factor of safety applied to such calculations in ETSU-R-97 for wind turbine noise, or in those of any subsequent reports by acousticians representing the wind energy industry during the process of many applications and appeals.

David Cocks, QC, advised by consulting acoustician Michael Stigwood, MAS Environmental, Cambridge, illustrated the wide chasm about understanding and predicting wind turbine noise immissions, even between expert acousticians. In his *Closing Submission to the Three Moors Planning Inquiry* (Devon) on behalf of The Rural Exmoor Alliance (TREA) in 2009, Mr Cocks wrote:

> "The assessment of how much noise turbines make and whether it is below a set limit, is controlled for the most part by 'The Assessment and Rating of Noise from Wind Farms' (ETSU R 97), written by a working group of which Hayes, HMP partner and witness for SSE and Trinick, solicitor for Coronation Power, were members.
>
> The science of noise is complex, uncertain and inexact. In the UK it is also highly incestuous being confined to a small number of experts, all known to each other and mostly working for the developers.
> When an outsider like Stigwood (MAS Environmental) appears to question the consensus, it gives rise to much fierce controversy and a good deal of intemperate abuse.
>
> ***Three Moors Wind Turbines***
> Predicted sound levels at receiving house or 'receptor' are worked out by taking the sound level at the turbine and calculating the attenuation of that sound on its journey to the house. Sound sent out from the turbine is an **emission** and sound received is an **immission.**
>
> The sound level emitted by the turbine is taken to be either the warranted power level or the measured power level with and adjustment for uncertainty of +2dB. This amounts to the same thing because the warranted level is the measured level +2dB correction.
>
> In calculating immission levels one of the factors taken into account for attenuation is the condition of the ground (G) over which the sound is transmitted. Sound travels faster over hard ground (G=0) than over soft (G=0.5 or more). The worst case scenario for a developer was formerly used, combining an emission level with a +2dB correction and G = 0. This was thought fairer to the householder.
>
> Hayes of HMP, SSE's consultant at Three Moors, used to be a strong proponent of this method which was used in his Three Moors ES. Hayes has now changed his mind on this and uses the warranted power level + G=0.5. This works in favour of the developer and against the householder. When asked why the goalposts had been moved he had no explanation.
>
> The candidate turbine here is a Vestas V80 which can be run in different modes, some noisier than others. If run to try and produce a 30% capacity factor, it will not meet the ETSU noise limits.
>
> A candidate turbine means what it says. There is no guarantee that such a turbine, figuring in the ES, will be the one installed. If the installed turbine has varying modes of operation, the temptation will be to extract the maximum power output, at increased risk to the residents in the area.
>
> ETSU does not cover noise propagation. The most commonly used methodology is laid down in ISO9613. A worst case scenario is used, i.e. most favourable to the receiver of the sound, in which there are meteorological conditions favourable to propagation, lowest air absorption figures and hard ground (G=0).

***Meteorological conditions.***
There is disagreement amongst the experts as to whether ISO9613 has built in provision for wind shear. Stigwood for TREA said that it does not cater for wind shear whilst Hayes, although not explicit, inferred that it does.

The wording of ISO is clear and limited: it makes clear that it caters for downwind propagation **or** propagation under a well developed moderate ground based temperature inversion at night (conditions giving rise to possible wind shear), but not both.

Hayes also attacked Stigwood for the use of another algorithm with the ISO methodology, details of which need not detain us here, in which attack he made some very unfortunate arithmetical errors giving rise to wild and wrong headed assertions about wind shear and how he accounted for it. (See below)

***G=0***
Hayes has abandoned warranted power levels + G=0 and changed to G = 0.5, a change that favours the developer. Previously he had been a stout defender of G=0 on the basis that it was representative of noise levels that a receptor would experience when "located in a garden with the normal facade of a dwelling house and other structures in close proximity". Quite; we could not have put it better ourselves.

ISO is not an exact science. It was not designed for wind turbines and has a number of built in reservations and margins for error.

***Wind shear***
In certain climatic conditions wind speed at hub height may greatly exceed that at ground level. Since it depends on climatic conditions it is a variable phenomenon and there is no constant relation between wind speeds at ground level and those at hub height, particularly at night.

ETSU assumes such a constant relation and has been recognised recently as defective in this respect. Van den Berg did the vital early research. HMP until very recently fought a prolonged rearguard action against him. They said variable wind shear only occurred at flat inland sites and constantly refused to account for it. They have now been forced to recognise ETSU's defects.

Hayes and McKenzie were members of the group of acousticians who have come to an agreement on a new methodology to cope with wind shear. It has been published in the Institute of Acoustics bulletin and is precisely that, an agreement. There is no referenced evidence for the change and no peer review. It advocates:

- Acquire background noise levels
- Measure wind speed at two different speeds on site
- Correct wind speed at greater height to hub height wind speed to discover wind shear exponent m by using power law formula
- Correct hub height wind speed to 10m height wind speed using the old ETSU logarithm

The last step produces what McKenzie of HMP calls a 'fictitious' measurement. Stigwood and Van den Berg say the method is incorrect and can lead to error. The power law formula should be used for this step as well, and not the old discredited ETSU logarithm.

Hayes evidence on wind shear was, to use a polite word, unconvincing. First, during the course of an attack on Stigwood, and basing himself on some faulty arithmetic, he came out with the ludicrous proposition that wind shear had no application to small wind farms where the separation distances between source and receiver were 500-800m. This would have meant that it applied to neither site here. He had to withdraw that assertion when he discovered his sums were wrong.

Second, he said that he had taken wind shear into account since 2002-3 (the time of the Van den Berg research). When pressed on how he did it and in particular

where such calculations appeared in the ES for Three Moors he said they did not, and wind shear was based on an estimate.

There are no outward and visible signs of it being accounted for in any of his assessments in this inquiry.

The limited wind shear data that has been disclosed to us does not give a comprehensive picture. It is averaged data for each month and does not represent variations within the month. It has the fatal defect of all averaged data. We have been denied the full data for the year to analyse.

***Amplitude Modulation***
The predisposing conditions for amplitude modulation, namely a high wind shear factor and overcrowding of the site with inadequate separation distances between turbines, both exist at Three Moors.

Stigwood says that there is a high likelihood of AM at this site and that the appropriate penalty would be between 5-8dB

Stigwood has carried out convincing research into AM at various properties including a house at Deeping St Nicholas owned by Jane Davis. She has described how she and her husband were driven from the house by thumping and whooshing sounds and forced to acquire a dormitory house elsewhere. Stigwood has established a maximum variation, peak to trough at her house of 8dB(A) caused by AM. Hayes says nothing about AM.

***Background noise monitoring***
ETSU noise limits are fixed at a certain level above background noise levels. A higher background noise level enables the turbine to emit more noise and thus favours the developer.

Given the central role background noise levels in noise control from wind turbines, it is unfortunate that background noise monitoring is not a precise science-see North Dover Inspector.

What the monitoring seeks to establish is what the background noise levels are in the amenity area of someone's house. Much turns therefore on the siting of the monitoring equipment. Levels in a quiet amenity area will be lower than levels in a field, exposed to wind and foliage noise.

None of the five sites monitored was the equipment correctly sited. If the gathering of the data was defective, so was the plotting. There is data missing for the lower and higher wind speeds. The background noise data undergoes a dramatic transformation when it is transferred to charts that plot that data against the turbine noise levels and the ETSU limits. Lines appear for wind speeds where there was no data and, instead of heading down, they start going up.

Hayes said that this plotting without data was based on "estimates". Just like his alleged adjustment for wind shear. When this guesswork is removed from the calculations, it is obvious that there are increased breaches of the ETSU limits and the already tight margins on which the turbines are predicted to operate become even tighter.

Stigwood says that while it is difficult to quantify the errors in background noise levels, they will reduce the levels by several dB.

***Breaches of ETSU limits***
The HMP calculations show tight margins and some breaches of the ETSU limits. When built in margins for error, penalty for AM, and corrections for HMP error are factored in to the equation, there will be massive non-compliance with the ETSU limits.

The best form of noise mitigation is proper separation distances between the turbines and receivers of the noise. Nine turbines have been crammed into insufficient space. The site has shrunk because land owners withdrawing. The

> consequence is that there are inadequate separation distances between turbines and houses and also between the turbines themselves."
> [Cocks D. Closing Submissions on Behalf of the Rural Exmoor Alliance: Summary. PINS Ref: APP/X1118/A/08/2083682, LPA Ref 45489, and PINS APP/Y1138/A/08/2084526, LPA Ref 07/02262/MFUL, 24 November 2009]

In December 2009, Michael Stigwood responded when asked to comment on a statement by acousticians working for developers who claimed that ETSU-R-97 follows WHO Guidelines:

> "This is simply wrong as those values (WHO values) relate to **steady continuous noise dose at the facade as well as** noise that is free field. Thus it includes all noise from sources near and far and **NOT just windfarm noise.** Thus 3dB has to be deducted to achieve free field (from a facade) and a further 2dB to get to dB LA90 as opposed to LAeq. Thus 40 LAeq in the guidance (ETSU) equates to 35dB LA90 and not just wind farm noise. However, steady noise is generally benign and less disturbing than fluctuating noise. That leads generally to a further downwards shift of an unspecified value, but arguably 5dB. Put another way, a fluctuating free field noise equates to the likely impact of a steady noise at the facade that is 8dB higher. Plus the 2dB difference for converting from LAeq to LA90 and the fluctuating noise needs to be 10dB lower i.e. to avoid health concerns it suggests an external value of 30dB LA90. It has to be remembered this value relates to total fluctuating noise and not just windfarm noise.
>
> If you ignore the 'steady' noise point it still means that the total noise dose to which the windfarm adds should not exceed 35dB LA90 to fall within the WHO guidelines and not 35dB LA90 for the wind farm noise on its own. In summary it is factually incorrect for windfarm acousticians to suggest the limits fall within the WHO Guidelines which compounds the error the ETSU-R-97 working group made in the first instance when they also considered the WHO values as applying just to the wind turbine noise when they are a total noise dose value."
> [Stigwood M. Personal Communication, 29 December 2009; emphasis added.]

The UK Government's Planning Policy Statement for Renewable Energy – PPS22, S.22 – states that:

> "Renewable technologies may generate small increases in noise levels... **Local planning authorities should ensure that renewable energy developments have been located and designed in such a way to minimise increases in ambient noise levels.** Plans may include criteria that set out minimum separation distances between different types of renewable energy projects and existing developments. The 1997 report by ETSU-R-97 for the Dti should be used to assess and rate noise from wind energy developments". [Emphasis added.]
> [UK Government Planning Policy Statement 22 (PPS22): Renewable Energy, 10 August 2004
> http://www.communities.gov.uk/publications/planningandbuilding/pps22]

Thus, the UK Government allows uncontrolled and unrestrained 'self regulation' of wind turbine noise emissions by the wind energy industry, endorsing noise guidelines that set procedures for using outdoor external measurements to estimate the noise levels inside nearby homes. These procedures intertwine in a formula that includes guesswork (albeit informed) and supposition, which conjoin in a site plan that no consultant or developer is willing to professionally indemnify with a 'fit for purpose warranty', i.e., to guarantee there will not be sleep disturbance nor sleep interruption to nearby families. Furthermore, only a handful of acousticians have a detailed and working knowledge of ETSU-R-97, which leads to inconsistent interpretations and implementation.

David Cocks, QC, clearly illustrated how two experienced and capable professional acousticians cannot agree on the implementation of the ETSU-R-97 formula, especially as guesstimates influence the result, i.e., assumptions and predictions are built into the process. There is no evidence Government sought appropriate medical or epidemiological expertise when formulating acceptable acoustic guidance that allows uninterrupted sleep. Instead, engineers made these decisions. Government has encouraged the powerful and influential wind energy industry to 'self-regulate', but this has been at the cost to the health of innocent families wherever wind turbines are permitted in close proximity to homes. As a result, government has lost sight of its obligation

to protect the health of ordinary families, i.e., according to the evidence-based WHO environmental noise standards and recommendations.

Case Law, however, takes a far more rational and impartial view, cutting through unfair government dictates, ignoring commercial and ideological pressures. A release by 4-5 Gray's Inn Square, London, The Chambers of Jonathan Moffett, Barrister, stated:

> "*Court of Appeal allows Windfarm Appeal*.
> On 24 November 2010, the Court of Appeal allowed the Welsh Ministers appeal against a judgment of Wyn Williams J concerning a windfarm development in North Wales.
> An Inspector had dismissed an appeal lodged after a refusal of planning permission. The basis of the refusal contended that, although the proposed windfarm might operate within the noise limits recommended by ETSU-R-97, residents already experienced noise disturbance from existing windfarms (also operating within the ETSU-R-97 limits). Thus, residents would experience noise disturbance for longer periods, with the result of unacceptable adverse effects on residential amenity. Wyn Williams J had quashed the Inspectors decision, holding that it was inconsistent for the Inspector to conclude that, on the one hand, the existing and proposed windfarms would operate within relevant limits, but on the other hand, local residents would suffer noise disturbance that was unacceptable.
>
> The Court of Appeal held that there was no such inconsistency and allowed an appeal against the Judge's decision. It held that **while the ETSU-R-97 limits were a matter to which the Inspector was required to consider, he was not bound by these limits. In particular, the ETSU-R-97 limits represented only one view as to the appropriate balance between the adverse effects of noise disturbance and the wider beneficial effects of wind farms. It was for the Inspector to form his own planning judgement as to whether the noise generated by a particular proposal would be unacceptable, taking into account the evidence of local residents and his own experiences on site visits**. Counsel: Jonathan Moffett represented the Welsh Ministers."
> [4-5 Gray's Inn Square. Court of Appeal Allow Windfarm Appeal. 4-5 News, 25 November 2005] [Emphasis added.]

Demonstrably, ETSU-R-97 does not provide adequate protection from the impact of noise radiation to those living near wind turbines. As Lord Justice Elias said,

> "As my Lord, Lord Justice Pitchford, has indicated, it seems to me that the duration of an interference is plainly a material consideration when determining whether the level of noise is acceptable... Plainly, the Inspector had regard to the guidance in ETSU 97. He recognised that it would not be infringed. Nonetheless, he was satisfied that the increase in the frequency [duration] of the noise would be unacceptable. He had a proper evidential basis for that conclusion, he explained his reasons adequately, and I see no error of law in his analysis."
> [S.37 & S.38, Case No: C1/2010/1426/Qbenf, Lord Justice Carnwath, Lord Justice Elias and Lord Justice Pitchford between: Tegni Cymru Cyf Respondent - And - The Welsh Ministers & ANR Appellant]

In this same judgement, Lord Justice Pitchford also noted:

> "In my judgment the Inspector is clearly correct when he says (as he does in paragraph 21 of the decision letter) that **the indicative noise levels set out in ETSU-R-97 are guidance not absolute values**. That is the clear effect of paragraph 2.16 of TAN 8. **It follows that there may be circumstances in which it is open to a local planning authority or an Inspector to conclude that noise levels associated with a wind farm are unacceptable notwithstanding compliance with ETSU-R-97**."
> [S.24, Case No: C1/2010/1426/Qbenf, Lord Justice Carnwath, Lord Justice Elias and Lord Justice Pitchford between: Tegni Cymru Cyf Respondent - And - The Welsh Ministers & ANR Appellant] [Emphasis added.]

Furthermore, if the leading expert acousticians on wind turbine noise radiation cannot agree with numerous aspects of the ETSU-R-97 formula, it is unreasonable for central government to expect

that local authority Environmental Health Officers have the specialist expertise to appraise the noise submission of an Environmental Assessment accompanying a planning application. This is an unacceptable standard of control in a modern democratic society. In fostering unrestricted self-regulation by the wind industry, the UK Government has failed to exercise a basic duty of care towards its citizens. (Does the Government accept self-governance from the pharmaceutical industry?) Noise modeling is not an exact science, as illustrated by James' Rebuttal Testimony to the Public Service Commission, Wisconsin, USA, October 2009. [James R. Surrebuttal Testimony of Richard R James on Behalf of the Coalition for Wisconsin Environmental Stewardship. Wisconsin Public Service Commission, docket 6630-CD-302: Wisconsin Electric Power Company (WEPCO), 28 October 2009, p SR9.8]

The number of wind farm sites in the UK where noise complaints still exist is evidence that the Planning Conditions that flow from ETSU-R-97 are either unenforceable or that the original design Guidance is not 'fit for purpose' in providing adequate protection for families living nearby. This stems partly from linking the maximum noise limit to the background noise, but the problems are compounded because the Local Authority does not have the right to require the wind farm to shut down while independent site measurements of background noise are recorded and analysed.

During a seminar in October 2008, David Forsdick, Barrister of Landmark Chambers, London, noted that:

> "Conditions can only be imposed when they are reasonable, necessary, precise and enforceable. The drafting of enforceable noise conditions for wind turbines is fraught with difficulty... Model BERR conditions are now customarily imposed – 'Onshore Wind Energy Planning Conditions Guidance Notes October 2007'."
> [Note that the Dti, reconfigured as BERR, and now DECC, had oversight of wind turbine noise guidelines at that time.]

Mr Forsdick continued:

> "On their face, the standard conditions seem fine – but very significant difficulties arise when one comes to consider how, in practice, the conditions are to be policed/enforced. The model condition imposes measurement and reporting requirements by reference to the ETSU noise limits but there is no mechanism contained in the conditions to ensure that the turbines close down as soon as there is an exceedance. There is no requirement for continual monitoring and interventions. The position is thus that on a complaint, the LA may require monitoring in accordance with ETSU (but as I have shown above there is always room for considerable debate as to what ETSU requires and how it will be complied with) and may thereafter be able to identify infringements. But even if the Council were to take enforcement action, how would a notice be worded and how would that be enforced. Further the condition is incapable of taking into account differing atmospheric conditions and is tied to a height of 10m without any consideration of the impact of wind shear factor adjustment."
> [Forsdick D. Noise and Wind Turbine Proposals. Landmark Chambers (London): Renewable Energy Seminar, 1 October 2008]

Hansard, the UK Parliament's official proceedings, reveals the powerful influence that the wind energy industry exerts on government. On 27 July 2010 (ACC08), Philip Davies, MP, asked the Secretary of State for Energy and Climate Change if he planned to review the noise guidance recommended by the Dti Noise Working Group in ETSU-R-97, published in 1997. (9445) [HC Deb C.888W]

Charles Hendry responded:

> "Noise is a key issue to be taken into account in considering proposals for wind farm development. **There is no reason to believe that the protection from noise provided for by ETSU-R-97 guidance does not remain acceptable, and we have no plans to change this."**
> [Hansard: Davies P and Hendry C, Noise: Wind Farms, 27 July 2010, c888w] [Emphasis added.]

Jonathan Edwards, MP, at a later date, asked Gregory Barker, the Secretary of State, whether he planned to revisit or revise the noise assessment guidance for wind turbines, i.e., ETSU-R-97.

Gregory Barker repeated precisely the same statement as that used by Charles Hendry.
[Hansard. Edwards J and Barker G, 27 July 2010, c893w]

Andrew Stephenson, MP, then asked a similar question and again received the identical scripted response.
[Hansard. Stephenson A and Hendry C, 27 July 2010, 5568]

It is clear that the character, duration, and dosage of wind turbine noise delivered to homes are important factors in determining whether a family sleeps at night or whether a serious loss of amenity ensues. With a multidisciplinary team of international experts, the impartial and independent World Health Organization devises guidelines for noise levels that, if exceeded, will likely trigger adverse health consequences.

It is more straightforward to comply with a strict maximum allowable noise level of 30 dBA inside the home, with the window partly open, in accordance with WHO Guidelines, rather than to accommodate the tortuous methodology of ETSU. (WHO NNG 2009 Executive Summary XVIII '*Relation with Guidelines for Community Noise 1999*') Environmental Protection Officers can monitor these levels more easily. Violations should be subject to swift corrective action. For example, if an Environmental Officer observes that the noise exceeds guidance or conditions, or has evidence that the noise breached allowable limits and conditions, then the local authority must have the authority to shut down the wind turbine array immediately until the agent responsible for the wind turbine array provides an acceptable solution. For example, a recording device could support noise-measuring instruments in the home in order to help identify the degree and character of the noise. MAS Environment has demonstrated that this method of collecting noise data is practical. [MAS Environmental. Noise Monitoring Graph measured within first floor bedroom – window open – Davis's House - Wind Farm Amplitude Modulation showing Significant Low Frequency Content, 5 July 2007, in: Assessing Noise from Proposed Wind Turbine Developments. MAS Environmental, Cambridge, UK, May 2009; and MAS Environmental. Noise Monitoring Graph within first floor bedroom - Davis's House - Wind Farm Noise, 5 July 2007, in: Assessing Noise from Proposed Wind Turbine Developments. MAS Environmental, Cambridge, UK, May 2009]

In this way, local authorities might be able to avoid the expense of hiring acousticians to analyse every calculation and estimate in the style of an Environmental Impact Statement [EIS]. [Krogh C; Gillis L; and Kouwen N. A Self-Reporting Survey: Adverse Health Effects with Industrial Wind Turbines and the Need for Vigilance. WindVOiCe Wind Vigilance for Ontario Communities, Ontario, Canada, July 2010; and Alleyne R. Wind Farm Forced to Close after Complaints over the Noise (Scotland). *Daily Telegraph* 16 June 2011 http://www.telegraph.co.uk/earth/environment/8579747/Wind-farm-forcedto-close-after-complaints-over-the-noise.html]

In addition, it should be mandatory for the developer and/or the consulting acousticians to provide a design warranty that ensures that the wind turbine(s) will not produce a noise exceeding 30dBA LAmax at night, in a bedroom, with a window open, and that the low frequency noise and amplitude modulation will be strictly limited with conditions strictly met. Moreover, similar noise restrictions must apply during the daytime hours so that people continue to enjoy the amenities of their homes or other recreational or business areas.

However, if the developer and/or the consulting acousticians cannot provide a warranty, regardless of the wind industry's self-regulated committee findings, and if they cannot guarantee strict adherence to the Court's rulings, then the site is unsuitable for wind turbines.

In May 2011, there was progress in securing a level of improved protection for families by the Court of Appeal, in the case concerning Den Brook Valley (Devon), particularly for amplitude modulation, which agreed that

> "... the swish noise was seen as creating its own particular problem… there is an obligation on the developers to comply with AM levels specified in Condition 20."

> [MW Hulme v Secretary of State & RES, 2011 EWCA Civ 638, 26.05.2011; and the Appeal decision permitting the Den Brook wind farm APP/Q1153/A/06/2017162]
> [See also S.2.5, Amplitude Modulation, p 60.]

That is, although the Court action decided in favour of the developer, RES, in its pursuit to construct the Den Brook Valley wind turbines, the Court also agreed with the conditions to control critical noise levels, which the developer/operator/owner must not exceed, particularly to prevent Amplitude Modulation. These conditions stand:

> "20. a) A change in the measured LAeq, 125 milliseconds turbine noise level of more than 3dB (represented as a rise and fall in sound energy levels each of more than 3dB) occurring within a 2 second period.
> 20.b) The change identified in (a) above shall not occur less than 5 times in any one minute period provided the LAeq, 1 minute turbine sound energy level for that minute is not below 28dB.
> 20.c) The changes identified in (a) and (b) above shall not occur for fewer than 6 minutes in any hour."

Although some acousticians argue that wind turbine noise has no impact on health, engineers do not have the qualifications to make these assertions. The willingness to express these opinions as facts displays a profound professional arrogance; the authors of such statements imply that they have superior medical expertise and authority than, e.g., the international, multidisciplinary panel of medical experts who authored the World Health Organization reports, as well as evidence on noise impacts on health published in clinical research articles. Those with medical and epidemiologic expertise have found that families suffer health problems when exposed to noise due to the 'dosage', duration, and character of environmental noise (e.g., pulsating noise, low frequency noise), particularly when sleep is disturbed over prolonged periods. Indeed, pilot studies and research articles have revealed these problems exist with wind turbine noise, and the WHO reports underscore the intrusive nature of noise that wind turbine noise exhibits: noise that is continuous, with a pulsating character, with a low frequency component, and with long-term exposure. Noise with these characteristics affect the sleep, health, and amenities of families.

## 2.2 WIND TURBINE NOISE GUIDANCE

WHO developed its *Night Noise Guidelines for Europe*(2009) by calling upon experts from leading research institutions from many nations, representing the disciplines of acoustics and medicine and the related health sciences. As stipulated in WHO's guidelines:

> "The key milestones of project activities were technical meetings of topic-specific experts in the field of acoustics, exposure assessment, sleep pathology, accident epidemiology, immunology, mental health, and health impact assessment. The experts produced the background papers based on their review of scientific evidence on the impacts of noise on sleep and health. These background documents were synthesized into one document proposing health-based guidelines.
>
> This document was then distributed among the experts and stakeholders for final peer-review. The final products of the project were discussed at the final meeting of experts and stakeholders where the consensus on the guideline values was reached."
> [World Health Organization: Regional Office for Europe. Evaluation and Use of Epidemiological Evidence for Environmental Risk Assessment: Guideline Document. WHO, 2000, EUR/00/5020369, p 5
> http://www.euro.who.int/__data/assets/pdf_file/0006/74733/E68940.pdf]

WHO's process of developing its health and noise guidelines is rigorous and systematic:

> "In 2003, the WHO Regional Office for Europe set up a working group of experts to provide scientific advice to the European Commission and to its Member States for the development of future legislation and policy action in the area of control and surveillance of night noise exposure. The review of available scientific evidence on the health effects of night noise was carried out by an interdisciplinary team who set out to derive health-based guideline values. The contributions from the experts were reviewed by the team and integrated into draft reports following discussion at four technical meetings of the working group. In 2006, all the draft reports were compiled into a draft document on guidelines for exposure to noise at night, which was reviewed and commented on by a number of stakeholders and experts.
>
> At the final conference in Bonn, Germany, on 14 December 2006, representatives from the working group and stakeholders from industry, government and nongovernmental organizations reviewed the contents of the draft document chapter by chapter, discussed several fundamental issues and reached general agreement on the guideline values and related texts to be presented as conclusions of the final document of the WHO Night Noise Guidelines for Europe."

Regarding noise indicators,

> "From the scientific point of view the best criterion for choosing a noise indicator is its ability to predict an effect. Therefore, for different health end points, different indicators could be chosen.
>
> Long-term effects such as cardiovascular disorders are more correlated with indicators summarizing the acoustic situation over a long time period, such as yearly average of night noise level outside at the façade (Lnight,outside 1), while instantaneous effects such as sleep disturbance are better with the maximum level per event (LAmax), such as passage of a lorry, aeroplane or train.
>
> From a practical point of view, indicators should be easy to explain to the public so that they can be understood intuitively. Indicators should be consistent with existing practices in the legislation to enable quick and easy application and enforcement.
>
> Lnight,outside, adopted by the END, is an indicator of choice for both scientific and practical use. Among currently used indicators for regulatory purposes, LAeq (A-weighted equivalent sound pressure level) and LAmax are useful to predict short-term or instantaneous health effects."

[World Health Organization: Regional Office for Europe. Evaluation and Use of Epidemiological Evidence for Environmental Risk Assessment: Guideline Document. WHO, 2000, EUR/00/5020369, p 17]

WHO NNG discussed the overlap with the recommendations from the WHO *Guidelines for Community Noise 2000* (1999), because several values were updated in the NNG to reflect the most recent research findings:

"The WHO Guidelines for Community Noise, published in 2000, also address night noise. As they are based on studies carried out up to 1995 (and a few meta-analyses some years after), **important new studies have become available since then, together with new insights into normal and disturbed sleep.**

The currently recommended guideline values of Lnight,outside = 30 dB, 40dB, 55 dB are not directly comparable with the 2000 guideline value of LAmax,inside = 45 dB(A) because the sound level units are different. However, it is clear that new information since 2000 has made more precise assessment of the risk from night noise. The thresholds for a number of effects are now known, and this is much lower than an LAmax,inside of 45 dB.

**One important recommendation still stands: there are good reasons for people to sleep with their windows open, and to prevent sleep disturbances one should consider the equivalent sound pressure level and the number of sound events.** The present guidelines allow relevant authorities and stakeholders to do this. Viewed in this way, the present guidelines may be considered as an extension to, as well as an update of, the 2000 WHO Guidelines for Community Noise. That also means that the recommendations contained in the sections on noise management and control of 2000 document can be applied to the guideline values of this document."
[WHO NNG, p 25
http://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf]
[Emphasis added.]

WHO's careful analysis says that:

"In one of the most sophisticated field studies (Passchier-Vermeer et al (2002)), increased probability of instantaneous motility was found for events with a maximum sound level LAmax > 32 dB(A), while in a meta-analysis conscious awakening was found for events with LAmax > 42 dB(A) (Passchier-Vermeer, 2003). Above their threshold, these effects were found to increase monotonously as a function of the maximum sound level during a noise event (aircraft noise). It is important to note that in another recent sophisticated field study (Basner et al., 2004), the threshold found for EEG awakening was LAmax = 35 dB(A), i.e., only a little higher than the 32 dB(A) found for noise-induced awakenings. This strengthens the evidence that noise starts to induce arousals at LAmax values in the range 30 to 35 dB(A). Given the night-time noise levels to which people are exposed, these results imply that instantaneous effects are common. Although most studies concerned aircraft noise, the instantaneous effects can be assumed to occur at similar levels for different types of transportation.

The above observations can be used as a basis for setting limits with respect to night-time transportation noise. For transparency, it is useful to distinguish two steps in choosing actual limits: the first step is the derivation of a health-based limit, the second step is the derivation of an actual limit that takes into account the health based limit as well as feasibility arguments. Here we are concerned with the first step.

When deriving a health based limit, two points need to be considered: the dose-dependent effects of a single noise event, and the number of events. With respect to the dose-dependent effects of a single event, adverse effects can be distinguished from effects that by themselves need not be adverse but can contribute to an adverse state. We propose to classify conscious awakenings as an adverse effect. Conscious awakenings have been estimated to occur at a baseline rate of 1.8 awakening per night. A substantial increment of conscious awakenings over this baseline is thought to be adverse. Since in general falling asleep after

conscious awakening takes some time, and this latency is longer after noise induced conscious awakening that will often also induce an emotional reaction (anger, fear), it will also reduce the time asleep and may affect mood and functioning next day. Although additional, more sophisticated analyses could be performed to refine this estimate, we propose LAmax = 42 dB(A) as the currently best estimate of the threshold for conscious awakening by transportation noise. This would mean that the No Observed Effect Level (NOELAmax) for transportation noise events is at most 42 dB(A).

The most sensitive instantaneous effect that has been studied extensively in field studies is motility. A single interval with (onset of) noise induced motility by itself cannot be considered to be adverse. However, noise induced motility is a sign of arousal, and frequent (micro-)arousal and accompanying sleep fragmentation can affect mood and functioning next day and lead to a lower rating of the sleep quality. Therefore, motility is relevant for adverse health effects, but more than a few intervals with noise induced motility are needed for inducing such effects. Although additional, more sophisticated analyses could be performed to refine this estimate, we propose LAmax = 32 dB(A) as the currently best estimate of the threshold for motility induced by transportation noise. The threshold found for EEG awakening was LAmax = 35 dB(A), i.e., only a little higher than the 32 dB(A) found for noise-induced awakenings. This would mean that the No Observed Effect Level (NOELAmax) for transportation noise events is most likely at most 32 dB(A), and definitely not higher than 35 dB(A).

It is important to note that the above given NOELAmax ~32 dB(A) and NOELAmax ~ 42 dB(A) are indoor levels, in the sleeping room. Although events below 32 dB(A) are audible, and, hence, further research may show more sensitive effects than motility, on the basis of the presently available evidence we propose to assume that NOELAmax = 32 dB(A) and set a health based nighttime noise limit that is tolerant for transportation noise events with LAmax ~ 32 dB(A). On the other hand, since adverse health effects need to be prevented by health based limits and even though vulnerable groups may require lower limits, on the basis of the presently available evidence we propose to assume that NOELAmax = 42 dB(A) and set a health based night-time noise limit that does not tolerate transportation noise events with LAmax > 42 dB(A)." [WHO NNG, Ch IV, p 98]

WHO makes this key recommendation for health protection from night noise:

**"For the primary prevention of subclinical adverse health effects in the population related to night noise, it is recommended that the population should not be exposed to night noise levels greater than 30 dB of Lnight,outside during the night when most people are in bed. Therefore, Lnight,outside 30dB is the ultimate target of Night Noise Guideline (NNGL) to protect the public, including the most vulnerable groups such as children, the chronically ill and the elderly, from the adverse health effects of night noise. "**
[WHO NNG, p 24] [Emphasis added. Note also that this recommendation is primarily for transportation noise, which is not pulsating/intermittent like industrial wind turbine noise; intermittent noise is more disruptive.]

In testimony to the Wisconsin Public Service Commission regarding an application for industrial wind turbines, acoustician Richard James explained the differences between the WHO Night Noise Guidance 2007 and the WHO NNG 2009 model in respect to sleep interference:

"The WHO 2007 document states:
"Lnight,outside 30dB is the ultimate target of Night Noise Guideline (NNGL) to protect the public, including the most vulnerable groups such as children, the chronically ill and the elderly, from the adverse health effects of night noise."

The WHO 2009 document states:
The LOAEL of night noise, 40 dBLnight,outside, can be considered a health-based limit value of the night noise guidelines (NNG) necessary to protect the public, including most of the vulnerable groups such as children, the chronically ill and the elderly, from the adverse health effects of night noise".

> There is no conflict between the 2007 and 2009 documents: just a different goal. On the one hand, the 2007 WHO guidelines set 30dBA as the target to protect the public, while on the other hand, the 2009 WHO guidelines state that 40 dBA should be considered as the health-based limit value. Limit values are "limits", not "targets". A value of 40dBA is a not-to-exceed-without-risk-of-harm limit." [James R. Surrebuttal Testimony of Richard R James on Behalf of the Coalition for Wisconsin Environmental Stewardship. Wisconsin Public Service Commission, docket 6630-CD-302: Wisconsin Electric Power Company (WEPCO), 28 October 2009, pp SR10 – SR12]

In 2001, the European Commission issued its Environmental Noise Directive [END], detailed in *"Relating to the Assessment & Management of Environmental Noise"*. The EC's Environmental Noise Directive seeks to "achieve a high level of health and environmental protection." Integral to this goal is "protection against noise. In the *Green Paper on Future Noise Policy*, the Commission addressed noise in the environment as one of the main environmental problems in Europe."

In its Resolution of 10 June 1997, the European Parliament

> "urged that specific measures and initiatives should be laid down in a Directive on the reduction of environmental noise, and noted the lack of reliable, comparable data regarding the situation of the various noise sources."
>
> Moreover, the Directive would act as a basis for "measures concerning noise emitted by the major sources, in particular... infrastructure… and industrial equipment... and for developing additional measures, in the short, medium and long term." The Directive also notes that it is essential to "establish common assessment methods for 'environmental noise' and a definition for 'limit values', in terms of harmonized indicators for the determination of noise levels…" [Environmental Noise Directive 2002/49/EC, 25 June 2001]

The EC Environmental Noise Directive works in concert with the WHO noise guidelines, making use of WHO's multidisciplinary, international expertise, its ongoing efforts to provide guidance based on current knowledge, and its inclusion of industry and government policy and decision makers to advise on pragmatic aspects of its guidance:

> "The WHO Regional Office for Europe set up a working group of experts to provide scientific advice to Member States for the development of future legislation and policy action in the area of assessment and control of night noise exposure. The working group reviewed available scientific evidence on the health effects of night noise, and derived health-based guideline values. In December 2006, the working group and stakeholders from industry, government and nongovernmental organizations reviewed and reached general agreement on the guidance values and key texts for the final document of the Night noise guidance for Europe…
>
> Considering the scientific evidence on the thresholds of night noise exposure… These guidelines are applicable to the Member States of the European Region, and may be considered as an extension to, as well as an update of, the previous WHO Guidelines for community noise (1999)."

The WHO NNG 2009 clearly provides the guidance on 'limits' referred to by the Environmental Noise Directive (END):

> "The selected common noise indicators are Lden, to assess annoyance, and Lnight, to assess sleep disturbance.
>
> **Article 1 'Objectives'**
> (1) The aim of this Directive shall be to define a common approach intended to avoid, prevent or reduce on a prioritized basis the harmful effects, including annoyance, due to exposure to environmental noise. To that end the following actions shall be implemented progressively:
> (c) adoption of action plans by Member States, based upon noise-mapping results, with a view to preventing and reducing environmental noise where necessary and particularly where exposure levels can induce harmful effects on human health and to preserving environmental noise quality where it is good.

(2) This Directive shall also aim at providing a basis for developing Community measures to reduce noise emitted by the major sources, in particular...industrial equipment and...

**Article 2 'Scope'**
(1) This Directive shall apply to environmental noise to which humans are exposed in particular... in quiet areas in open country... and other noise-sensitive buildings and areas.
Article 3 'Definitions'
(b) 'harmful effects' shall mean negative effects on human health.
(j) 'dose-effect relation' shall mean the relationship between the value of a noise indicator and a harmful effect.
(m) 'quiet area in open country' shall mean an area, delimited by the competent authority, that is undisturbed by noise from traffic, industry or recreational activities.

**Article 6 'Assessment methods'**
(3) Harmful effects may be assessed by means of the dose-effect relations referred to in Annex III.

**Article 8 'Action plans'**
(1) Member States shall ensure that no later than 18 July 2008 the competent authorities have drawn up action plans designed to manage, within their territories, noise issues and effects, including noise reduction if necessary for (b) such plans shall also aim to protect quiet areas against an increase in noise.

**Article 11 'Review and reporting'**
(2) (c) the protection of quiet areas in open country.

**Annex III Assessment Methods for Harmful Effects.**
**Dose-effects** – the relation between sleep disturbance and Lnight for...
Industrial noise.
If necessary, specific dose-effect relations could be presented for:
-dwellings with a quiet facade as defined in Annex VI
-vulnerable groups of the population
-tonal industrial noise
-impulsive industrial noise and other special cases."

## 2.3 WIND TURBINE NOISE: GUIDANCE PROCESS

The World Health Organization and the UK Government differ substantially on the methods used and the personnel involved with setting environmental noise guidelines in an effort to protect people and reduce their exposure to the risk of adverse health effects.

For its environmental noise guidelines, the World Health Organization (WHO) relies on international experts in their fields of specialty, who analyse current research findings, and who find pragmatic solutions that policy and decision makers can apply.

The UK government appears to rely almost entirely on consultants to and employees of the wind energy industry to advise government policy and decision makers, as well as to prepare wind energy and wind turbine noise guidance. There is no indication or mention that medical experts were consulted, nor is there any indication that people living near wind turbines were interviewed for any of these consultations. Self-regulation invariably produces regulation that weighs heavily in favour of that particular industry, often at a cost to the public – not necessarily financial, as this paper demonstrates. As a point of comparison, one may ask if the government would permit the pharmaceutical industry the same opportunity for self-regulation, without appropriate independent oversight by multidisciplinary panels of experts.

Seventeen university and research groups from twelve European countries contributed to the WHO NNG report, as well as a number of noteworthy individuals, all with expertise in their fields, and many with long and distinguished careers in their disciplines.

Part of the WHO process in devising the Night Noise Guidelines included these steps:

> "The key milestone of project activities were technical meetings of topic-specific experts in the field of acoustics, exposure assessment, sleep pathology, accident epidemiology, immunology, mental health, and health impact assessment. The experts produced the background papers based on their review of scientific evidence on the impacts of noise on sleep and health. These background documents were synthesized into one document proposing health-based guidelines. This document was then distributed among the experts and stakeholders for final peer-review. The final products of the project were discussed at the final meeting of experts and stakeholders where the consensus on the guideline values was reached." [WHO NNG, S.1.0, p 6]

In stark contrast, the UK Government convened the Dti Noise Working Group, whose 14 members represented mainly those with a vested interest in wind farm development; i.e., 1 member from government, 3 from local government (1 now with npower), 1 from a firm of solicitors (who was also Secretary to RenewableUK, then known as BWEA), 5 from wind energy development companies, 2 acoustic consultants to the wind energy industry, and 1 from a physics laboratory. [ETSU-R-97, Preface, p i]

ETSU described its format and formulae:

> ".... in August 1993, the DTI [Department of Trade and Industry], facilitated the establishment of a Working Group on Noise from Wind Turbines, consisting of experts with experience in the environmental assessment of noise from wind turbines. The objectives of the NWG were:
>
> To define recent experience in the field of wind turbine noise. This was to include an attempt to relate measured data to complaints and provide an expert assessment of the issues relating to wind turbine noise.
>
> To define a framework which can be used to measure and rate the noise from wind turbines...
>
> To provide indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours and encourage best practice in turbine design and wind farm siting and layout.
>
> To encourage the widespread adoption of the Working Groups recommendations."

[ETSU-R-97, Introduction, p 1]

In the knowledge that wind turbines built too close to family homes cause sleep disturbances and other injuries to health, public officials appear to have approached the problem by asking acousticians from the wind industry to design their own regulations, which provided some degree of noise protection to neighbouring families but did not place 'unreasonable' restrictions on wind farm development. This was equivalent to an 'open cheque' for self-regulation; and who can blame the wind energy industry for procuring a guidance that permits high noise emission from the wind turbines while providing a modest degree of protection for neighbouring families. The wind energy industry benefits by locating wind turbines in close proximity to homes, thereby maximising development of sites, all within legal mechanisms. At the same time, public officials do not appear to have consulted medical experts in order to support evolving guidance. Thus, one is led to conclude that public officials are more concerned with achieving wind energy targets rather than ensuring that neighbouring families are protected from the harm of environmental noise pollution. The ETSU Guidance produced typical Noise Conditions that should apply to Planning Permissions, but in practise, local council Environmental Health Officers, faced with a family clearly suffering from wind turbine noise, have found it nearly impossible to take action and reduce the noise emission, because invariably, onsite measurements of noise satisfy the ETSU conditions.

The WHO Night Noise Guidelines 2009 make this *Recommendation for Health Protection*:

> "Sleep is an essential part of human functioning and is recognised as a fundamental right under the European Convention on Human Rights, (Article 8.1)...
>
> For the primary prevention of subclinical adverse health effects in the population related to night noise, it is recommended that the population should not be exposed to night noise levels greater than 30 dB of Lnight,outside during the night when most people are in bed. Therefore, Lnight,outside 30 dB is the ultimate target of Night Noise Guidance (NNGL) to protect the public, including the most vulnerable groups such as children, the chronically ill and the elderly, from the adverse health effects of night noise." [WHO NNG, p 23-24]

In stark contrast, the UK Government Contractors, ETSU, state:

> "This document describes a framework for the measurement of wind farm noise and gives indicative noise levels thought **to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development or adding unduly to the costs and administrative burdens on wind farm developers or local authorities.**
>
> The recommendation of the NWG is that, generally, the noise limits should be set relative to existing background noise at nearest noise sensitive properties and that the limits should reflect the variation in both turbine source noise and background noise with wind speed. We have also considered whether the low noise limits which this could imply in particularly quiet areas are appropriate and have concluded that it is not necessary to use a margin above background approach in such low-noise environments. **This would be unduly restrictive on developments which are recognised as having wider and global benefits.** Such low limits are, in any event, not necessary in order to offer a reasonable degree of protection to the wind farm neighbour."
> [ETSU-R-97, Executive Summary, Introduction] [Emphasis added.]

WHO makes its recommendation based on the evidence of the health effects of night noise on people. WHO notes that 32dB is the threshold (LA max inside) for the biological onset of 'motility'; 35dB is the threshold (LA max inside) at which the biological effect of EEG awakening occurs; and 42dB is the threshold (LA max inside) at which 'waking up in the night and/or too early in the morning' take place.

Therefore, WHO sets a maximum nighttime, outside target of 30 dB (Lnight, outside). This target covers all environmental noise, for all sources, e.g., industrial, commercial, motorway, or airport. [WHO NNG, 2009, ch 3.2, p 49]

In contrast, the UK government approach appears to be compatible only with the financial goals of the wind turbine developer: 'what is the maximum noise we can get away with without crossing the threshold of triggering expensive nuisance litigation claims'. This view is illustrated quite clearly within ETSU-R-97 itself:

> **"indicative noise levels thought to offer reasonable degree of protection** to wind farm neighbours, **without placing unreasonable restrictions on wind farm development..."** And: "**This would be unduly restrictive on developments which are recognised as having wider national and global benefits."**
> [ETSU-R-97, p v & p 11]

One might very well ask, who stipulated that there are 'wider benefits'? What precisely is the risk/benefit analysis upon which the authors have relied? There is no scientific evidence to support this statement other than ideology or solely entrepreneurial interests. While an international agreement exists to encourage power generation from non-carbon fuels, there is no evidence that wind energy is any better or cheaper than other alternatives. The fact remains that wind energy does not provide a secure, on-demand, predictable, and reliable flow of electricity because it depends on the weather for the wind supply; sometimes the wind is non-existent, too weak, or too powerful, and the wind is always unpredictable:

> "The nature of wind output has been obscured by reliance on "average output" figures. Analysis of hard data from National Grid shows that wind behaves in a quite different manner from that suggested by study of average output derived from the Renewable Obligation Certificates (ROCs) record, or from wind speed records which in themselves are averaged. It is clear from this analysis that wind cannot be relied upon to provide any significant level of generation at any defined time in the future. There is an urgent need to re-evaluate the implications of reliance on wind for any significant proportion of our energy requirement."
> [John Muir Trust. Analysis of UK Wind Power Generation, November 2008 - December 2010. Published March 2011 www.jmt.org]

> "Centrica and other energy companies last week told DECC (Dept Energy and Climate Change) that, if Britain is to spend £100 billion on building thousands of wind turbines, it will require the building of 17 new gas-fired power stations simply to provide back-up for all those times when the wind drops and the windmills produce even less power than usual." This would necessitate "an additional £10 billion on those dedicated power stations which will be kept running on 'spinning reserve', 24 hours a day… This will add billions more to our fuel bills for no practical purpose. The other absurdity, as recent detailed studies have confirmed, is that gas-fired power stations running on 'spinning reserve' chuck out much more CO2 than when they are running at full efficiency – thus negating any savings in CO2 emissions…"
> [Booker C. Proof that the PM is tilting at windmills, Sunday Telegraph, 3 July 2011]

The total insecurity, unpredictability, and unreliability of relying on wind power for electricity is detailed in a report by the Renewable Energy Foundation [REF], *"Low Wind Power Output in 2010: An Information Note"*:

> "Variability over short time scales has been much discussed, and it is now well known that low wind conditions can prevail at times of peak load over very large areas. For example, at 1730 on the 7th December 2010, when the 4th highest UK load of 60,050 MW was recorded, the UK fleet of approximately 5,200 MW was producing about 300 MW (i.e., it had a load factor of 5.8%).
>
> At the same time load factors in Germany were 3% and Denmark 4%. One of the largest wind farms in the UK, the 32 MW Whitelee Farm was producing approximately 5MW (i.e., a load factor of 1.6%). Such figures confirm theoretical arguments that regardless of the size of the wind fleet, the UK will never be able to reduce its conventional generation fleet below peak load plus a margin of 10%."
> [Dr J Constable and Dr L Moroney. Low Wind Power Output in 2010: An Information Note. Renewable Energy Foundation, 2 February 2011]

On 2 January 2011, *The Daily Telegraph* reported that during a particularly harsh wintry spell:

> "Last Thursday night the amount of electricity supplied to the National Grid by wind turbines was again a mere 'one thousandth' of the total. Again we (UK) are importing 40 times that much power from France generated by nuclear reactors."
> [Gray L. Wind farms becalmed just when needed the most. *Daily Telegraph* 2 January 2011]

According to a recent article in *The Times* (UK),

> "The research, published by the Committee on Climate Change, calls into question the Government's decision to rely heavily on wind turbines for future energy. The committee said changes in wind speeds could undermine progress towards having legally-binding targets to cut emissions. Heatwaves and cold snaps tend to cause wind speeds to drop close to zero and are expected to occur more frequently as the average temperature rises. At 5.30pm on December 7 last year, when the country was blanketed in snow and demand for electricity was at its fourth-highest level recorded, wind farms produced only 0.4 per cent of the power needed. On a windy day they can supply up to 10 per cent. The average wind speed can also vary sharply from year to year, with Britain's 274 onshore wind farms operating at only 21.4 per cent of their maximum potential capacity last year, compared with 27.4 per cent in 2009."
> [Webster B. Climate Change Could 'Lead to Rise in Coal Power Plants'. *The Times* 15 July 2011]

Professor James Lovelock, CH, CBE, FRS, an early and articulate environmentalist and creator of the Gaia hypothesis, contends that modern nuclear energy plants not only are smaller, safer, and more efficient than older facilities, they also produce a predictable, reliable, and secure flow of electricity. Moreover, these modern nuclear energy facilities can meet electricity demands at an affordable cost to the nation and meet environmental standards, i.e., without carbon emissions. [The recent and tragic earthquake, tsunami, and ensuing nuclear plant problems in Japan do not undermine the argument in support of nuclear energy. See Monbiot G. The Unpalatable Truth is that the Anti-Nuclear Lobby has Misled Us All. *The Guardian*, 5 April 2011; and Black R. Fukushima: As Bad as Chernobyl? *BBC News*, 12 April 2011 http://www.bbc.co.uk/news/science-environment-13048916 accessed 14 April 2011. See also an interview with John Ritch, Director General of the World Nuclear Association, July 2011, http://rt.com/programs/interview/energy-fukushima-nuclear-expert/ )

Just because wind turbines are not sited in more populous urban areas, there remains no national benefit that justifies discriminating against rural families – e.g., families with children; the frail, ill or vulnerable; the elderly – and designating them as 'expendable' or 'collateral damage' to an arbitrary renewable energy target. There is no national benefit that justifies discriminating against rural families and exposing them to sustained sleep deprivation in order to promote one form of industrial technology – operating 24/7, in close proximity to their homes, as the Department of Energy and Climate Change attempts to meet an arbitrary renewable energy target by promoting wind energy. The scattershot effect of this approach by the UK Government is evidenced by the large number of onshore wind farms that are the subject of noise complaints from neighbouring families, twenty-seven sites, according to evidence from the Salford Report 2007, though other figures suggest thirty-six sites as sources of complaint.
[Gray L. Noise Complaints about One in Six Wind Farms. *Daily Telegraph* 6 March 2010; and *Analysis of Wind Farms with Noise Complaints based on the Salford Report.* Xcel spreadsheet; see the Bibliography for the links to Constable, J and Moroney L. Data obtained under the Freedom of Information Act: Wind Turbine Noise Complaint Survey Data Collected by the University of Salford under contract to the Department of Business, Enterprise and Regulatory Reform: Research into Aerodynamic Modulation of Wind Turbine Noise URN 07/1235. Renewable Energy Foundation (REF), London, UK, 6 Februrary 2009.]

The WHO Night Noise Guidelines, designed for policy- and decision-makers, recommend a measurement that averages all nights for one year, each night counting as 8 hours, L,night,indoors (derived from L,night outside; see the Executive Summary XIV and the EU definition Directive 2002/49). However, this formula does not provide the control needed for wind turbine noise inside the home. Wind turbines produce electricity only when the wind is blowing, which is

usually when the major noise events occur. In addition, wind turbines can run at different modes and the noise emissions may change at similar wind speeds depending upon the mode. Wind shear, which leads to amplitude modulation (AM), is influenced by ground and weather conditions, e.g., temperature inversions at night, increasing the noise levels, creating the characteristic 'thumping' noise.

For these reasons, taking the 8 hour nightly noise readings for one year, and then averaging these findings, will not accurately represent the noise impact on the bedroom at night nor the dose/exposure experienced.

However, WHO bases its formula on the need to identify the dB(A) level of noise events that trigger sleep disturbance, and these levels of dB(A) dictate the methodology and the allowable levels and dosage that should not be exceeded in the bedroom at night with the window partially open.

Significantly, the WHO Night Noise Guidelines make the point that even when at a higher dB(A) level than the polluting noise, **natural background noise will not mask the polluting noise if the polluting noise has a different frequency composition than the background noise**. [Executive Summary XIII, 'Threshold for observed effects'] (1.3.6.) These are the traits that describe wind turbine noise, which has both a pulsating character and a low frequency component, which are not masked by background noise, particularly in a rural and tranquil environment.

The WHO Night Noise Guidelines note that:

> "If negative effects on sleep are to be avoided the equivalent sound pressure level should not exceed 30 dBA indoors for continuous noise..."
> [Ed. note: Previous evidence explained that once wind turbines power up, the noise is continuous, with a pulsating, modulating character.]

The WHO NNG complement the WHO *Community Noise Guidelines 1999* (published in 2000), but the NNG use the more current evidence-based research findings as the basis for updating some details:

> "The 1999 guidelines are based on studies carried out up to 1995 (and a few meta-analyses some years later). Important new studies (Passchier-Vermeer et al. 2002; Basner et al, 2004) have become available since then, together with new insights into normal and disturbed sleep. New information has made more precise assessment of exposure-effect relationship. The thresholds are now known to be lower than LA max of 45 dB for a number of effects. The last three sentences stand... Viewed in this way, the night noise guidelines for Europe are complimentary to the 1999 guidelines. This means that the recommendations on government policy framework on noise management elaborated in the 1999 guidelines should be considered valid and relevant for the Member States to achieve the guideline values of this document."
> [WHO NNG 2009: Executive Summary XVIII, '*Relation with the Guidelines for Community Noise 1999*']

**WHO Guidelines compared to the UK ETSU Guidance**

ETSU, the UK government contractors, chose a methodology that placed limits on wind turbine noise over a range of wind speeds up to 12m/s when measured at a height of 10m at the wind turbine site. [ETSU-R-97, p. v 10] This method of measurement creates many of the wind turbine noise problems referred to by Michael Stigwood of MAS, and David Cocks, QC, in the evidence presented to the Three Moors Planning Inquiry, discussed in S.2.1, pp 30-33.

ETSU guidance says that noise from the wind farm should be limited to 5dB above background noise for both day and nighttime. (ETSU p. vii 21) However, this assumes that 'background noise' masks wind turbine noise up to background noise level. But as noted above, the WHO NNG says that is not a valid assumption when the polluting noise has a different composition; additionally:

> "The rule of thumb that a noise can be considered masked if the signal is 10 dB below background is only valid if the noises have the same frequency composition

> and if they actually occur at the same time. This is particularly important to stress where LA eq levels are compared..."
> [WHO NNG, Background Level, 2009, Ch. 1 S.1.3.6]

The ETSU approach assumes the noise emission is at the centre of the turbine motor, i.e. the nacelle or hub height. However, this is not the case. In fact, the noise sources are the blade tips and the entire sweep of the turbine blades, which for modern turbines can be up to 11,000 sq metres, and a swept height to 160 metres. Estimating a noise imission at a home 1km distance is likely to be significantly different comparing a point source estimating emission at 100m high with a swept area emission of 11,000 sq metres up to a height of 160 metres (520 feet).
[Makarewicz R. Is a Wind Turbine a Point Source? JASA *Journal of the Acoustical Society of America* Feb 2011;129(2): 579-581]

Enforcing noise conditions based on the ETSU guidance is difficult because the wind turbines must be powered down in order to measure background noise in a variety of weather conditions, and then fully powered up again to take further measurements. Moreover, blade angles and nacelle directions also influence results, and this is further complicated when accounting for an array of wind turbines, because the vortices (air turbulence) created by wind turbine blades also interact in changing patterns:

> "It is well known that when wind turbines are deployed in large arrays, their efficiency decreases due to complex interactions among themselves and with the atmospheric boundary layer (ABL)."
> [Calaf M, Meneveau C, and Meyers J. Large eddy simulation study of fully developed wind-turbine array boundary layers. *Physics of Fluids* 2010;22(1):015110-01--115110-16]

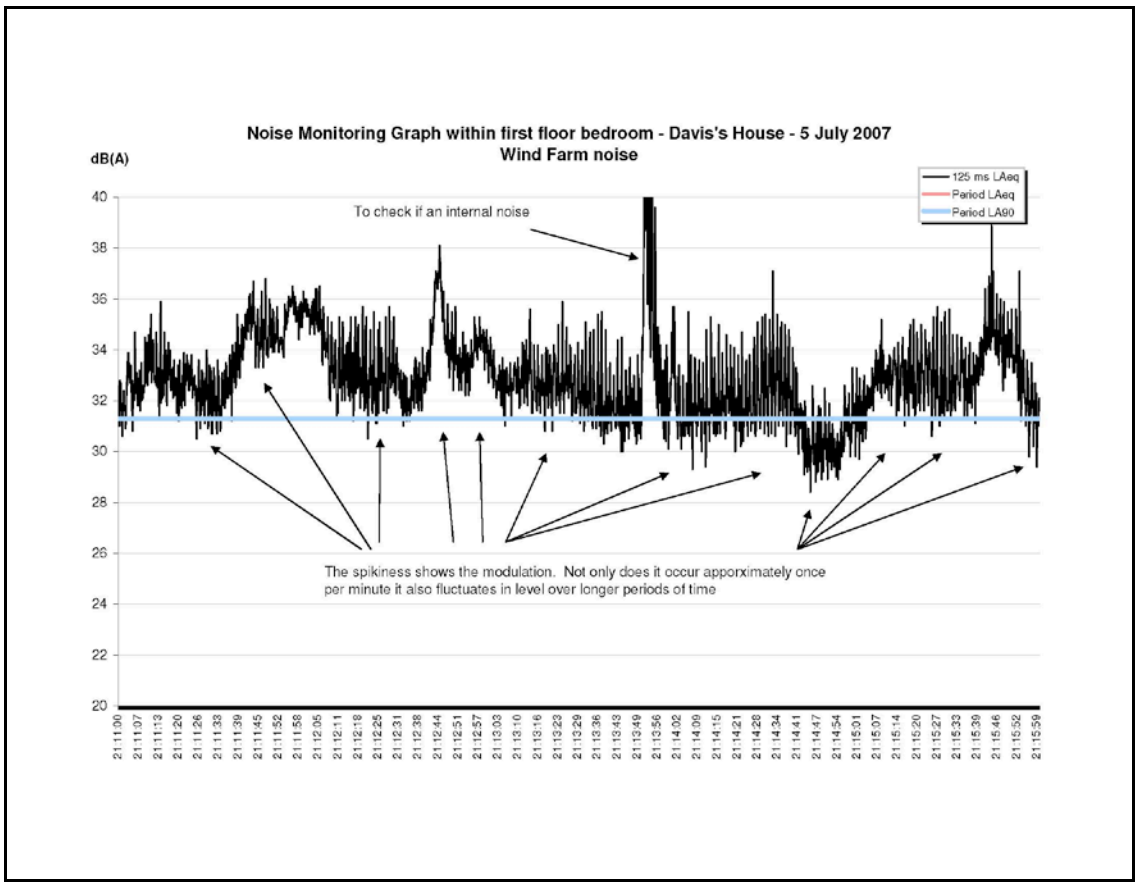
Meneveau, of Johns Hopkins University (USA), and Meyers, of Katholieke Universiteit Leuven (Belgium), are among those who found that underperformance at wind farms is caused partly by site design; the researchers found that:

> "large wind farm operators are going to have to space their turbines farther apart... placing the wind turbines 15 rotor diameters apart – more than twice as far apart as in the current layouts – results in more cost-efficient power generation."
> [Meneveau C and Meyers J. Optimization of Turbine Spacing in the Fully Developed Wind Turbine Array Boundary Layer. *Bulletin of the American Physical Society* Nov 2010;55(16):QD.00005 http://meetings.aps.org/link/BAPS.2010.DFD.QD.5;
> Kirk W. Study Yields Better Turbine Spacing for Large Wind Farms. Johns Hopkins University Press Release.]

> "For realistic cost ratios, we find that the optimal average turbine spacing may be considerably higher than that conventionally used in current wind farm implementations."
> [Meyers J and Meneveau C. Optimal turbine spacing in fully developed wind farm boundary layers. *Wind Energy* 14 APR 2011 DOI: 10.1002/we.469]

Thus, the guidance relied upon before commissioning is most critical, and research since 1997 partially explains why ETSU does not and cannot predict nor preclude noise problems at wind turbine sites.

This MAS Chart illustrates the amplitude modulation component of wind turbine noise, with modulations of 10 dB peak/trough fluctuations occurring approximately 5 times per minute, and these continue to fluctuate over periods of time. This ongoing fluctuation, or 'thumping', is the sound as actually experienced by people.




[MAS Environmental. Noise Monitoring Graph within first floor bedroom - Davis's House - Wind Farm Noise, 5 July 2007, in: Assessing Noise from Proposed Wind Turbine Developments. MAS Environmental, Cambridge, UK, May 2009]

The Conditions imposed by the Inspector and upheld by the Court of Appeal on the RES wind farm at Den Brook take these fluctuations into account; see S.2.5, p 60.

These Conditions are in stark contrast to the method advocated by ETSU-R-97, which averages the sound measurements so that the measurement appears as a straight line, eliminating the peaks and troughs. (ETSU uses LA90, 10min, so that over a 10 minute period, the sound is averaged, which does not show the fluctuations as experienced by the human ear.) Thus, if the measurement shows 31 dBA, this disguises the fact that the recipient family may endure peaks as high as 38 dBA or higher in a modulating harmonic pattern.

Thus, wind turbine noise is not a continuous 'hum', which the ETSU methods suggest, but can be a continuous swishing or even a thumping, oscillating noise. Furthermore, wind turbine noise has a low frequency component, not necessarily audible to the human ear, that has an impact on the auditory system and the human body.

The WHO *Night Noise Guidelines* and *Guidelines for Community Noise* are clear: if the polluting noise differs from the background noise in frequency and character, then one must not assume that the polluting noise is masked by the background noise.

Current UK government guidance makes that assumption, leading to noise problems for those living near wind turbines. Furthermore, ETSU-R-97 does not consider the impact of wind turbine noise dosage on families and their long-term exposure. This is a serious omission in the context of assessing its impact on health.

The WHO NNG were designed for use by policy- and decision- makers as well as by acousticians. Thus, most Environmental Officers, even at the local level, referring to the most recent WHO noise guidelines, should be able to assess planning applications for the breadth, depth, accuracy, and quality of the accompanying statements and reports, whether for wind turbine applications or other potentially noise polluting proposals.

However, the UK government's wind turbine noise policy as devised by ETSU is a highly technical document that demands highly qualified and experienced acousticians to interpret the guidance and to follow the involved procedures set down in the document. While the guidance may well have been appropriate at its inception, although even then it was untested for its amelioration of noise problems for those living near wind turbines, most wind turbines have increased dramatically in size since 1997. In the interim, there is also now a somewhat better understanding of wind turbine noise characteristics. As a result, when noise is a potential issue at Planning Inquiries because there are homes, or other sensitive residential or work facilities, near a proposed site, many days, much time, and considerable cost are consumed as acousticians debate the ETSU guidance, its interpretation, and its application.

Although approximately 27 to 36 wind turbine arrays have generated complaints about noise, wind turbine array owners persist in claiming that the noise immissions at homes comply with the Planning Conditions recommended by ETSU. This equates to tacit acknowledgement by the wind industry that ETSU-R-97 does not provide protection from harmful noise radiation to nearby homes.

In the paper *"Wind Turbine Noise, Sleep, and Health"*, Dr Christopher Hanning, a physician with expertise in sleep medicine, wrote:

> "The recent RIVM and WHO reports and the draft DTI/HMP reports confirm the potential for noise to adversely effect health through sleep disturbance and set maximum permissible noise levels which are less than those permitted by ETSU-R-97... [3.12.5]
>
> **In my expert opinion, from my knowledge of sleep physiology and a review of the available research, I have no doubt that wind turbine noise emissions have been clearly associated with sleep disturbances. Further, the evidence now available is quite clear that present UK noise guidelines are inadequate to protect the sleep of residents living too close to wind turbines...** [3.12.6]
>
> As a guide to the limits of acceptability, ……
> **Overall, it is apparent that the present ETSU-R-97 noise limits are too high to protect receptors from severe annoyance and sleep disturbance and that a level of 35dB(A) is appropriate, in the absence of excessive modulation.** [4.4.2 Acceptable limit]
>
> **Turbines which result in external noise levels greater than 35dB(A) or are sited closer than 1.5km from housing therefore present an unacceptable risk of causing sleep disturbance and high levels of annoyance to those residents and, to a smaller number, a risk to health.** [4.3.5]
>
> There is a large body of evidence also showing that ETSU-R-97 noise levels are too high for human health and well being. These include the 2009 WHO Night Noise Guidelines and the 2006 draft reports by HMP to DTI. It follows that it is appropriate and reasonable for planners and decision makers not to rely exclusively on ETSU-R-97 methodology and to take account of other material considerations set out in this paper." [5.1.4]
> [Hanning C. Wind Turbine Noise, Sleep and Health. Society for Wind Vigilance, April 2010 http://www.windvigilance.com/about-adverse-health-effects/wind-turbine-noise-sleep-and-health-by-dr-hanning] [Emphasis added.]

In June 2011, **The Australian Senate**, Community Affairs Reference Committee, in their report, *The Social and Economic Impact of Rural Wind Farms*, made seven Recommendations, among them:

> **"Recommendation 4: The Committee recommends that the Commonwealth Government initiate as a matter of priority thorough, adequately resourced epidemiological and laboratory studies of the possible effects of wind farms on human health. This research must engage across industry and community, and include an advisory process representing the range of interests and concerns."** [The Australian Senate: Community Affairs References Committee. The Social and Economic Impact of Rural Wind Farms. Commonwealth of Australia, June 2011, section 2.101]

**In the UK**, the document ***Noise Policy Statement for England*** (Defra 2010), states:

> "The Government is committed to sustainable development and Defra plays an important role in this by working to secure a healthy environment in which we and future generations can prosper. One aspect of meeting these objectives is the need to manage noise for which Defra has the overall responsibility in England. [1.1]
>
> This Noise Policy Statement for England (NPSE) sets out the long term vision of Government noise policy:
>
> **Noise Policy Vision: Promote good health and a good management of noise within the context of Government policy on sustainable development.** [1.6]
>
> This long term vision is supported by the following aims:
> **Noise Policy Aims:**
> **Through the effective management and control of environmental, neighbor and neighbourhood noise within the context of Government policy on sustainable development:**
> **- avoid significant adverse impacts on health and quality of life;**
> **- mitigate and minimize adverse impacts on health and quality of life; and**
> **- where possible, contribute to the improvement of health and quality of life."** [1.7]

Considering the evidence within this paper, Defra's *Noise Policy Vision* and the *Noise Policy Aims* appear to have been ignored by DECC and the wind energy industry when considered in the context of noise emissions from industrial wind turbines. Despite the catalogue of suffering reported by families when wind turbines are built too close to their homes, Defra does not acknowledge that the prejudicial health consequences to these families warrant a health Inquiry. Nor does Defra consider it significant enough to warrant an independent and impartial Inquiry into the financial suffering endured by these families, who find much of their life savings effectively sequestered by the State. These families are shouldering the burden for the State. [Department for Environment, Food and Rural Affairs (Defra). Noise Policy Statement for England (NPSE). Defra, UK, March 2010 http://www.defra.gov.uk/environment/quality/noise/npse/]

**In Europe**, the *Assessment and Management of Environmental Noise* is set out in Directive 2002/49/EC of the European Parliament and the Council of 25 June 2002, also known as END, or the Environmental Noise Directive:

> "1. It is part of Community policy to achieve a high level of health and environmental protection, and one of the objectives to be pursued is protection against noise...
> 5. This Directive should, inter alia, provide a basis for developing and completing the existing set of Community measures concerning noise emitted by major sources, in particular... infrastructure [and] industrial equipment..."

Under Article 1, the Directive states that:

> "...The following actions shall be implemented progressively... ensuring that information on environmental noise and its effects is made available to the public."

The Directive continues:

"Article 2, Scope:
1. This Directive shall apply to environmental noise to which humans are exposed in particular... in quiet areas in open country... and other noise sensitive buildings and areas.

Article 3, Definitions:
a. 'environmental noise' shall mean unwanted or harmful outdoor sound created by human activities including... sites of industrial activity...
b. 'harmful effects' shall mean negative effects on human health."

The Directive's Annex 1.3, Supplementary Noise Indicators, states that:

"In some cases... it may be advantageous to use special noise indicators... e.g.:
-- The low frequency content of the noise is strong.
-- LAmax or SEL for night period protection in the case of noise peaks.
-- Extra protection weekends, day periods, evening periods.
-- A combination of noises from different sources.
-- Quiet areas in open country.
-- The noise contains strong tonal components.
-- The noise has an impulsive character."

Annex 3 of the Directive, *"Assessment methods for harmful effects"* states that:

"Dose-effect relations should be used to assess the effect of noise on populations", which includes
-- "Tonal industrial noise
-- Impulsive industrial noise and other special cases."
[Environmental Noise Directive (END). Directive 2002/49/EC of the European parliament and of the Council relating to the Assessment and Management of Envrionmental Noise, 25 June 2002. Official Journal of the European Communities 1.189/12 EN, 18.7.2002 http://ec.europa.eu/environment/noise/directive.htm]

There is no indication that DECC has taken any action to implement or accommodate this EEC Parliament Directive regarding industrial wind turbine noise emissions.

**In Japan**, where residents living near wind turbines reported incidents of insomnia, headaches, dizziness, and tinnitus:

'The Environment Ministry will conduct its first field survey of possible health hazards of wind turbines, covering all of more than 1,500 units in operation across the country. The four-year study, to start in April, was planned following complaints from neighbourhood residents about noise and environmental problems as well as health issues.

The Ministry's field survey will measure low frequency sounds from turbine operations and interview residents face to face, according to officials.

At the 30 locations where complaints have been filed, 90 percent concerned health problems. Residents say they suffer from insomnia, headaches, dizziness or buzzing in the ear...

Izumi Ushiyama, president of the Ashikaga Institute of Technology and an expert on wind power generation, says operators must listen to residents before pushing their projects.

'Some operators make light of communications with residents in carrying out their projects, which causes friction,' he says. 'This has tarnished the image of wind power generation and blocked its promotion.' "
[Ito A and Takeda T. Sickness Claims Prompt Study of Wind Turbines. The Asahi Shimbun, 19 January 2010. http://www.asahi.com/english/Herald-asahi/TKY201001180410.html]

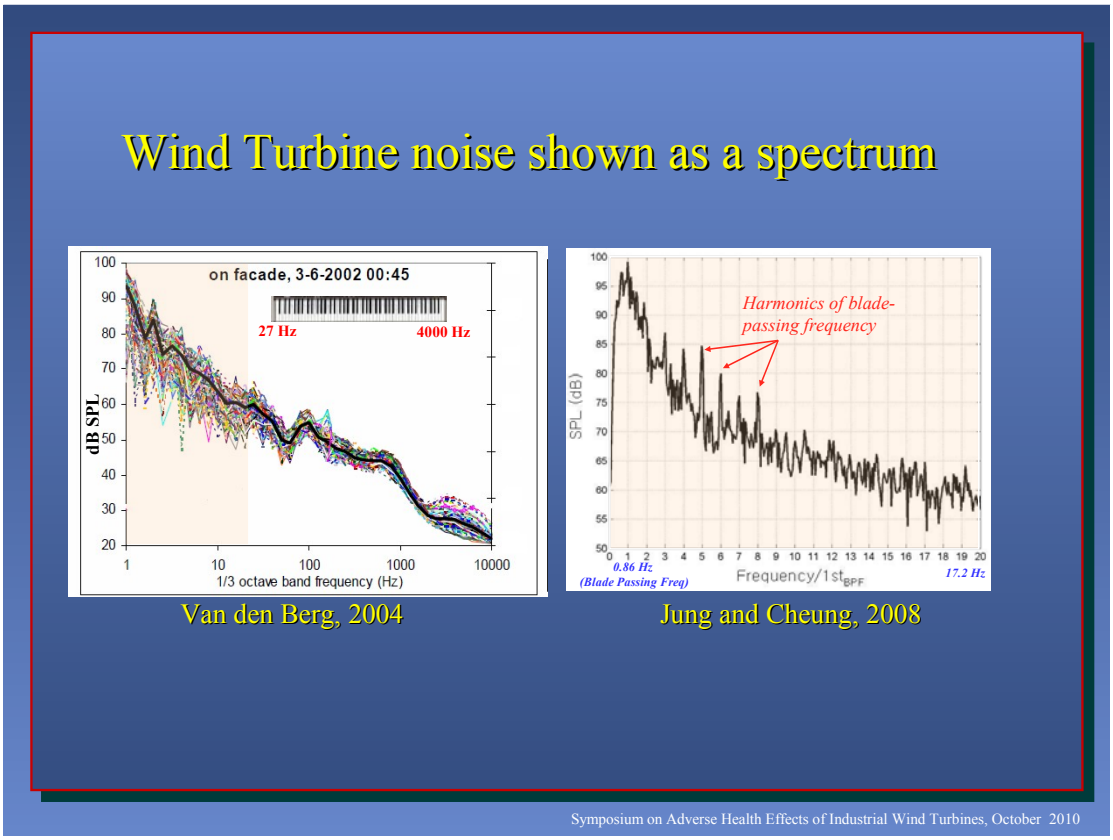
In contrast, some governments pass legislation and enforce guidelines that exclude local participation, leaving only recourse to expensive judicial process. [See Appendix 3.1 and pp 105 – 106 of this paper for an overview of the situation in Ontario, Canada. Krogh C. Industrial Wind Turbine Development and Loss of Social Justice. *Bulletin of Science, Technology & Society* 2011;31(4):321-333]

## 2.4 WIND TURBINE NOISE: LOW FREQUENCY NOISE [LFN]

During a presentation in October 2010 on the adverse health effects of industrial wind turbines, Dr Alec Salt described how the human auditory system responds to LFN and how the brain interprets signals from the ear. According to Salt, using dBA-weighted spectra totally misrepresents the effects of wind turbine noise – including its infrasound or LFN components – on the auditory system. Salt suggests that dB(G) weighting accounts for the effects of LFN more accurately, as noted in 2005 by Jacobsen in *"Infrasound emissions from wind turbines".* [Jacobsen J. Infrasound Emissions from Wind Turbines. *Journal of Low Frequency Noise, Vibration, and Active Control* 2005;24:145–155]

Salt's chart below compares the wind turbine acoustic levels measured by van den Berg (2006) and Jung and Cheung (2008). Noise below 20Hz is below the normal audible level for humans. The chart below shows the measured acoustic levels from wind turbines at 20Hz indicated at 60 dB to 95 dB. Above 20Hz, the acoustic levels range between 60 dB to 40dB at 1,000Hz.

**Chart 1. Wind turbine Noise Shown as a Spectrum**




[Dr Alec N Salt, PhD, Washington University School of Medicine, USA. Infrasound: Your Ears Hear It But They Don't Tell Your Brain. *First International Symposium: The Global Wind Industry and Adverse Health Effects: Loss of Social Justice?* Ontario, Canada, 29-31 October 2010 http://www.windvigilance.com/international-symposium/proceedings-first-international-symposium]

Because LFN travels long distances without attenuation, and can affect buildings and their occupants, Salt recommends setbacks of wind turbines from homes of at least 1¼ miles, and in home monitoring of both A-weighted and G-weighted noise levels, 24 hours/day, for all dwellings within 2 miles of wind turbines. [Salt, AN. Infrasound: Your Ears Hear It But They Don't Tell Your Brain.
*First International Symposium: The Global Wind Industry and Adverse Health Effects: Loss of Social Justice?* Society for Wind Vigilance, Ontario, Canada, 29-31 October 2010]

ETSU-R-97 and some UK acousticians adhere to the presumption that if a sound is inaudible, it therefore does not have an effect on humans. However, medical experts argue this is inaccurate. Inaudible sound, i.e., infrasound and low frequency noise, can intrude on awareness and cause discomfort and other injurious health effects depending upon dosage and exposure. To illustrate the fallacy of this assumption, Salt used these examples to highlight adverse effects caused by other agents that are below human detection except by other means of measurement:

> "1. If you can't taste it, it can't affect you. Can you taste Salmonella?
> 2. If you can't smell it, it can't affect you. Try breathing pure CO or CO2.
> 3. If you can't see it, it can't hurt you. Ultra violet light is invisible but can harm you."

Previous research has demonstrated that low frequency noise does create physiological responses in the human body; e.g., a chart from a Bruel & Kjaer *Technical Report* showed these measurements in the human body in response to low frequency noise:

**Table 1. Human Body Vibration Exposure and its Measurement**
The frequency ranges given are those where the symptoms are most predominant.

| | | |
|---|---|---|
| 1) | General feeling of discomfort | 4 – 9 Hz |
| 2) | Head symptoms | 13 – 20 Hz |
| 3) | Lower Jaw | 6 – 8 Hz |
| 4) | Influence on speech | 13 – 20 Hz |
| 5) | Chest pains | 5 – 7 Hz |
| 6) | Abdominal pains | 4 – 10 Hz |
| 7) | Influence on breathing movements | 4 – 8 Hz |
| 8) | Muscle contractions | 4 – 9 Hz |

[Rasmussen G. Symptoms for Vibration Exposure at Frequencies of 1 -- 20 Hz, in Human Body Vibration Exposure and its Measurement. Bruel & Kjaer *Technical Review*, v. 1, 1982]

This is the range of LFN as illustrated in **Chart 1: Wind Turbine Noise shown as a Spectrum**, reproduced earlier in this chapter.

As early as 1982, research by Hubbard on wind turbine noise showed that:

1) "A person inside the house can sense the impingement of noise on the external surfaces of the house by means of the following phenomena: noise transmitted through the structure… Vibrations of the primary components of the building such as the floors, walls and windows; the rattling of objects…"
2) Addressing the issue of 'whole body perception' Hubbard refers to the ISO Guidelines and observes that a noise level outside a building between 55 – 60dB (around 0.001 rms) in a frequency of 0.1 Hz – 80 Hz, is the most sensitive threshold of perception of vibratory motion by humans. [Hubbard HH. Noise induced house vibrations and human perception. *Noise Control Engineering* 1982;19(2):49-55]

In '*The Inaudible Noise of Wind Turbines*', a report by Ceranna et al, of the Federal Institute for Geosciences and Natural Resources (BGR, Hannover, Germany), elements of wind farm infrasound were measured at a distance of 30km from the wind turbines. [Ceranna L, Hartmann G, and Henger M. *The Inaudible Noise of Wind Turbines*. Infrasound Workshop, November 28 – December 2, 2005, Tahiti]

More recently, the Ministry of Defence banned wind turbines within a 31-mile radius of its nuclear test monitoring station in Eskdalemuir because of seismic interference. [Wind Farms Banned as MoD Listening Post Demands Hush to Detect Nuclear Blasts. *The Scotsman* 10 February 2010]

These examples further illustrate the long distances low frequency noise travels, including that of wind turbine noise, without attenuation.

A report to Noise-Con, in July 2011, by Bray and James presented the dynamic measurements of wind turbine acoustic signals, employing sound quality engineering methods that considered the time and frequency sensitivities of human perception:

> "The purpose of this paper is to present wind turbine acoustic measurements at these time-frequency scaling and to suggest that such consideration, frequently neglected in favor of frequency resolution and long term level averages, could augment the perceptually inappropriate averages (often A-weighted) typically taken over much longer intervals. The authors maintain that most measurements of wind turbines up to now have not considered, or not adequately considered, these signals' very complex and varying behaviors at the time/bandwidth scaling of human perception. Although treating wind turbine noise aspects at all relevant frequencies, this paper will concentrate on low-frequency information."
> [Bray W and James R. *Dynamic Measurements of Wind Turbine Acoustic Signals, Employing Sound Quality Engineering Methods Considering the Time and Frequency Sensitivities of Human Perception*. Noise-Con, Portland, Oregon, USA, July 25-27, 2011]

Dr M A Swinbanks advanced the understanding of LFN emitted by wind turbines during the Fourth International Wind Turbine Noise Conference, held in Rome, 2011, with his paper, *The Audibility of Low Frequency Wind Turbine Noise*:

> "A rigorous method of defining the lower limits of audibility or perception, based on the cumulative integration of spectra of arbitrary bandwidth has been investigated. It has been shown that for a typical wind turbine spectra, the upper frequency limit associated with this criterion corresponds closely to the intersection of 1/3$^{rd}$ octave levels with the conventional threshold of hearing. This criterion is, however, based on comparison of the cumulative mean square energy level of the signal, and does not take account of the much greater peak levels that occur in actual wind turbine sound fields. Time-domain simulation of the low frequency hearing response, using signals believed typical of wind turbines and industrial gas turbines has shown that sound can be perceptible at significantly lower levels than those defined solely on the basis of mean square energy.
>
> The resultant enhanced sensitivity is related to the crest factor of the signals. The effects are consistent with the audibility tests carried out and reported by NASA in 1982, and are also consistent with the authors own experience obtained during the 1980's relating to industrial gas turbine installations.
>
> Modern upwind-rotor configuration wind turbines can indeed give rise to very low frequency impulsive sound patterns. This effect is believed to be due to wind gradients and shadowing by obstructions, and was first identified and reported for upwind rotor turbines by NASA in 1989.
>
> A consequence of these results is that low frequency and infrasonic noise due to wind turbines may be audible at significantly lower sound levels than has hitherto been acknowledged."
> [Swinbanks MA. *The Audibility of Low Frequency Wind Turbine Noise: Conclusion*. The Fourth International Wind Turbine Noise Conference, Rome, April 12-14, 2011]

In 2006, the Hayes McKenzie Partnership issued a report contracted by the Dti, *'The Measurement of Low Frequency Noise at Three UK Wind Farms'*. Several years later, after the Dti denied requests to release the data and methods in more detail, *The Sunday Times* resorted to the Freedom of Information Act, as it revealed in its article, *'Officials Cover Up Wind Farm Noise Report':*

> "The guidance from consultants indicated that the sound level permitted from spinning blades and gearboxes had been set so high – 43 dB-that local people could be disturbed whenever the wind blew hard. The noise was also thought likely to disrupt sleep.
>
> The report said the best way to protect locals was to cut the maximum permitted noise to 38 dB, or 33 dB if the machines created discernable 'beating' noises as they spun.
>
> It has now emerged that officials removed the warnings from the draft report in 2006 by Hayes McKenzie Partnership, (HMP) the consultants. The final version made no mention of them.

> In their draft report the HMP researchers recommended that 'Consideration be given to a revision of the night-time absolute noise criterion', noting that this would fit with World Health Organization recommendations on sleep disturbance.
>
> **However, an anonymous government official then inserted remarks attacking this idea because it would impede wind farm development. He, or she, wrote: 'What will the impact of this be? Are we saying that this is the situation for all wind farms... I think we need a sense of the scale of this and the impact.'**
>
> **The final report removed any suggestion of cutting the noise limits or adding any further penalty it turbines generated a beating noise – and recommended local authorities to stick to the 1996 guidelines."**
> [Leake J and Byford H. Officials Cover Up wind Farm Noise Report. *The Sunday Times*, December 13 2009] [Emphasis added.]

Styles et al, of Keele University (UK), identified LFN as a component of wind turbine noise, in its July 2005, report to the UK MOD, *"Microseismic and Infrasound Monitoring of Low Frequency Noise and Vibrations from Windfarms":*

> "When the windfarm starts to generate at low wind speeds, considerable infrasound signals can be detected at all stations out to c. 10km. Clear harmonic components which are the second multiple and add up of 1.4Hz (the blade passing frequency) can be seen although interestingly and somewhat enigmatically the blade passing frequency itself is not strongly detected. (P.66)
>
> We have clearly shown that both fixed speed and variable speed wind turbines generate low frequency vibrations which are multiples of blade passing frequencies and which can be detected on seismometers buried in the ground at significant distances away from the wind farms even in the presence of significant levels of background seismic noise (many kilometres)." [Styles P, Stimpson I, Toon S, England R, and Wright M. Microseismic and Infrasound Monitoring of Low Frequency Noise and Vibrations from Windfarms: Recommendations on the Siting of Windfarms in the Vicinity of Eskdalemuir, Scotland. Report prepared for the UK Ministry of Defence (MoD), 18 July, 2005, p.76 http://geophysics.esci.keele.ac.uk/resources/docs/Final_Report.pdf]

Stigwood, as well as other acousticians, have also measured LFN as a component of wind turbine noise. [MAS Environmental. Assessing Noise from Proposed Wind Turbine Developments. MAS Environmental, Cambridge, UK, May 2009]

Møller and Pedersen, in their article *Low Frequency Noise from Large Wind Turbines*, found that:

> "As wind turbines get larger, worries have emerged that the turbine noise would move down in frequency and that the low-frequency noise would cause annoyance for neighbours…The relative amount of low frequency noise is higher for large turbines (2.3 – 3.6 mw) than for small turbines <2mw, and the difference is statistically significant... **It is thus beyond any doubt that the low frequency part of the spectrum plays an important role in the noise at the neighbours."**
> [Møller H and Pedersen CS. Low-Frequency Noise from Large Wind Turbines. JASA Journal of the Acoustical Society of America June 2011;129(6):3727-3744] [Emphasis added.]

Yet, the Dti HMP Report of August 2006 states that WHO found '... no reliable evidence that infrasound below the hearing threshold produce physiological or psychological effects." [Hayes M and McKenzie A (Hayes McKenzie Partnership). Measurement of Low Frequency Noise at Three UK Wind Farms. Department of Trade and Industry (Dti), UK, August 2006, p 66]

The Dti HMP Report **2006** repeats this on pages 2,10,46, and 66, quoting from WHO Community Noise **1995**.

However, the WHO Guidelines for Community Noise **1999** do not include the 1995 statement used by HMP in 2006. Instead, research that is more recent had convincingly demonstrated that low frequency noise does merit concern about effects on human health. The WHO Guidelines for Community Noise **1999** clearly state that:

> **"The evidence on low frequency noise is sufficiently strong to warrant immediate concern.**
> Health effects due to low frequency components in noise are estimated to be more severe than for community noises in general (Berglund et al 1996)."
> [WHO *Guidelines for Community Noise*, S.3.8, 1999] [Emphasis added.]

One might wonder why consultants to government, in a paper written in 2006, quote from the out-of-date, superseded WHO report from 1995, in order to support an important conclusion that informed and influenced government policy. Whether intentional or oversight, the result is that people's health and well being continue to be at risk because government policy has relied on these reports.

Not only is there evidence that wind turbines generate low frequency noise, there is also evidence that low frequency noise has an impact on people and is detectable physically, even though LFN is primarily inaudible.

More MPs are now aware that wind turbine noise is an important issue to their constituents. During Parliamentary Questions about Wind Turbines as a Health Hazard, Mr Geoffrey Cox, MP, QC, asked the then-Secretary of State for Trade and Industry:

> "What qualifications Hayes McKenzie possessed in relation to infrasound emitted by wind turbines; and what role medical experts played in the production of the report."

Malcolm Wicks, Minister for Energy at that time, replied*:*

> "The Hayes McKenzie report for DTI '*The measurement of low frequency noise at three wind farms'* investigated the levels of low frequency noise and infrasound emitted by wind turbines, it was not within the remit of the study to undertake new medical analysis.
>
> However the study did refer to the document prepared for the World Health Organization 'Community Noise' which states; "there is no reliable evidence that infrasounds below the hearing threshold produce physiological or psychological effects"."
> [Hansard. Cox G and Wicks M. Turbines: Health Hazards, 18 May 2007, c1003W; and Hansard. Cox G and Wicks M. Turbines: Health Hazards, 15 June 2007, c1418w]

It is significant that the UK Minister for Energy evaded the question on the clinical research qualifications of the government's consultation team.

It is also significant that in 2007, the UK Minister for Energy was advised to quote from the outdated, superseded WHO Community Noise 1995 document to support the point he was making, without reference to the then current WHO Guidelines for Community Noise 1999, and its updated guidance on recognising LFN as a potential hazard to health.

In June 2011, the Australia Senate, Canberra, produced the result of their Inquiry into "*The Social and Economic impact of Rural Wind Farms"*. The Community Affairs Reference Committee's recommendations included:

> **"Recommendation 1: The Committee considers that the noise standards adopted by the states and territories for the planning and operation of rural wind farms should include appropriate measures to calculate the impact of low frequency noise and vibration indoors at impacted dwellings."**

> [The Australia Senate: Community Affairs References Committee. The Social and Economic Impact of Rural Wind Farms. Commonwealth of Australia, June 2011, 2.44]

In August 2011, the Environmental Protection Agency of the Danish Ministry of the Environment issued new guidelines for low frequency noise emitted by wind turbines:

> "All turbines can emit low frequency noise, irrespective of their size either int erms of electrical power (megawatts) or height... a limit value for low frequency noise from wind turbines must be determined. Clearer and more precise regulations for this type of noise will provide more security for people living near wind turbines...
>
> The present limit value for noise from wind turines is 44 dB outdoors near residences in the open country and 39 dB in residential areas, for a wind speed at 8 m/s [metres per second]...
>
> The proposed new regulation is based on a 20 decibels (dB) limit indoors for wind speeds of 6 and 8 m/s...
>
> [Applications] will have to comply with both the current limit values for 'general noise' and the new limit value for low frequency noise.
>
> The municipality has an obligation to inspect wind tubines to ensure that noise disturbance is not excessive and can require wind turbine owners to have the noise generated by their turbines measured to ensure that regulations are complied with. This will also apply to the new limits for low frequency noise... The new limit values will apply to all turbines, irrespective of ownership."
> [*Q&A: Low Frequency Noise from Wind Turbines*. Environmental Protection Agency, Danish Ministry of the Environment, August 2011, http://www.mst.dk/English/Focus_areas/FAQ_low_frequency_noise_from_wind_turbines.htm?wbc_purpose=b%23%23Top]

Because Denmark relies on wind turbine manufacture and export for a significant portion of its GNP, acknowledging evidence-based research on the adverse impact of wind turbine noise and responding with stricter limits in guidance represent significant – and welcome – changes in policy.

## 2.5 WIND TURBINE NOISE: AMPLITUDE MODULATION [AM]

Wind turbines produce noise characteristics that are difficult to predict even with sophisticated computer modeling and meteorological data. Known as Amplitude Modulation, this noise character also intrudes on people's awareness, causing considerable distress, and interfering significantly with sleep patterns. AM contributes to the 'thumping' sound so distinctive to wind turbine noise.

In 2006-2007, BERR (the former Dti, now DECC) sought a consultation from Salford University on amplitude modulation. The report, *'Research into Aerodynamic Modulation of Wind Turbine Noise'*, was co-authored by a team from Salford led by Dr Andy Moorhouse and by Mr Malcolm Hayes of Hayes McKenzie Partnership Ltd.

BERR's press release on the Salford report, *New Report Eases Concerns over Wind Turbine Noise*, stated forthrightly that:

> "... the noise phenomenon known as aerodynamic modulation (AM) is not an issue for the UK's wind farm fleet...
>
> Commenting on wind farm worries, Energy Minister Malcolm Wicks, said 'Based on these findings, Government does not consider there to be a compelling case for more work into AM and will not carry out any further research at this time: however it will continue to keep the issue under review."
> [BERR. New Report Eases Concerns over Wind Turbine Noise. Press Release. Department for Business, Enterprise & Regulatory Reform (BERR), 1 August 2007 http://www.gov-news.org/gov/uk/news/new_report_eases_concerns_over_wind_turbine/40357.html]

Yet the BERR press release neglected to mention Conclusion 11 of the Salford/Hayes report, which on page 47 states:

> **"On the other hand, since AM cannot be fully predicted at present, and its causes are not understood we consider that it might be prudent to carry out further research to improve understanding in this area."**
> [Emphasis added.]

On 2 August 2007, Dick Bowdler, one of the few independent acousticians on the BERR Noise Working Group, wrote a letter to BERR's Salford project manager:

> "I have read the Salford Report and the Government Statement. As a result I feel obliged to resign from the NWG.
>
> The Salford Report says that the aims of this study are to ascertain the prevalence of AM from UK wind farm sites to try to gain a better understanding of the likely causes and to establish whether further research into AM is required.
>
> This bears little relation to what we asked for which is clearly set out in minutes of the meeting in August 2006. We all knew then (as was recorded in the original notes of the meeting) that complaints concerning wind farm noise are currently the exception rather than the rule. The whole reason for needing the research was that the trend for large, more sophisticated turbines could lead to an increase in noise from AM...
>
> Looking at the Government Statement it is clear that the views of the NWG (that research is needed into AM to assist the sustainable design of wind farms in the future) have never been transmitted to Government and so the Statement is based on misleading information."
> [Wind Expert Quits Thinktank; Resignation Hits Wind Findings. *Noise Bulletin* Aug-Sept 2007;Issue 15, pp 1, 4-5]

On 5 August 2007, the Director of Programme Strategy at the British Wind Energy Association (BWEA, now RenewableUK), the trade and lobbying organisation for the wind energy industry, sent a letter to BWEA members that included these comments:

> "Some excellent news from a new report, and a strong message from Government to back it up...
>
> Based on these findings, Government does not consider there to be a compelling case for further work into AM and will not carry out any further research at this time: however it will continue to keep the issue under review.
> I would like to thank (The BERR Salford Project Manager) (former DTI fame) for her efforts in driving through the work on this issue with such great result and robust Government statement."

Apparently, the BERR Noise Working Group/Salford Project Manager was on secondment to BERR from a wind farm development division of a major energy utility.

At this time, Mr Geoffrey Cox, MP, QC, released a statement noting that many of the consultants who devised the noise guidelines for the (then) Dti, and who continued to consult at BERR on the same issues, were at the same time consultants to, and employees of, the wind energy industry:

> "It is astonishing that the Government has subcontracted the study of this vital subject to the very industry which has the most to gain from allaying those concerns."

Mr Cox expressed concern about the

> "... apparent conflict of interest surrounding energy firms dominating a group set up to consider the health impact of aerodynamic modulation – the swish or boom caused by turbine blades... is it conceivable that a study of the possible health effects of smoking would be chaired by someone on secondment from the tobacco industry?"
> [Wind Energy Staff Act As Advisors. *Western Morning News*, 13 August 2008]
> [Onshore Wind – a Clear Conflict of Interest? *North Devon Journal*, 13 August 2008]

These views were echoed by Mr P Atkinson, MP, who is "deeply concerned" about the risk to Government impartiality:

> "We face the ridiculous situation of Defra and other Government departments saying 'they believe there is no risk from noise because renewable energy companies have told us so'".
> [Turbines advice 'blowing in the wind'. *The Journal*, Newcastle-Upon-Tyne, 18 Aug 2008]

The same article quotes Northumberland County Council's leader, Roger Styring, who

> "called for greater scrutiny of those advising the Government... This indicates that in a sense the industry is being allowed to set its own standards, which is clearly wrong. I agree they should be consulted but there are enough other experts that can advise here, especially in our Universities... The noise these turbines create can have quite an impact on your standard of living..."

Styring was also

> *"concerned that environmental health officers, who help Councillors decide on the noise issues surrounding a planning decision, risked being guided by potentially biased Government advice."*
> [Turbines advice 'blowing in the wind'. *The Journal*, Newcastle-Upon-Tyne, 18 Aug 2008]

Inadequate or improper site design can exacerbate Amplitude Modulation [AM], e.g., when developers try to place too many wind turbines on a site. In the article, "*Distance between Wind Turbines Should Be Doubled, Researchers Say*", the authors comment:

> "So far, wind turbines had been considered as standalone units, with few researchers taking into account the effects that the distances between them have

> on their final output. Meneveau and Meyer found out that the current space of 7 rotor diameters between adjacent wind turbines is not enough to overcome the effects of the wind turbulence created. (www.greenoptimistic.com)
>
> Instead, they found that a distance of 15 rotor diameters would suffice (that would be about 4,500 feet, or 1.3KM). I don't know if the space would realistically be enough for all the turbines to have such a setup, but the researchers say they would be much more cost-efficient.
>
> The two scientists found that the energy generated by a large wind farm is not influenced as much by horizontal winds, but by the strong winds that the turbulence created by them pulls down from higher altitudes. Their new setup would stir the air even more and would draw more kinetic energy from those high altitudes, a fact confirmed by wind tunnel tests in the John Hopkins wind tunnel."
> [See also Calaf M, Meneveau C, and Meyers J 2010 in S.2.3, p 43.]
> [Calaf M, Meneveau C, and Meyers J. Large Eddy Simulation Study of Fully Developed Thermal Wind-Array Boundary Layers. *Geophysical Research Abstracts* 2010, Vol 12 EGV]

Because ETSU does not reflect current research findings on wind turbine noise and its measurement, it lacks credibility in the eyes of the British public who face existing or potential wind turbine noise problems. The Government has failed to assess health risks that onshore wind turbines pose to families living nearby, despite clear evidence from international authorities and evidence-based reports that noise with the combined acoustic characters emitted by wind turbines is likely to cause injury to health. As a result, UK families will continue to suffer extreme stress and adverse health effects directly caused by wind turbine noise and its intrusive character, continuing year after year, without mitigation or hope of official intervention to assert and implement effective noise conditions.

In a Planning Appeal Decision at '*Den Brook, Devon'*, although the Inspector allowed the application, he also imposed a noise condition in order to mitigate the possibility of amplitude modulation:

> "Condition 20. At the request of the local planning authority… Amplitude modulation is the modulation of the level of broadband noise emitted by a turbine at blade passing frequency. These will be deemed greater than expected if the following characteristics apply:
>
> a) A change in the measured LAeq, 125 milliseconds turbine noise level of more than 3 dB (represented as a rise and fall in sound energy levels each of more than 3 dB occurring within a 2 second period.
>
> b) The change identified in (a) above shall not occur less than 5 times in any one minute period provided the LAeq, 1 minute turbine sound energy level for that minute is not below 28dB.
>
> c) The changes identified in (a) and (b) above shall occur for fewer than 6 minutes in any hour.
>
> Noise immissions at the complainant's dwelling shall be measured not further than 35m from the relevant building, and not closer than within 3.5m of any reflective building surface, or within 1.2m of the ground.
>
> Condition 21. No wind turbine shall generate electricity to the grid until the planning authority….has approved in writing a scheme…"
> [Hulme MW. Appeal Decision permitting the Den Brook Wind Farm. Inspector A Pykett; PINS, APP/Q1153/A/06/2017162, 11 December 2009]

The developer challenged the condition, but in a Court of Appeal decision, 26 May 2011, not only were the conditions upheld:

> "additionally the Court held that the noise Condition 20 and 21 will also run for the life of the wind farm."
> [*M. Hulme v Secretary of State & RES* 2010 EWHC 2386 Admin, 19 August 2010]

It should be noted that the Planning Inspector authorised external night time noise levels of between 43 dB LA90, 10min at 1m/sec – 7m/sec wind speed derived by following suggested measures not included within ETSU. Indeed, these alternate methods were suggested by several acousticians, all but one with ties to the wind energy industry, in a non-peer reviewed paper, in which the methods were merely theoretical and never tested in the field, and never validated independently by other researchers and acousticians.

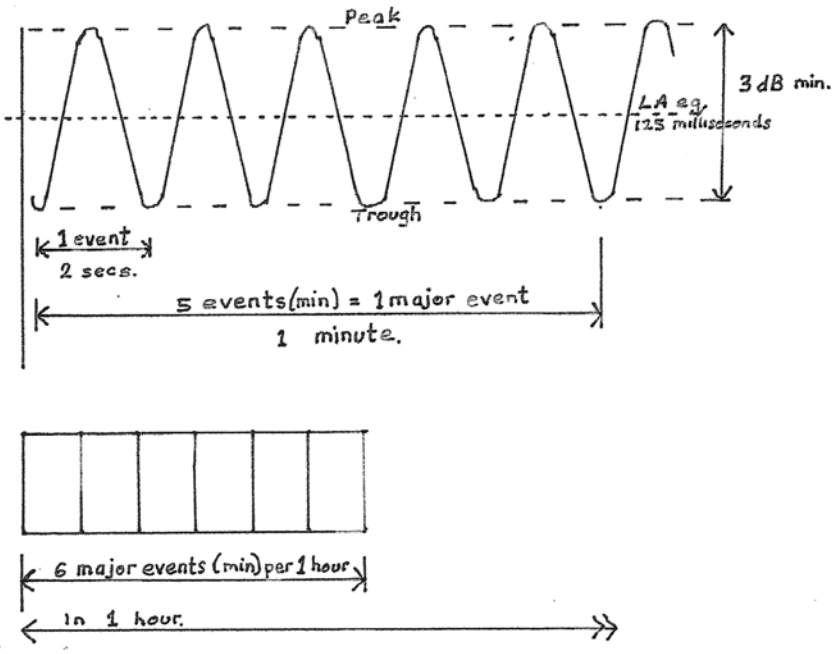
Deriving the 10m wind speeds allows even higher levels of environmental noise than if the wind speed is actually measured during compliance testing.
(See Table of Noise Limits Relating to Condition 16).

[*Ed.:* It is astounding that noise levels of 59.9 dB LA90 10min have been authorised, especially as this 'irons out' the pulsations of the peaks, which are even louder. Background noise will not mask the wind turbine noise, thus exposing those living and working nearby to prolonged and significant doses of industrial environmental noise pollution.]

The method to measure or derive the data using ETSU and its interpretations by industry acousticians "does not reflect the actual conditions causing complaint." The methods are not only "unlikely to indicate adverse noise impact at the planning stage, but once the development is operational, the article method virtually removes the ability for local communities to enforce controls over reasonable turbine noise impact."
[Stigwood M. The Effect of a Common Wind Shear Adjustment Methodology on the Assessment of Wind Farms when applying ETSUr-97. MAS Environmental, Cambridge, UK, 27 September 2011 http://www.masenv.co.uk/uploads/STUDYREPORTComparison%20of%20thearticleandETSUW111004FINAL_sec.pdf ; and Stigwood M. Summary to: The Effect of a Common Wind Shear Adjustment Methodology on the Assessment of Wind Farms when applying ETSUr-97. MAS Environmental, Cambridge, UK, 27 September 2011 http://www.masenv.co.uk/uploads/Summary%20ETSU%20IoA%20article.pdf]

Chart 2 illustrates a schematic of Condition 20:

**Chart 2. Diagrammatic Threshold for Condition 20, Den Brook Valley Wind Turbine Array Proposal.**



According to an Information Note issued by the Renewable Energy Foundation (REF) in October 2011, conditions 20 and 21 of the Den Brook Valley judicial decision would provide a valuable contribution if incorporated into noise assessments:

> "At first glance this condition appears complex and it has excited controversy, in part because it has been argued that it is difficult to distinguish wind farm AM noise from other noises in the environment.
>
> We believe that it would be a useful contribution to the understanding of the potential application of the Den Brook noise condition if it were used to assess actual, i.e. real and empirical, wind farm noise data.
>
> However there is little useful wind farm noise data in the public domain. We are fortunate in that we have recently obtained data collected by the Hayes McKenzie partnership as part of a Government contract in 2005 to investigate low frequency noise at wind farms.
>
> That this raw noise data has come into the public domain is testament to the determination of an individual who, with the assistance of the local MP and advice from the Campaign for Freedom of Information and the Information Commissioner, succeeded in obtaining the data from the Department of Energy and Climate Change in spite of a surprising unwillingness on the part of DECC (Department of Environment and Climate Change) officials to facilitate its release."

REF analysed a subsection of the data and concluded that:

> "... this exercise demonstrates that the Den Brook condition is straightforward and that it is possible for this condition to be employed in a transparent and objective manner to demonstrate the existence of excess AM in wind turbine noise.
>
> These findings should be welcomed by both wind-farm neighbours, developers, and decision makers in the planning process. AM noise provokes complaints and heated debates, and an enforceable, objective, condition to cap such noise gives all parties clarity, as well as sparing neighbours and developers the trouble, expense, and uncertainty of private nuisance actions. The Den Brook condition appears to be a readily workable solution to this very real problem."
> [Moroney L and Constable J. The Den Brook Amplitude Modulation Noise Condition: Information Note. Renewable Energy Foundation (REF), London, UK, 31 October 2011. http://www.ref.org.uk/publications/242-the-den-brook-amplitude-modulation-noise-condition]

## *Appendix 2*

**Wind Turbine Noise & Guidance: Additional References**


Alteri B.
**Does Wind Turbine Noise Affect Your Sleep or Health?**
*WLBZ Channel 2*, Bangor Maine, USA, 14 May 2009.
http://www.wlbz2.com/news/local/story.aspx?storyid=104717&catid=3

Copping J and Gray R.
**Switch-off for Noise Wind Farms.**
*Telegraph* (UK), 19 November 2011.
http://www.telegraph.co.uk/earth/energy/windpower/8901431/Switch-off-for-noisy-wind-farms.html

**Council Ruling to Change Future of Windfarm Plans (Carmarthenshire, Wales).**
*ThisIsSouthWales*, 23 March 2011.
http://www.thisissouthwales.co.uk/Council-ruling-change-future-windfarm-plans/story-12461867-detail/story.html

Crosby D.
**Legal Challenge against Wind Turbines Moves Forward with Appeal (Prince Edward County, Canada).**
*The Sun Times* (Canada), 20 March 2011.
http://www.owensoundsuntimes.com/ArticleDisplay.aspx?e=3036164

Edwards J.
**Calls for Alltwalis Wind Farm to be Shut Down, 7 July 2010.**
http://www.jonathanedwards.org.uk/calls-for-alltwalis-wind-farm-to-be-shut-down

Hanning C and Nissenbaum M.
**Selection of Outcome Measures in Assessing Sleep Disturbance from Wind Turbine Noise.**
Fourth International Meeting on Wind Turbine Noise, Rome, Italy, 12-14 April 2011.

Johansson M.
**We Now See Families Leaving Their Homes (Denmark).**
Letter to Editor, 26 May 2011.
http://www.windturbinesyndrome.com/news/2011/we-now-see-families-leaving-their-homes-reports-physician-denmark/print/

Leslie K.
**Ontario Unable to Tell if Wind Farms Exceed Noise Limits, Activists Say.**
*The Globe and Mail* (Toronto, Canada), 15/16 June 2011.
http://www.theglobeandmail.com/news/politics/ontario-unable-to-tell-if-wind-farms-exceed-noise-limits-activists-say/article2062789/

Mann T.
**Blumenthal Urges Tough Standards for Siting of Wind Power Projects.**
*The Day* (New London, Connecticut, USA), January 4 2011.
http://www.theday.com/article/20110104/NWS12/301049915/1069/rss

Oike YT.
**Japanese Conference on Big Wind: Presentations by Victims. (excerpts), 30 April 2010.**
http://www.epaw.org/documents/Japanese%20Conference%20against%20Big%20Wind.pdf

Ray P.
**Charges against Wind Companies Upheld.**
*Altoona Mirror*, 27 March 2009.
http://www.altoonamirror.com/page/content.detail/id/517439.html

Reid D.
**Health Effects of Turbines? We Already Know.**
*The Beacon Herald* (Ontario, Canada), 9 January 2011.
http://www.stratfordbeaconherald.com/ArticleDisplay.aspx?e=2922808

Saccorotti G, Piccinini D, Cauchie L, and Fiori I.
**Seismic Noise by Wind Farms: A Case Study from the VIRGO Gravitational Wave Observatory, Italy.**
*Bulletin of the Seismological Society of America* April 2011;101(2):568-578.

Swinbanks MA.
**Wind Turbines: Low-Frequency Noise & Infrasound Revisited.**
Environmental Protection UK One-day Workshop, Birmingham, 9 September 2010.
http://www.friendsofmainesmountains.org/uploads/Exhibit%2041,%20Wind%20Turbines-%20Low-Frequency%20Noise%20%20Infrasound%20Revisited%20Malcolm_Swinbanks.pdf

Todd W.
**Living with Turbines – a Personal Account, 16 February 2009.**
http://www.windaction.org/documents/15113

Todd W.
**Testimony to Maine Legislature, 30 April 2007.**
http://www.maine.gov/dep/ftp/bep/ch375citizen_petition/pre-hearing/AR-70%20Wendy%20Todd%20testimony.pdf or
http://www.wind-watch.org/documents/testimony-of-wendy-todd-to-the-maine-legislature-april-30-2007/

**Turbine Noise a Wind Developer Finds Objectionable.**
Industrial Wind Action Group, 15 June 2010.
http://www.windaction.org/faqs/27803

Webster B.
**Helicopter noise court challenge for wind farms.**
The Times 4 July 2011.
http://www.thetimes.co.uk/tto/environment/article3082809.ece

# *Chapter 3*

## Wind Turbine Noise: Impacts on Health

### 3.1 WIND TURBINE NOISE AND ITS IMPACTS ON HEALTH, SLEEP, AND COGNITION

This chapter examines why environmental noise is prejudicial and injurious to health, including its impacts on cognition and sleep. Although the chapter addresses wind turbine noise specifically, the noise characteristics associated with adverse health impacts are not unique to wind turbines. Indeed, wind turbine noise combines noise characteristics that engage negative physiological and psychological responses in people of all ages, i.e., wind turbine noise can be particularly intrusive, disruptive, and injurious to the health of those living, learning, and working nearby. The duration of exposure is a factor in the effects on health and well being. [See also *Noise Radiation from Wind Turbines Installed near Homes: Effects on Health*, Frey & Hadden 2007, which covers earlier material on this topic.]

> "In epidemiological noise studies, higher risk estimates were found when length of exposure was considered (years in residence)."
> [WHO Burden of Disease from Environmental Noise: Quantification of Health Life Years Lost in Europe, 2011]

The World Health Organization, in its review of evidence-based research on environmental noise, states unequivocally:

> "There is sufficient evidence from large-scale epidemiological studies linking the population's exposure to environmental noise with adverse health effects. Therefore, environmental noise should be considered not only as a cause of nuisance but also a concern for public health and environmental health."
>
> "In order to inform policy and to develop management strategies and action plans for noise control, **national and local governments need to understand and consider this new evidence on the health impacts of environmental noise**."
> [WHO Regional Office for Europe and the Joint Research Centre of the European Commission. Burden of Disease from Environmental Noise: Quantification of Healthy Life Years Lost in Europe, 2011 – WHO BDEN Report] (Emphasis added.)

The WHO EBD report notes also that assessing exposure to noise includes these major factors:

- "measured exposure or calculated/predicted exposure;
- choice of noise indicator;
- population distribution;
- time-activity patterns of the exposed population;
- combined exposures to multiple sources of noise".

> Moreover, "... despite the considerable effort and progress made in controlling noise from industry, there has been little improvement in the levels of noise exposure of people across Europe." The WHO Burden of Disease report estimated the health impacts of environmental noise "using exposure-response relationships, exposure distribution, background prevalence of disease and DWs [disability weight]." [WHO BDEN Report]

The European Noise Directive – END – includes these principles:

- "informing and consulting the public about noise exposure, its effects and the measures considered to address noise, in line with the principles of the Aarhus Convention;
- addressing local noise issues by requiring competent authorities to draw up action plans to reduce noise where necessary and **maintain environmental noise quality where it is good**; and,
- ...including objectives to reduce the number of people affected by noise."
  [European Noise Directive (END). Directive 2002/49/EC, 25 June 2002] (Emphasis added.)

END acknowledges that some environmental noise sources may require supplementary noise indicators and related limit values, particularly the following:

- "strong low-frequency content of the noise; and
- -- $L_{Amax}$ or SEL (sound exposure level) for night period protection in the case of noise peaks".
  [European Noise Directive 2002/49/EC]

Both these are characteristic of wind turbine noise: low frequency noise and unpredictable, intermittent peaks (pulsating noise). Noise, when it includes these components as well as tonal qualities, may initiate or exacerbate physical and physiological changes, e.g., increases in blood pressure and/or stress hormone levels, such as cortisol. Families, children, the elderly, and other vulnerable populations are unable to escape the effects when these noises affect homes, schools, businesses, residential homes, and other sensitive facilities. The occupants have no respite, no mitigation, particularly if they also do not have the financial resources to move away or to pursue restitution via the judicial system.

Clinical and laboratory studies on the effects of environmental noise on people show that:

> "Noise-inducing stress can lead to release of stress hormones. Acute stress whether physical or psychological is necessary for adaptation to change... During long-term stress there may be impairment of immune activity... if overstimulation due to chronic stress reaction continues, it may be damaging to the health of the individual... Other than the noise stress acting directly , it may also have an impact on the immune function via noise-induced sleep deprivation."
>
> "Noise-induced stress effects on cortisol can occur during sleep, which can develop into a chronic increase if noise exposure is repeated... High noise level may act directly as a stressor, but low levels may also affect cortisol secretion depending on the meaning and disturbing nature of the stimulus rather than its level."
>
> "Exposure to noise, particularly when it is unpredictable and intermittent can lead to noise-induced sleep disturbance."
> [Prasher D. Is There Evidence that Environmental Noise is Immunotoxic? (Report) *Noise and Health* 2009; 11(44):151-155]

Environmental noise, which is an unwanted or harmful outdoor sound, is more widespread, *'both in its duration and geographical coverage'*, with complaints on the rise. [EEA: About Noise 2011, European Environment Agency, www.eea.europa.eu/themes/noise/about-noise]

Because environmental noise *'is persistent and inescapable'*, large numbers of people are exposed to it. Indeed, the European Union Green Paper *Future Noise Policy* states that approximately *'20% of the EU's population suffer from noise levels that health experts consider to be unacceptable, i.e., which can lead to annoyance, sleep disturbance and adverse health effects'*. [European Environment Agency (EEA): About Noise, EEA, 2011]

Noise pollution is not only about loudness, annoyance, and hearing loss*:*

> "The effects of noise exposure cannot be understood only by taking mechanisms of toxic action into account. For example, the sounds of a discotheque are music to the dancers but noise to the neighbors. In the first case, the exposure would not be annoying but is expected to contribute to hearing loss; for the neighbors, hearing loss would be improbable, but annoyance would certainly occur."
> [Passchier-Vermeer W and Passchier WF. Noise exposure and public health. *Environmental Health Perspectives* March 2000;108 [Suppl 1]:123-131]

According to the American National Standard's *Methods for Estimation of Awakenings Associated with Outdoor Noise Events Heard in Homes*:

> "Nearly all sleep research has concentrated on populations that were exposed to the given noise source for a long period of time (more than one year)." Therefore, the equations used "are likely to underestimate the probability of awakening for sound that is new to an area... Over time, a percentage of the population acclimates, at least in part, to nighttime noise. Another percentage of the

> population develops coping strategies such as keeping windows closed at night. And before a new equilibrium is obtained, some fraction of the population moves away because they cannot cope or acclimate to the nighttime noise. Thus, it is likely that Equation (1) underestimates the probability of awakening for sounds that are new to an area."
> [American National Standard. Quantities and Procedures for Description and Measurement of Environmental Sound - Part 6: *Methods for Estimation of Awakenings Associated with Outdoor Noise Events Heard in Homes*. ANSI/ASA S12.9 - 2008 / Part 6]

Pawlaczyk-Luszczynska et al note that LFN is recognised as a

> "special environmental pollutant, affecting mostly sensitive people in their homes... The primary and the most frequent adverse effect of LFN is annoyance... related to feelings described by the words: disturbance, irritation, discomfort, dissatisfaction, bother, nuisance, uneasiness and distress."
> [Pawlaczyk-Luszczynska, M; Dudarewicz A; Szymczak W; and Sliwinska-Kowalska M. Evaluation of annoyance from low frequency noise under laboratory conditions. *Noise and Health* 2010; 12(48): 166- ]

Moreover, the authors note that

> "Annoyance related to noise (sound) is a combination of both physical and psychological factors... It has been shown that LFN differs from ordinary medium- or higher-frequency noise. LFN may cause different subjective symptoms and higher ratings of annoyance than noises at comparable A-weighted sound pressure levels (SPLs) that are not dominated by low frequencies.
>
> Annoyance from LFN is frequently reported at relatively low SPLs (slightly above the hearing threshold) and increases rapidly with its level."

These authors also note that research indicates

> "...people disturbed by LFN in their homes have shown that subjects who become annoyed by this type of noise develop a specific sensitivity to its sources, while they rarely consider themselves sensitive to noise in general."

Because the authors were particularly interested in the effects of LFN in occupational settings (e.g., those affected by ventilation systems, heating/air conditioning units), they note that several studies

> "suggest that LFN at levels normally occurring in control rooms and office-like areas (40-50 dBA) can be perceived as annoying and adversely affecting the human mental performance, particularly when more demanding tasks have to be executed.' LFN may affect those whose jobs require 'selective attention and/or processing [a] high load of information."

Thus, this untoward effect might also include many students. The authors' research upheld findings that when LFN is present,

> "noise annoyance was rated higher than its loudness."

Their findings also support other research results that found when performing more demanding tasks, people found

> the "disturbing effects related to noise were significantly higher."

These findings are supported also by Takahashi et al; the authors found that noise-induced vibration

> "... directly represents the effect of noise on a part of the body where some physical symptom has occurred, and it is expected not to vary in magnitude in long-term exposure to the noise, contrary to any psychological responses which may be reduced in magnitude as habituating... The noise-induced vibration

> measured on the chest is higher than the vibration measured on other parts of the human body."
> [Takahashi Y; Yonekawa Y; and Kanada K. A New Approach to Assess Low Frequency Noise in the Working Environment. *Industrial Health* 2001; 39:281-286]
>
> Indeed, "... the vibrations induced in the trunk of the body (the chest and the abdomen) really do contribute to the unpleasantness." The vibration acceleration level (VAL) "is not related to the loudness and the A-weighted sound pressure level is not related to the vibration... This indicates that noise content at lower frequencies should be given more importance in evaluating high-level low-frequency noise... Noise-induced vibrations primarily induce vibratory sensation and through the vibratory sensation or together with some other stimulating factors, they secondarily contribute to inducing unpleasantness." Therefore, to evaluate the effects of LFN, "the effect of vibration should be taken into account."
> [Takahashi Y; Kanada K; Yonekawa Y; and Harada N. A Study on the Relationship between Subjective Unpleasantness and Body Surface Vibrations Induced by High-Level Low-Frequency Pure Tones. *Industrial Health* 2005; 43:580-587]

These authors also note, as others have, that the A-weighted sound pressure level "is useful for measuring noise" but focuses on audible noise and underestimates LFN. Other scales for LFN, the LFNR or G-weighting curve, "are useful for evaluating temporary psychological effects..."

These responses are "expected to be gradually reduced" as the person habituates to the noise. However, many workers need evaluation of the noise "from the standpoint of preventing its chronic and physical health effects." And this may certainly hold also for the many who live near wind turbines, which are 24/7 sources of noise with an LFN component, for as the authors Takahashi et al note, the vibration evokes a physical and mechanical response from the human body and is not expected to reduce even with long-term exposure. It is "induced not only on the body surface but also in the inner body such as the internal organs". However, the authors did find that body fat could 'damp' or obstruct the propagation of LFN through the body.
[Takahashi Y; Yonekawa Y; Kanada K; and Maeda S. A Pilot Study on the Human body Vibration Induced by Low Frequency Noise. *Industrial Health* 1999; 37:28-35]

According to Alayrac et al,

> "Indeed, noise annoyance studies focusing on industrial noise are not as numerous as those on transportation noise, presumably because this noise is less widespread. Another reason may be that industrial noise sources are heterogeneous due to the different types of industrial activities...Nevertheless, previous field surveys have provided information about the assessment of industrial noise sources, such as noise immission sound levels leading to complaints, or spectral features and non-acoustical parameters influencing noise annoyance... In the case of a tone added to a background noise, Hellman (1982) observed that annoyance response depends on the overall sound pressure level, the frequency of the tone, the tone-to-noise ratio and the spectral shape of the noise."
> [Alayrac M, Marquis-Favre C, Viollon S, Morel J, and Le Nost G. Annoyance from Industrial Noise: Indicators for a Wide Variety of Industrial Sources. *JASA Journal of the Acoustical Society of America* Sept 2010;128(3):1128-1139]

More specifically, Pedersen et al found that:

> "The expectation that the presence of road traffic sound would reduce the prevalence or annoyance due to noise from wind turbines in general was not confirmed in this systematical analysis of a large data set. The relationships between sound levels and annoyance with the noise were in most cases separate for wind turbine and road traffic, respectively, and not interacting... Wind turbine sound is, as found in other studies, very easily perceived and about 80% of the respondents in this study could hear the sound at levels as low as 35--40DB(A) Lden when background sound levels were low." This situation prevails in many situations when wind turbines are sited in rural or particularly tranquil areas, but near homes."

> [Pedersen E; van den Berg F; Bakker R; and Bouma J. Can Road Traffic Mask Sound from Wind Turbines? Response to Wind Turbine Sound at Different Levels of Road Traffic Sound. *Energy Policy* 2010;38:2520-2527]

However, Pedersen et al also found that:

> "Wind turbines were less easily heard when road traffic sound dominated over wind turbine sound, but this did not result in a change in annoyance: the dose-response relationship between levels of wind turbine noise and annoyance were about the same despite levels of road traffic sound. The exception is that high levels of road traffic sound (>55 dB(A)) did seem to have a masking effect on wind turbine sound, but only at moderate levels of wind turbine sound (35 -- 40 dB(A))."

That is, even with the presence of loud traffic noise, wind turbine noise adversely affects those within hearing – an impact greater than that of the traffic noise:

> "Wind turbine sound levels do not follow the same behaviour as road traffic noise levels. Road traffic usually calms at night, whereas modern, tall wind turbines may produce more sound at night than in daytime."
> [Pedersen E; van den Berg F; Bakker R; and Bouma J. Can Road Traffic Mask Sound from Wind Turbines? Response to Wind Turbine Sound at Different Levels of Road Traffic Sound. *Energy Policy* 2010;38:2520-2527]

These results replicate earlier findings:

> "Noise from wind turbines was found to be more annoying than noise from several other sources at comparable Lden sound levels...Like aircraft, wind turbines are elevated sound sources visible from afar and hence intrude both visually and aurally into private space."
> [Pedersen E; van den Berg F; Bakker R; and Bouma J. Response to Noise from Modern Wind Farms in The Netherlands. *JASA Journal of the Acoustical Society of America* August 2009;126(2): 634-643]

Salt and Hullar's paper, *Responses of the Ear to Low Frequency Sounds, Infrasound and Wind Turbines*, discusses the physiology, functions, and responses of the ear; the cochlea – the auditory part of the ear – has two types of sensory cells, inner and outer hair cells, that respond to stimuli and transmit 'hearing' to the brain. The inner hair cells' sensitivity decreases as sound frequency is lowered. In contrast, the outer hair cells

> "are directly coupled to mechanical stimuli...At very low frequencies the OHC are stimulated by sounds at levels below those that are heard." The authors note that: "There are, however, abnormal states in which the ear becomes hypersensitive to infrasound. In most cases, the inner ear's responses to infrasound can be considered normal, but they could be associated with unfamiliar sensations or subtle changes in physiology. This raises the possibility that exposure to the infrasound component of wind turbine noise could influence the physiology of the ear."

This has significance because, as Salt and Hullar observe,

> "Infrasonic sounds are generated internally in the body (by respiration, heartbeat, coughing etc.) and by external sources, such as air conditioning systems, inside vehicles, some industrial processes and, now becomingly increasingly prevalent, wind turbines." Infrasonic sound that cannot be heard can influence inner ear physiology. Moreover, using the A-weighted scale for wind turbine noise "underestimates the influence of the sound on the ear. A greater effort should be made to document the infrasound component of wind turbine sounds under different conditions." The authors conclude that "there is an urgent need for more research directly addressing the physiologic consequences of long-term, low level infrasound exposures on humans."
> [Salt AN and Hullar TE. Responses of the Ear to Low Frequency Sounds, Infrasound and Wind Turbines. *Hearing Research* 2010 Sept 1;268(1-2):12-21. The authors' research was supported by an RO1 research grant from 2004 – 2010

from the National Institute on Deafness and Other Communication Disorders, US National Institutes of Health.]

Thus, applications for wind turbine arrays sited near sensitive facilities such as schools or hospitals, as well as homes, would benefit from greater scrutiny, including stringent enforceable noise conditions and greater setback distances from these facilities.

Quantifying the related disease burden is, as one might imagine, a challenge not only for those who collect and analyse public health data, but also for policy makers. Noise exposure – whether environmental, occupational, or recreational – leads to sleep disturbances, annoyance, hearing impairment, and to other health problems such as cardiovascular diseases.

During the nineteenth century, environmental or occupational illnesses were sometimes more easily identified than in today's society, which is more mobile. For example, in towns with factories producing matches that used phosphorus in the process, a phosphorus-related disorder developed, somewhat easily tracked to the source. The office workers in the same factories did not develop the dreaded 'phossy jaw' that afflicted the floor workers, who developed the condition as the result of phosphorus exposure on the factory floor. 'Phossy jaw' was marked by osteonecrosis (death of the bone), accompanied by pain, swelling, debilitation, and exposed bone of the jaw. Because workers lived in a well-defined area and were observed by the same physicians, clusters or patterns of illnesses could be recognised early. [Marx RE. Uncovering the Cause of 'Phossy Jaw' circa 1858 to 1906: Oral and Maxillofacial Surgery Closed Case Files - Case Closed. *Journal of Oral and Maxillofacial Surgery* 2008; 66(11): 2356-2363]

Though occasionally working conditions were improved by the owners, often the working conditions were 'tolerated' until changes were mandated. In the case of 'phossy jaw', the disease was finally eradicated when the US Congress joined with other nations to eradicate the disease and passed The Match Act in 1912, placing a tax on phosphorus matches, forcing manufacturers to find a less expensive – and non-toxic – substitute. [Felton JS. Classical syndromes in occupational medicine: phosphorus necrosis -- a classical occupational disease. *American Journal of Industrial Medicine* 1982; 3(1): 77-120; Myers ML and McGlothlin JD. Matchmakers' 'phossy jaw' eradicated. *American Industrial Hygiene Association Journal* Apr 1996; 57(4): 330-332]

However, people are now more dispersed in their work and living arrangements; neighbours do not necessarily visit the same physicians, and individual patients may see different physicians in the course of the same health complaint or illness. Medical care is more sophisticated today, but the provision of care may be more fragmented than in the past.

Thus, identifying a public health problem -- such as the adverse health effects of noise, and then studying the problem, e.g., designing studies, getting funded, collecting data, and analysing the data, becomes more complex. Epidemiologic studies do not usually deliver answers immediately, much to the chagrin of many, but it is crucial to get the science right for those who suffer as well as for those who have to make decisions on behalf of the public's health.

With noise, people may suffer in silence – that is, the silence of official response and assistance. With smoking, not every smoker falls victim to lung cancer, yet public health and government campaigns target smokers because of the cost to the health care system and those potentially affected by second-hand smoke. Moreover, there is the cost to the health care system by those smokers who develop respiratory or cardiovascular diseases. The effects of smoking are well-advertised and well-studied. Yet people who suffer from the adverse impact of environmental noise are labeled NIMBYs (not in my back yard...), or are told that their numbers are small in relation to the total number of exposed individuals or the population in general, thus their complaints do not appear on the radar of urgent concern by those who make and enforce policy.

However, recent research on noise and its adverse effects on health indicates that people are affected by noise even when they sleep through intrusive sounds. Sleep is so important to the restorative process, people are unaware of the intrusion. They may not necessarily attribute their daytime fatigue or inability to concentrate on the extended exposure to nighttime noise, but the noise intrusions during sleep may indeed cause the sleep disturbance and the resulting changes in daytime concentration and learning performance.

> "Public health experts agree that environmental risks constitute 25% of the burden of disease. Widespread exposure to environmental noise from road, rail, airports and industrial sites contributes to this burden...Epidemiological evidence indicates that those chronically exposed to high levels of environmental noise have an increased risk of cardiovascular diseases such as myocardial infarction. Thus, noise pollution is considered not only an environmental nuisance but also a threat to public health."
> [WHO Regional Office for Europe and the Joint Research Centre of the European Commission. Burden of Disease from Environmental Noise: Quantification of Healthy Life Years Lost in Europe, 2011; European Environment Agency EEA. Good Practice Guide on Noise Exposure and Potential Health Effects. EEA Technical Report No 11/2010]

In its evidence-based analysis of the burden of disease from environmental noise, the World Health Organization included cardiovascular disease, cognitive impairment, sleep disturbance, tinnitus, and annoyance. When there are high levels "of annoyance caused by environmental noise", then it "should be considered as one of the environmental health burdens".
[WHO Regional Office for Europe and the Joint Research Centre of the European Commission. Burden of Disease from Environmental Noise: Quantification of Healthy Life Years Lost in Europe, 2011; European Environment Agency EEA. Good Practice Guide on Noise Exposure and Potential Health Effects. EEA Technical Report No 11/2010 http://www.eea.europa.eu/publications/good-practice-guide-on-noise]

The science regarding the adverse effects of noise on people has advanced significantly during the past few decades, establishing that

> "Noise is an underestimated threat' that can cause many short-term and long-term health problems. Among these problems are: 'sleep disturbance; cardiovascular effects; poorer work or school performance; hearing impairment including tinnitus; aberrations in social behaviour such as aggressiveness and passivity; pain and hearing fatigue; speech problems; and hormonal responses (stress hormones) and their consequences on human metabolism, and immune system problems."
> [WHO/Europe: Noise 2011; see also the WHO NNG for Europe.]

This emphasises another aspect of noise that can affect health and behaviour: noise that is inaudible to the human ear. (ETSU-R-97 does not include inaudible noise effects in its predictions or guidance.) People – while awake or while sleeping – experience both audible and inaudible sound. Because the auditory system does not 'shut down' during sleep, the body continues to experience and react to noise.
[WHO Regional Office for Europe and the Joint Research Centre of the European Commission. Burden of Disease from Environmental Noise: Quantification of Healthy Life Years Lost in Europe, 2011; European Environment Agency EEA. Good Practice Guide on Noise Exposure and Potential Health Effects. EEA Technical Report No 11/2010 http://www.eea.europa.eu/publications/good-practice-guide-on-noise]

> "In the 1960s most of the effects of sound on health and quality of life were already known or at least hypothesized... In the 1970s, the research results were sufficiently reviewed to allow science-based recommendations to be made for policy measures to protect public health. In the last three decades new data have confirmed the earlier insights [and] have made more precise assessments of exposure-response relationships and observation thresholds possible."
> [Passchier-Vermeer W and Passchier WF. Noise exposure and public health. *Environmental Health Perspectives* March 2000; 108[Suppl 1]: 123-131]

Low frequency noise, which can disturb people even when the noise is inaudible, also travels long distances without attenuation, and when a building is affected, LFN can 'bounce' throughout a room, or create 'vibrations' within walls or floors and other building features. Furthermore, any people within the structure can also be affected. LFN is felt through the body, especially the torso. When LFN combines with intermittent noise (e.g., 'thumping' wind turbine noise), a person can experience the effect and react physiologically while asleep, without actually awakening. The effect can also be distressing while the person is awake, because there is no escape from the noise and its effects; and if the LFN is inaudible, the person may be unable to identify the source of the

problem. This is one reason why the effects of wind turbine noise were not fully predicted or anticipated, until more wind turbines were built nearer more homes and other sensitive structures. Then the complaints escalated to a more critical number – as is often the case with public health consequences from environmental pollution.
[Ceranna L; Hartmann G; and Henger M (Federal Institute for Geosciences and Natural Resources, Hannover Germany). *The Inaudible Noise of Wind Turbines*. The Infrasound Workshop, Tahiti, Nov 28 - Dec 2, 2005; van den Berg GP. *The Beat is Getting Stronger: the Effect of Atmospheric Stability on Low Frequency Modulated Sound of Wind Turbines*. Journal of Low Frequency Noise, Vibration and Active Control 2005; 24(1): 1-24; van den Berg GP. *Do Wind Turbines Produce Significant Low Frequency Sound Levels?* 11th International Meeting on Low Frequency Noise and Vibration and its Control, Maastricht, The Netherlands, 30 August - 1 September 2004; Waye K. *Effects of Low Frequency Noise on Sleep.* Noise and Health 2004; 6(23); Pedersen E and Waye KP. *Wind Turbine Noise, Annoyance and Self-Reported Health and Well-Being in Different Living Environments*. Occup Environ Med 2007; 64: 480-486; Alayrac M, Marquis-Favre C, Viollon S, Morel J, and Le Nost G. *Annoyance from Industrial Noise: Indicators for a Wide Variety of Industrial Sources*. J of the Acoustical Society of America 2010 Sept; 128(3): 1128-1139; Bray WR. *Measurement and Sound Quality Issues Concerning Low-Frequency Noise.* Noise-Con 2007, Reno, Nevada, October 22-24 2007; papers presented at the Fourth International Conference on Wind Turbine Noise, Rome, 11-14 April 2011 www.windturbinenoise2011.org]

Interestingly, when ETSU-R-1997 was published, much of this information was available, just not included or alluded to in the report. It appears that ETSU's authors did not consult epidemiologists and experts in the medical fields of sleep and noise nor is there evidence that they reviewed the published research in those fields. This remained consistent throughout further government agency consults on wind turbine noise. As evidenced by convening the Dti Noise Working Group (NWG), wind turbine noise was an identified problem for those living near wind turbine arrays. Yet, even then, government agencies and its noise consultants chose to exclude available expertise. The NWG (and future government consultations) focused on audible noise.

Yet as early as 1982, a NASA Technical Memorandum by Stephens *et al* noted that wind turbine noise affects even those who are indoors; they experience

> *"noise modified by the house structure and may also experience noise-induced building vibration... The recommended goal for designing and siting future machines is that the noise and vibration levels at the receiver location be below the respective perception threshold values when considered with the background noise."*
> [Stephens DG; Shepherd KP; Hubbard HH; and Grosveld FW. *Guide to the Evaluation of Human Exposure to Noise from Large Wind Turbines*. NASA Technical Memorandum 83288, March 1982]

Moreover:

> "Tests were conducted to determined [sic] the threshold of detection for the impulsive 'thumping' sounds which result from blade/tower-wake interactions. This stimulus is believed to be the dominant source of annoyance in large downwind machines... this may be an important noise generation mechanism for both 'upwind' and 'downwind' machines."

Stephens et al continue:

> "Since house structures have many components which are readily excited by noise and which can be coupled, they respond as complex vibrating systems. These dynamic responses are significant because they affect the environment of the observers inside the house... The LF components (below 125 Hz) are thus believed to be most significant... Thus there is an indication that there are significant extra-auditory effects such as noise induced house vibration or that there are localized areas in the houses where the inside noise levels are considerably higher than the limited data indicate."

Thus it is no surprise that ETSU-R-97 has in-built shortcomings, as it maximises allowable noise levels in favour of wind energy development, focuses on audible noise, does not account for the impulsive character of wind turbine noise, and does not account for the low frequency component

of wind turbine noise. Assuming that most people living near sites where wind turbines were later built are unfamiliar with the Stephens *et al* research, it is striking how similar their responses – both physical responses and verbal descriptions – were, back into the 1980s and 1990s, without the benefit of information sharing via the Internet, and how accurate Stephens *et al* were in describing the reactions of those exposed to wind turbine noise. However, one must assume that acousticians in the 1990s would have had familiarity with the Stephens *et al* and related research reports.

In November 2010, Stephen Tromans, QC, of ThirtyNine Essex Street, a firm that often represents the wind energy industry with applications and appeals, wrote:

> "The ETSU-R-97 four stage process is cumulative. Each step relies on the previous step, and everything relies on the first..."

Tromans then acknowledges, in a brief summary of the Weaverthorpe Road, Bradford Appeal decision, that Inspector Ord had emphasised:

> "The measuring is complicated and inexact... sensitive to small physical variations in location of the microphone, and to ambient conditions such as temperature, humidity and rain so that the results of any two sets of background measurements, taken on the same place on different days, are likely to vary."

Furthermore, writes Tromans:

> "Wind turbines have changed dramatically since ETSU-R-97 was drafted... ETSU was not a government report, it was the consensus view of a limited group of experts, produced in the context that existing guidance on noise in BS4142 was not appropriate or adequate for wind farms, and produced a compromise which ETSU itself acknowledges was intended in the public interest to offer a reasonable degree of protection to neighbours without imposing unreasonable restrictions on wind farm development or adding unduly to the costs and administrative burdens on developers and local authorities."

This emphasis on easing the way for development continues today, even with all the caveats mentioned by Tromans:

> "... planning inspectors are generally and unsurprisingly unwilling to depart from ETSU... With one exception, permission for wind farms is hardly ever refused on the basis of noise impact when the inspector has accepted that the development will be ETSU-compliant.
>
> **This is true even 'In the not unlikely event of a flawed background survey..."**
> [Tromans, S, QC. *Assessing the Noise Impacts of Onshore Wind Turbines*. *ThirtyNine Essex Street Environmental and Planning Law Newsletter*, November 2010, pp 3-4] [Emphasis added.]

Because those with medical expertise on noise and health were not included in the Noise Working Group, the endorsement by authorities of ETSU, 'the consensus of a limited group of experts' – acousticians and engineers, an even more select group – leaves the victims of wind turbine noise pollution with little recourse, especially as planning inspectors are so unwilling to depart from ETSU and examine current research and conditions objectively. Yet, although aware of ETSU-R-97 shortcomings, authorities and the wind energy industry remain willing to exploit ETSU regardless of the adverse impact on people's lives.

This further exposes the disconnect between government officials (decision-makers) and their renewable energy policy and the public's adverse experiences with that policy, and the inability or unwillingness of government to amend the policy in order to protect the public's health. Moreover, even as families attempt to cope with the health and financial problems because of wind turbine noise, government officials are apparently content that these families shoulder the burden for the state. It appears as though families who suffer environmental noise pollution are discriminated against, because public officials presume that noise is not a significant problem, other than

annoyance, unaware that the cumulative body of research on noise and health points to a distinct relationship between noise and an adverse impact on health.

**Noise and Sleep**

As discussed previously in this paper, wind turbines emit noise with several characteristics -- a low frequency component, tonal qualities, periodicity or intermittency ('thumping', 'whooshing' as the blades move through the air and pass the tower), and mechanical (the nacelle and the oscillation of the hub) -- several of which individually can create noise that is particularly disruptive. Taken in combination, these characteristics are especially disturbing, and the WHO Guidelines for Community Noise 1999, and its complementary report, WHO Night Noise Guidelines for Europe 2009, recommend lower allowances for noise with these characteristics, particularly at night – regardless of the source.

Epidemiological studies show that

> "noise affects sleep in terms of immediate effects (e.g. arousal responses, sleep stage changes, awakenings, body movements, total wake time, autonomic responses), after-effects (e.g. sleepiness, daytime performance, cognitive function deterioration) and long-term effects (e.g. self-reported chronic sleep disturbance)...Environmental noise may reduce the restorative power of sleep by means of repeatedly occurring activations (so-called sleep fragmentation). Acute and chronic sleep restriction or fragmentation has been shown to affect, among other things, waking psychomotor performance, memory consolidation, creativity, risk-taking behaviour, signal detection performance and risks of accidents."
> [WHO Burden of Disease of Environmental Noise]

> "Environmental sleep disorder", as classified in the International Classification of Sleep Disorders, "of which noise-induced sleep disturbance is an example, is a sleep disturbance due to a disturbing environmental factor that causes a complaint of either insomnia or daytime fatigue and somnolence." [WHO BDEN Report]

According to the WHO Guidelines 1999,

> "... the intermittent character of noise has to be taken into account when setting night-time limits for noise exposure..."
> [WHO Guidelines for Community Noise 1999, p 46]

As recommended in both the WHO Guidelines for Community Noise (1999) and in the WHO Night Noise Guidelines for Europe (2010),

> "in order to prevent sleep disturbances, one should consider the equivalent sound pressure level and the number and level of sound events."
> [WHO BDEN Report]

Yet, the ETSU methodology evens out the intermittent character of wind turbine noise by 'averaging' the noise level, thus actually assigning intermittency less significance rather than accurately representing the fluctuating nature of the noise.

The WHO report also states that the following conditions merit special attention:

1. 'Noise sources in an environment with a low background noise level. For example, night-traffic in suburban residential areas.'
2. 'Environments where a combination of noise and vibrations are produced. For example, railway noise, heavy duty vehicles.'
3. 'Sources with low-frequency components. Disturbances may occur even though the sound pressure level during exposure is below 30 dBA.'

It is significant that:

1. Wind turbine arrays are most often sited in rural areas with extremely low background noise levels, particularly at night;
2. Wind turbine arrays produce noise is characterised by intermittent vibrations; and,
3. Wind turbine arrays produce noise with a low frequency component.

The WHO BDEN Report observes that

> "...since night noise is assessed separately according to Directive 2002/49/EC, it does not appear reasonable when daytime noise and nighttime noise exposures are then combined in a weighted 24-hour indicator. With respect to health effects it would make much more sense to clearly distinguish between real day and night indicators...From a cardiovascular point of view, there is no rationale known for weighing factors such as +5 dB(A) or +10 dB)A) for the evening and night periods of the day. It would be a better approach to consider day and night exposures separately with respect to its effects, particularly for noise sources other than road traffic noise (where the day and night noise levels are usually highly correlated). Studies should also try to distinguish between the exposure of the living room (during daytime) and the exposure of the bedroom (during nighttime)."
> [WHO BDEN Report]

Thus, wind turbine noise deserves particular scrutiny, as the noise is comprised of the components that WHO experts state 'merit special attention' in order to protect health.

As the WHO Guidelines note,

> '... it should be possible to sleep with a bedroom window slightly open... To prevent sleep disturbances, one should thus consider the equivalent sound pressure level and the number and level of sound events.'
> [WHO Guidelines for Community Noise, 1999, p 46]

A wind turbine produces separate sound events as each of its three blades passes the tower, the 'swish' and 'whoosh' that people often cite as unrelenting and even torturous. It is not surprising that many people living near wind turbines complain of impaired sleep as well as other symptoms.

> "Chronic sleep loss is a widespread problem... Sleep is a physiologic recuperative state... our main physiological recuperative state..."
> [Zaharna M & Guilleminault. Sleep, noise and health: review. *Noise and Health* 2010; 12(47): 64-69]

Sleep is crucial to good health and to well being, as well as to task performance. As an example, Mah *et al* found that sleep duration and quality contributes to the performance of athletes. In this study, male basketball players with extended sleep over multiple weeks improved their reaction times, sprint times, shooting accuracy (9%), along with improvements in mood and decreased fatigue. These changes were measured on standardised tests, though the players themselves also reported improved feelings of well-being. Sleep quality and duration were 'beneficial in reaching peak athletic performance'. [Mah C, Mah KE, Kezirian EJ, and Dement WC. The Effects of Sleep Extension on the Athletic Performance of Collegiate Basketball Players. *Sleep* 2011 Jul 1;34(7):943-950]

> "The findings suggest that is important for sleep to be prioritised over a long period of time," and optimal sleep is an overlooked but critical factor in reaching peak performance.

> "Derk-Jan Dijk, professor of sleep and physiology at the University of Surrey, said we should look at sleep in the same way as exercise. 'Getting enough sleep is a positive thing which will help you perform in all aspects of life.'"
> [BBC News | Health. *Sleeping Longer 'Helps Athletes Reach Peak Performance'*, 1 July 2011 http://www.bbc.co.uk/news/health-13974130 accessed last on 13 July 2011]

> "Yet fractured sleep is disturbingly prevalent in our society, partly due to insults from a variety of noises."
> [Dang-Vu TT; McKinney SM; Buxton OM; Solet JM; and Ellenbogen JM. *Spontaneous Brain Rhythms Predict Sleep Stability in the Face of Noise*. Current Biology 10 August 2010; 20(15): R626-627]

**In response to the prevalence of noise-induced sleep disruptions, and because of the "limited appreciation of the importance of sleep disorders and sleep deprivation for individuals and the public health",** the American Academy of Sleep Medicine, the

National Center for Sleep Disorders Research [NCSDR] at the National Institutes of Health (NIH), the National Sleep Foundation, and the Sleep Research Society, asked the Institute of Medicine of the National Academies (Washington, DC) to **review and to quantify "the public health significance of sleep health, sleep loss, and sleep disorders."**
[Colten HR and Altevogt BM, eds. *Sleep Disorders and Sleep Deprivation: an Unmet Public Health Problem.* Committee on Sleep Medicine and Research, Institute of Medicine of the National Academies. Washington, DC: The National Academies Press, 2006] (Emphasis added.)

> [N.B.: "The advances in sleep research are brought together by the multidisciplinary scientific field of somnology, which is devoted to the study of the physiology of sleep, the behavioural dimensions of sleep, and the consequences of sleep loss and sleep disorders on an individual's and the general population's health, performance, safety, and quality of life. As one might expect, somnology brings together experts and specialists in fields that include internal medicine, neurology, nursing, otolaryngology (ear, nose, throat or ENT), pediatrics, psychiatry, psychology, and pulmonology."
> From the Glossary, Colten & Altevogt, IOM Sleep Disorders and Sleep Deprivation, 2006]

The Institute of Medicine concluded that

> "sleep loss and sleep disorders affect an individual's performance, safety, and quality of life. Almost 20 percent of all serious car crash injuries in the general population are associated with driver sleepiness, independent of alcohol effects." [Colten & Altevogt, IOM, p 137, ch 4: *Functional and Economic Impact of Sleep Loss and Sleep-Related Disorders*]

> "Compared to healthy individuals, individuals suffering from sleep loss, sleep disorders, or both are less productive, have an increased health care utilization, an increased likelihood of accidents" [p 137, ch 4 IOM], and a reduction in quality of life due to "nonrestorative sleep and excessive daytime sleepiness."
> [Colten & Altevogt, IOM, p 151, ch 4: *Functional and Economic Impact of Sleep Loss and Sleep-Related Disorders*]

The IOM's review found that, indeed,

> "nearly all types of sleep problems are associated with performance deficits in occupational, education, and other settings. The deficits include attention, vigilance, and other measures of cognition, including memory and complex decision making ... The prevailing view until the 1990s was that people adapted to chronic sleep loss without adverse cognitive effects...
>
> More recent research has revealed sleep loss-induced neurobehavioral effects, which often go unrecognized by the affected individuals. The neurobehavioral impact extends from simple measures of cognition (i.e., attention and reaction time) to far more complex errors in judgment and decision making... [p 138, ch 4 IOM] This includes a decline in short-term recall of working memory, a reduction in learning cognitive tasks, slower response time, involuntary microsleeps, and unstable attention to intensive tasks, with increased errors of omission and commission." [Colten & Altevogt, IOM, p 138, 140, ch 4: *Functional and Economic Impact of Sleep Loss and Sleep-Related Disorders*]

What the IOM found most striking was that:

> "**... subjects remained largely unaware of their performance deficits.**"
>
> [Colten & Altevogt, IOM, p 142, ch 4*: Functional and Economic Impact of Sleep Loss and Sleep-Related Disorders*] [Emphasis added.]

With implications for public safety and work settings, two large and well-designed studies found that:

> "sleep-related fatigue is an independent risk factor in work-related injuries and fatalities."

> [Colten & Altevogt, IOM, p 149, ch 4: *Functional and Economic Impact of Sleep Loss and Sleep-Related Disorders*]

The consequences of sleep disturbance also disrupt families and communities, because the impacts extend to the health and well-being of partners and family members; and daytime sleepiness, inadequate sleep, and other sleep disorders

> "place a significant burden on the health care system through increased utilization of the health care system."

Thus,

> "the indirect costs associated with sleep loss and sleep disorders also result in billions of dollars of annual expenditures, including costs associated with illness-related morbidity and mortality, absenteeism, disability, reduction or loss of productivity, industrial and motor vehicle accidents, hospitalization, and increased alcohol consumption."

The IOM reports that a study published in 2001 revealed that:

> "sleep-related fatigue costs an estimated $150 billion per year to businesses in absenteeism, workplace accidents, and other lost productivity."
> [Colten & Altevogt, IOM, p 153, 155, 158, ch 4: *Functional and Economic Impact of Sleep Loss and Sleep-Related Disorders*]

Although not all these sleep disturbances are due to noise, these findings indicate the importance of sleep and its protection from disruption by noise. Sleep disturbance caused by noise is not only a significant health problem for the individual, but also one with substantive implications for the individual's family, the public's health and safety, and for public health policy. Moreover, as populations increase, there is added pressure to urbanise or industrialise new areas, including agricultural land and forests; thus, the percentage of people affected increases.

According to WHO, the less affluent *'are likely to suffer disproportionately'* because they have less financial flexibility and therefore less mobility to escape the noise impacts.
[WHO/Europe: *Noise: Facts and Figures*, 2011 http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/noise/facts-and-figures]

Noise creates sleep disturbances by affecting

> "the number and duration of nocturnal awakenings; the number of changes in sleep stage; the number of electroencephalographic arousals [EEGs]; global changes in total amount of sleep stages or in their time organization (sleep architecture)."
> [WHO/Europe: *Health Effects of Noise* 2011 http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/noise/facts-and-figures/health-effects-of-noise]

The WHO Night Noise Guidelines for Europe [2009] review in extensive detail the relationship between noise and sleep quality and health.

> "Impaired sleep... is related to a number of diseases... sleep deprivation is definitely a condition that deeply afflicts health."

Moreover, people who are sleep deprived 'typically show dramatic function loss after a few days'.
[European Environment Agency (EEA). *Good Practice Guide on Noise Exposure and Potential Health Effects.* European Environment Agency, EEA Technical Report No 11/2010, p 12 http://www.eea.europa.eu/publications/good-practice-guide-on-noise]

During sleep, the body begins to react to intruding sounds at a low level, 33 dB(A) $L_{max}$, measured inside the bedroom. Although awakenings or interference with the stages of sleep are not an ill effect on health in themselves,

> "they are considered significant early warning signals when the incidence starts to rise above background"

– i.e., above the norm for spontaneous non-noise related reactions. [European Environment Agency (EEA). *Good Practice Guide on Noise Exposure and Potential Health Effects*. European Environment Agency, EEA Technical Report No 11/2010, p 13 http://www.eea.europa.eu/publications/good-practice-guide-on-noise]

People tend to awaken 1 or 2 times per night under normal circumstances, so that 'any increase in awakenings is therefore to be taken seriously'. In addition, because sleep is such a critical restorative physiological function, people tend to suppress awakenings. That is why remembered awakenings remain low 'even at high noise levels'. [European Environment Agency (EEA). *Good Practice Guide on Noise Exposure and Potential Health Effects*. European Environment Agency, EEA Technical Report No 11/2010, p 14 http://www.eea.europa.eu/publications/good-practice-guide-on-noise]

In this regard, Basner et al observe that

> "... decision making should certainly not solely be based on behavioral awakenings, as this outcome measure is too insensitive and relevant noise effects on sleep will be missed... There is enough evidence demonstrating that noise-induced changes in sleep macro- and microstructure relevantly impair restoration **even if they are not accompanied by conscious awakenings**."

The authors acknowledge that:

> "...limit values are not set by scientists but by politicians and legislators. However, we still think that science should guide this process and at least define a decision set for the political decision process. The WHO Night Noise Guidelines for Europe (2009) are a good example in this respect. Here, experts in the field defined consensus L [sub]night ranges that are linked to specific outcomes related to sleep disturbance and health. These will be very helpful and may facilitate consensus among politicians and legislators for the definition of future limit values."
> [Basner M; Griefahn B; and Hume K. Comment on 'The State of the Art of Predicting Noise-Induced Sleep Disturbance in Field Settings'. *Noise and Health* 2010; 12(49):283-285] (Emphasis added.)

In terms of adapting to an intermittent noise intrusion, a study with a population with a mean age of 46.7, found that:

> "...aircraft noise annoyance is very stable through time."

That is, people did not become habituated to the noise over time. Noise with an intermittent character appears to be intrusive and have an adverse impact because of its periodicity. [Kroesen M; Molin E; and Wee B. Determining the direction of causality between psychological factors and aircraft noise annoyance. *Noise and Health* Jan-Mar 2010; 12(46): 17-25]

Other research also supports this finding:

> "For external noise, it appears to be the noise levels of individual events that have the most impact..."
> [Ljung R; Sorqvist P; and Hygge S. Effects of road traffic noise and irrelevant speech on children's reading and mathematical performance. *Noise and Health* 2009; 11(45): 194-203]]

Wind turbines may cause annoyance at night because of the characteristics already described, but if the wind speed and/or direction of the wind changes, so must the pitch of the blades and the direction they face (the nacelle at the hub must rotate). This process, repeated during the night, creates additional intermittent noise events that are unpredictable and may contribute to the intrusive character of wind turbine noise.

Many studies that examine sleep interruption caused by periodic, intrusive noise have used nocturnal airport noise as a basis for data collection because many airports are in or near highly

populated areas. However, some of these studies are applicable also to noise and sleep in general or to sleep disrupted by sudden, or periodic, intrusive noise. For example, one study found that both in the field and in the laboratory:

> "noise-induced sleep fragmentation is associated with performance impairments in a psychomotor vigilance task (PVT) and a memory search task.' The influences of noise on sleep and daytime performance are '... consistent and significant, stressing the potential public health impact of nocturnal noise exposure." [Elmenhorst E-M; Elmenhorst D; Wenzel J; Quehl J; Mueller U; Maass H; Vejvoda M; and Basner M. Effects of nocturnal aircraft noise on cognitive performance in the following morning: dose-response relationships in laboratory and field. *International Archives of Occupational and Environmental Health* Oct 2010;83(7): 743-751]

> "Studies on sleep disturbance in children and in shift workers clearly show the adverse effects such as increased accidents on the following day." [Kim R and van den Berg M. Summary of Night Noise Guidelines for Europe. *Noise and Health* 2010; 12(47): 61-63]

There are those who suggest that wind turbine noise is more benign than other noise sources, based on its mitigation over distance and wind energy's renewable energy credentials, thus encouraging policy to favour wind turbine schemes (see ETSU-R-97 and PPS22, among other official documents, and Planning Inspectorate appeal decisions). Yet, the physics of wind turbine noise, and the impact of this noise on those nearby, are no different from other noise sources with shared characteristics, nor on the adverse impact on those living with the prolonged exposure. The suggestion that wind turbine noise is somehow less intrusive is unsubstantiated by peer-reviewed research regarding noise and its adverse effects on sleep, cognition, performance, and health.

The WHO Guidelines for Community Noise (1999), a report by a multidisciplinary and internationally renown panel of experts summarising current research, noted that:

> "Special attention should also be given to the following considerations... Noise sources in an environment with a low background noise level... [and] Sources with low-frequency components. Disturbances may occur even though the sound pressure level during exposure is below 30 dBA...
>
> ... it should be possible to sleep with a bedroom window slightly open (a reduction from outside to inside of 15 dB). To prevent sleep disturbances, one should thus consider the equivalent sound pressure level and the number and level of sound events."
> [WHO Guidelines for Community Noise 1999. Chapter 3: *Adverse Health Effects of Noise*, Section 3.4: *Sleep Disturbance*, p 46]

In 2010, the European Environment Agency [EEA] published its 'Good Practice Guide on Noise Exposure and Potential Health Effects' [EEA Technical Report No 11/2010], which presents research findings that wind turbines are second only to aircraft with respect to annoyance; road, rail, and industry are considered less annoying than either aircraft or wind turbines:

**Table 6.1 Comparison of $L_{den}$ values for different sources with respect to annoyance**

**Percentages of highly annoyed**

| $L_{den}$ | Road | Rail | Aircraft (revised estimate) | Industry | Windturbine |
|---|---|---|---|---|---|
| 55 dB | 6 % | 4 % | 27 % | 5 % | 26 % |
| 50 dB | 4 % | 2 % | 18 % | 3 % | 13 % |
| 45 dB | 1 % | 0 % | 12 % | 1 % | 6 % |

[Lden = day-evening-night equivalent sound]

> "As for the Lden threshold of 55 db, it should be noted that this does not take into account the differences that exist between sources. Lden = 55 db is a fair threshold for railway noise, but for other sources this leads to an underestimate of the actual burden. [See Table 6.1, above] This shows that a sensible approach for action planning is to make a distinction between sources when assessing the magnitude of the impact on the population."
> [European Environment Agency (EEA). *Good Practice Guide on Noise Exposure and Potential Health Effects*. European Environment Agency, EEA Technical Report No 11/2010, p24 http://www.eea.europa.eu/publications/good-practice-guide-on-noise]

**Annoyance depends on the noise source, and for some sources, e.g., transport noises,**

> "the thresholds are taken to be the same." **However, this is not true for "special noise sources like wind-turbines and shunting yards."**
> [EEA *Good Practice Guide*, 2010, p 9]

**As noted also with road traffic and railway noise,**

> **"increased low frequency noise" leads to an "increase in annoyance", and "vibrations could increase annoyance."** [EEA *Good Practice Guide*, 2010, pp 9, 10 EEA] (Emphasis added.)

The EEA's Good Practice Guide on Noise Exposure and Potential Health Effects was published

> "to assist policymakers, competent authorities and any other interested parties in understanding and fulfilling the requirements of the EU Directive and was based on reviews by WHO, professional organizations, and national health departments."
> [EEA Good Practice Guide, 2010, p 24; the Directive refers to the EU Directive on Environmental Noise [END], 2002/49/EC]

Policymakers and authorities are supposed to consider 'dose-effect' relationships, which highlight

> "the potential harmful effects of noise in the population." This "should then inform the 'action planning' process in order to mitigate or reduce any harm to the population under consideration." [EEA Good Practice Guide, 2010, p 24; see also Annex III of END]

Not only should a noise action plan include 'dose-effect' relationships, the plan should also

> "make a distinction between sources when assessing the magnitude of the impact on the population." [EEA, 2010, p 24]

Furthermore, one must use

> "caution against indiscriminate use (e.g., in small populations) and alertness to ethical objections when dealing with DALYs, vulnerable groups and exposure to extreme noise levels."
> [EEA, 2010, p 25; DALY = Disability Adjusted Life Years]

**In other words, even small populations deserve the same consideration and protection as larger groups. Wind turbine noise does not stop at night when other industries near homes may lie idle (possibly because of planning and noise conditions). Wind turbine noise radiates 24/7 for 20 to 25 years, the estimated life of each turbine.**

The EEA Good Practice Guide reiterates the WHO Night Noise Guidelines for Europe:

> "Night is a special period which merits its own indicator... In recent times it has frequently been suggested in the scientific community that Lnight should be accompanied by an additional indicator that accounts for the maximum noise level and/or the number of events." [EEA, 2010, p 34]

Thus, the EEA Good Practice Guide focuses on ways in which noise action plans account for the unwanted effects of noise. As the guide notes, the adverse effects of noise

> "occur when intended activities of the individual are disturbed... The sound level of the acoustic stimulus, its psycho-acoustical sound characteristics, the time of its occurrence, its time course, its frequency spectrum and its informational content modify the reaction." [EEA, 2010, p 5]

The EEA Guide continues:

> "During sleep, however, unconscious activation of the autonomous nervous system takes place without cortical (cognitive) control, due to direct interaction between the hearing nerve and higher structures of the central nervous system." [EEA, 2010, p 5]

That is, the auditory system functions even during sleep, even if an individual sleeps through the disruption.

> "If a certain population is exposed to substantial noise, many people will notice it and develop adverse feelings to this... Victims of noise pollution may experience annoyance, connected to feelings of 'discomfort, anger, depression and helplessness... Within a part of this exposed population, stress reactions, sleep-stage changes and other biological and biophysical effects may occur. These in turn increase risk factors like blood pressure.'" [EEA, 2010, pp 5, 9]

Some of the adverse health effects of noise are summarised in the following chart:

**Table 2.1 Effects of noise on health and wellbeing with sufficient evidence**

| Effect | Dimension | Acoustic indicator * | Threshold ** | Time domain |
|---|---|---|---|---|
| Annoyance disturbance | Psychosocial, quality of life | $L_{den}$ | 42 | Chronic |
| Self-reported sleep disturbance | Quality of life, somatic health | $L_{night}$ | 42 | Chronic |
| Learning, memory | Performance | $L_{eq}$ | 50 | Acute, chronic |
| Stress hormones | Stress Indicator | $L_{max}$ $L_{eq}$ | NA | Acute, chronic |
| Sleep (polysomnographic) | Arousal, motility, sleep quality | $L_{max, indoors}$ | 32 | Acute chronic |
| Reported awakening | Sleep | $SEL_{indoors}$ | 53 | Acute |
| Reported health | Wellbeing clinical health | $L_{den}$ | 50 | Chronic |
| Hypertension | Physiology somatic health | $L_{den}$ | 50 | Chronic |
| Ischaemic heart diseases | Clinical health | $L_{den}$ | 60 | Chronic |

**Note:** * $L_{den}$ and $L_{night}$ are defined as outside exposure levels. $L_{max}$ may be either internal or external as indicated.
** Level above which effects start to occur or start to rise above background.

[EEA, 2010, p 8]

A cross-sectional study of wind turbine noise and health-related quality of life underscores the heightened impact of wind turbine noise compared to other noise sources. The study, conducted by Shepherd *et al*, was not limited to nor did it emphasise wind turbine noise over other sources. Instead, study participants were queried on noises they found annoying, indicating their degree of noise sensitivity and the effects on amenity. Using the brief version of the World Health Organization quality of life scale:

> "Statistically significant differences were noted in some HRQOL (Health-Related Quality of Life) domain scores, with residents living within 2 km of a turbine installation reporting lower overall quality of life, physical quality of life, and environmental quality of life. Those exposed to turbine noise also reported significantly lower sleep quality, and rated their environment as less restful."

> [Shepherd D, McBride D, Welch D, Dirks KN, and Hill EM. Evaluating the Impact of Wind Turbine Noise on Health-Related Quality of Life. *Noise and Health* 2011;13:333-9]

Furthermore, the authors also found that:

> "Specifically, those residing in the immediate vicinity of a wind farm scored worse than a matched comparison group in terms of physical HRQOL and environmental QOL, and HRQOL in general. No differences were found in terms of psychological and social HRQOL, or in self-rated health. The high incidence of annoyance from turbine noise in the turbine group is consistent with the theory that exposure to wind turbine noise is the cause of these differences."

Study participants who cited wind turbine noise as more annoying also scored lower on sleep satisfaction ratings, "suggesting that both annoyance and sleep disruption may mediate the relationship between noise and HRQOL. These findings are consistent with those reported in relation to aviation noise and traffic noise."

As the authors note, previous research indicates that:

> "... for equivalent noise levels, people judge wind turbine noise to be of greater annoyance than aircraft, road traffic, or railway noise. This may be due to the unique characteristics of turbine noise, that is, clusters of turbines present a cumulative effect characterized by a dynamic or modulating sound as turbines synchronise. The characteristic swishing or thumping noise associated with larger turbines is audible over long distances, up to 5 km and beyond in some reports. van den Berg showed that sound is the most annoying aspect of wind turbines, and is more of a problem at night."

Moreover, the authors note that the number of people exposed is significant and increasing as wind turbine installations increase:

> "For example, in the Netherlands it is reported that 440,000 inhabitants (2.5% of the population) are exposed to significant levels of wind turbine noise. Additionally, policy makers are demanding more information on the possible link between wind turbines and health in order to inform setback distances... Thus, nations undertaking large-scale deployment of wind turbines need to consider the impact of noise on the HRQOL of exposed individuals. Along with others, we conclude that night-time wind turbine noise limits should be set conservatively to minimize harm, and, on the basis of our data, suggest that setback distances need to be greater than 2 km in hilly terrain."
> [Shepherd D, McBride D, Welch D, Dirks KN, and Hill EM. Evaluating the Impact of Wind Turbine Noise on Health-Related Quality of Life. *Noise and Health* 2011;13:333-9]

**Noise and Cognition, Learning, and Memory**

The WHO BDEN report notes that:

> "Over 20 studies have shown negative effects of noise on reading and memory in children: epidemiological studies report effects of chronic noise exposure...Tasks affected are those involving central processing and language, such as reading comprehension, memory and attention. Exposure during critical periods of learning at school could potentially impair development and have a lifelong effect on educational attainment."

In some situations, children recover deficits when they are removed from the source of the noise, or if the noise ceases.

Sleep disturbance caused by noise negatively affects cognitive performance, e.g., one's ability to learn, read, or concentrate on a task, which can result

> "in a reduction in the productivity at work and the learning performance at school."
> [World Health Organization. WHO/Europe: Health Effects of Noise 2011.

> http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/noise/facts-and-figures/health-effects-of-noise]

For example, researchers have found that

> "chronic exposure to aircraft noise has a negative effect on children's performance on tests of episodic memory."
> [Matheson M; Clark C; Rocio M; van Kempen E; Haines M; Barrio I; Hygge S; Stansfeld S. The effects of road traffic and aircraft noise exposure on children's episodic memory: the RANCH Project (Applied aspects of auditory distraction) (Report). *Noise and Health* 2010; 12(49): 244-254]

Ljung et al (2009) also found that

> "Older primary school children, around 11 years of age, appear to be more affected by noise than the younger children."

The authors reiterate the findings that individual (or intermittent) noise events might be "the most important in affecting children's performance"; they suggest that "loud short events are the main problem with road traffic noise", e.g., trucks passing by. [Ljung et al 2009] A notable and often cited characteristic of wind turbine noise highlights the repetitive 'thumping' or 'whooshing' sounds, which are also loud, short events, recurring as each of the three blades passes the tower.

Yet another study, by Jones *et al*, replicates this result, finding that "the distraction from a single sound (one deviating from a prevailing sequence) results in attentional capture", which may adversely affect ones' recall of material being learned at that time.

> "Changing-state sequences were more disruptive than a steady-state sound because the change kept evoking capture" [i.e., diverting the attention of the person] "whilst with a steady-state sound, repetition resulted in habituation of the capture response."

Indeed, the authors found that the effect of these 'changing-state' sounds did not diminish nor were the subjects habituated to the noise, as the authors expected.

Instead, the subjects were increasingly affected by the 'changing-state' sequences. Furthermore,

> "the better participants were at the passive sequence processing task, the more disrupted they were by irrelevant sound."
> [Jones D; Hughes R; Macken W. Auditory Distraction and Serial Memory: the Avoidable and the Ineluctable. *Noise and Health* 2010; 12(49): 201-209]

Thus, schools near sources of noise with an 'intermittent' character present different problems than those subject to (possibly) less intrusive continuous sounds. However,

> "children do not spend all of their time within the school environment, and consequently, whether they are exposed to noise at home, may be an important determinant of whether they exhibit cognitive impairments... there is evidence that exposure to nighttime road traffic noise can adversely affect children's sleep quality and is associated with daytime sleepiness."
> [Matheson M, Clark C, Rocio M, van Kempen E, Haines M, Barrio I, Hygge S, and Stansfeld S. The effects of road traffic and aircraft noise exposure on children's episodic memory: The RANCH Project. (Applied Aspects of Auditory Distraction) (Report). *Noise and Health* 2010;12(49):244-254]

In some rural areas, where wind turbines are usually sited, children may both live and attend school near this source of 'distracting' noise. If noise interferes with learning, these types of impairments may have lifelong implications for a child's academic achievement and career opportunities, as well as for health, well-being, and quality of life.

Although WHO emphasises the adverse effects of noise on children and older adults, e.g., on their cognitive performance, research by Van Gerven *et al* found that in terms of annoyance,

> "relatively young as well as relatively old individuals report less annoyance than people of intermediate ages do."

Using a long-term, extensive, international dataset, the authors found that

> "... one potential determinant of age-related noise annoyance is the average level of mental workload or cognitive challenge a person experiences in daily life. High average workload may limit the ability of a person to adapt to uncontrollable environmental noise.
>
> ... Although cognitive performance can be maintained in noise by investing more mental resources, this leads to an increased physiological stress response ... the disturbing effects of a stressor may continue even after the stressor has disappeared. These 'after effects' might lead to a continuous lack of resources required to cope with noise and other stressors, and thus to continuously elevated levels of annoyance."

The authors' conclusions have public health implications for environmental noise decision-making because

> "... those age groups that supposedly are most resilient to environmental noise are, on balance, most vulnerable to it [i.e., the middle aged population, particularly those in their 40s]. This age-related vulnerability may also apply to effects of noise on health."
> [Van Gerven PWM; Vos H; van Boxtel MPJ; Janssen SA; and Miedema HME. Annoyance from Environmental Noise across the Lifespan. *JASA Journal of the Acoustical Society of America* July 2009; 126(1): 187-194]

Although some studies have speculated that noise sensitive individuals may have mental health issues such as depression (though the 'direction' of cause and effect are not clear), and that women may report more noise sensitivity than men, in a comprehensive study Schreckenberg *et al* found that "noise sensitivity is associated with self-reported physical health but not with reported mental health."

The authors also found that there was little evidence that noise sensitivity [NS]

> "affects the perception of general environmental quality in general. This indicates that NS is more specific and therefore a reliable predictor of responses to noise rather than a predictor of the way in which people perceive the environmental quality in their residential area in general."

Both men and women identify intrusive noise, e.g., airport noise, as a source of annoyance, and this is not due to mental health issues or other environmental factors. [Schreckenberg D; Griefash B; and Meis M. The associations between noise sensitivity, reported physical and mental health, perceived environmental quality, and noise annoyance. *Noise and Health* 2010; 12(46): 7+] The annoyance or sensitivity is due to the noise itself.

**Noise and Health**

The auditory system does not have an on/off switch. People, both those who hear or those who are hearing impaired, can feel the vibrations produced by sound. Noise – both what one hears and does not hear – may harm one's health. Noise may affect those sleeping even in those subjects tested for EEG awakenings (EEG=electroencephalogram). Significantly, although "clear subjective habituation" occurs for people after a few nights exposure to noise, their autonomic responses do not adapt on a long-term basis. One may eventually sleep through noise disturbances, but one's body – the auditory system and one's physiologic responses – continue to respond to these external noise events. [EEA Good Practice, 2010, p 14 http://www.eea.europa.eu/publications/good-practice-guide-on-noise ]

Non-auditory noise has a physiological effect:

> "either directly through synaptic nervous interactions, or indirectly through the emotional and the cognitive perception of sound... The auditory system is

> continuously analysing acoustic information, which is filtered and interpreted by different cortical and sub-cortical brain structures...In the long run, chronic noise stress may affect the homeostasis of the organism...Noise is considered a nonspecific stressor that may cause adverse health effects in the long run. Epidemiological studies suggest a higher risk of cardiovascular diseases, including high blood pressure and myocardial infarction, in people chronically exposed to high levels of road or air traffic noise." [EEA Good Practice, 2010, p14]

Studies on these sources have been ongoing for many years because of the numbers of people exposed, especially in urban settings. Duration of exposure is also a factor, and those living near wind turbines are exposed for many hours of the day (and significantly, at night), over a period of many years. Furthermore, wind turbine noise has also been found more annoying than road noise, so these findings may well have a relationship to the adverse effects of wind turbine noise. Additionally, wind turbine noise is characterised by peaks and troughs ('whooshing', 'thumping'), and low frequency noise, and in some circumstances, amplitude modulation. Thus, one might expect that wind turbine noise similarly affects the health of those exposed to environmental noise sources that share those characteristics. [WHO BDEN]

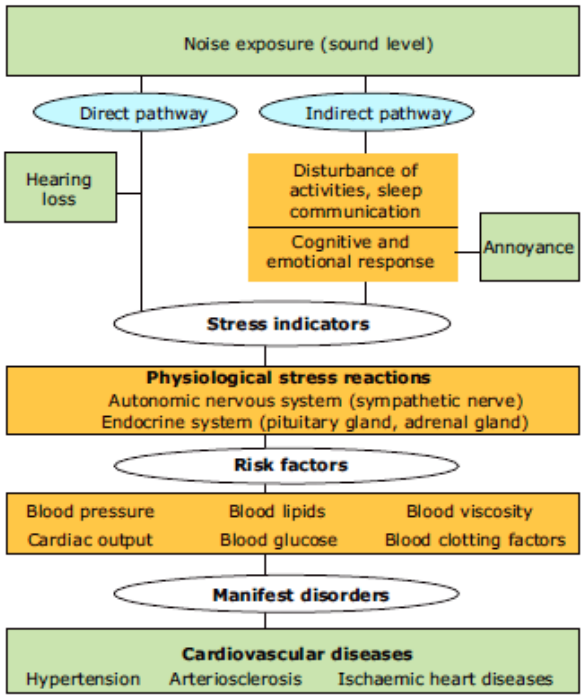
Ischaemic heart diseases "include angina, acute myocardial infarction, subsequent myocardial infarctions and complications of infarctions, other acute forms of ischaemic heart disease and chronic ischaemic heart disease". Essential hypertension includes "hypertensive heart failure, hypertensive renal disease and hypertensive heart and renal disease". [WHO BDEN]

Yet, protecting people from exposure to loud noise is often the focus of regulation, although acute noise effects occur

> "at relatively low environmental sound levels when certain activities such as concentration, relaxation or sleep are disturbed... the long-term exposure to noise may lead to health effects through the pressure on the organism via the stress effects... Both laboratory and field studies suggest that there is 'a biological pathway between the exposure to noise, via the stress mechanism to cardiovascular diseases." [EEA Good Practice, 2010, p 14]

Babisch addresses this 'cascading' effect, summarised in this chart:

**Simplified Noise Effects Reaction Scheme**



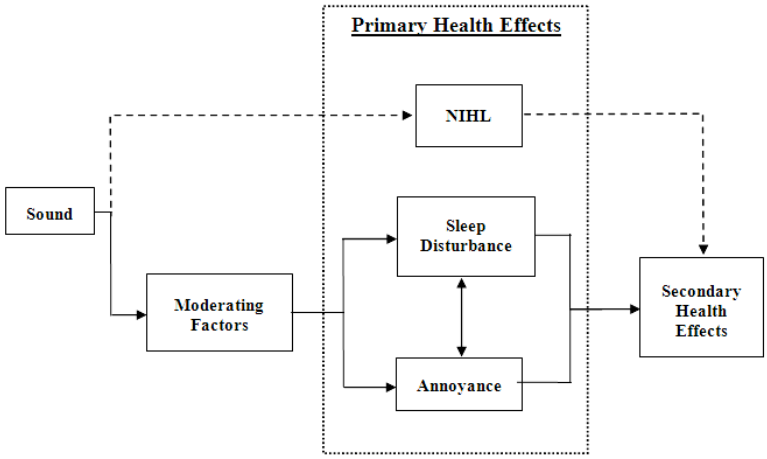

[Babisch, W. *The noise/stress concept, risk assessment and research needs*. Noise and Health, 2002; 4(16): 1–11]

The direct pathway is:

> "the direct interaction of the acoustic nerve with other parts of the central nervous system... This is particularly relevant during sleep, where autonomous [i.e., involuntary] responses to single noise events, including changes in blood pressure and heart rate, have been shown in subjects" who indicated that they did not think they were disturbed by noise events during sleep. [EEA Good Practice, 2010, p 14]

In their paper, Shepherd *et al* also illustrate the sequence of the impact of environmental noise on health:

**How Noise Might Compromise Health.**




[Shepherd D, Welch D, Dirks KN, and Mathews R. Exploring the Relationship between Noise Sensitivity, Annoyance and Health-Related Quality of Life in a Sample of Adults Exposed to Environmental Noise. *International Journal of Environmental Research and Public Health* 2010;7:3579-3594]

In the figure, the dashed lines indicate the physical effects of noise, which include Noise Induced Hearing Loss [NIHL], which is not the focus of this paper.

Note the solid lines, emanating from the box labeled Sound, which represent the non-physical effects of noise:

> • "The box labeled "moderating factors" represents the cumulative effect of traits, contextual factors, and noise parameters (e.g., amplitude modulation).
> • Annoyance and sleep disruption act as mediators between predisposing factors and secondary health effects (e.g., health-related quality of life or disease)."

According to Shepherd *et al*,

> "Noise standards emphasize noise level as the primary factor in noise-induced health deficits, however, laboratory and epidemiological findings are increasingly challenging this stimulus-orientated approach, and have instead sought to uncover factors associated with the listener that predict health risk."

In other words, researchers now emphasise the impact of noise on people and study their reactions, e.g., the psychological or psychophysiological processes, rather than concentrating solely on loudness.

In their study on environmental noise, Shepherd *et al* found that there was no association

> "between years of residence and aviation noise annoyance... adverse reactions to noise have not dampened with repeated exposures, that is, there is no evidence of habituation." The authors conclude that "... noise sensitivity can degrade HRQOL through annoyance and sleep disruption, though further research is needed to establish causation and afford greater generalizability."

The authors also note that their

> "...aviation annoyance data are consistent with the mode of transport effect, with severe annoyance ratings reported in studies on road traffic... generally less than aviation and wind turbine noise."

As Shepherd *et al* also note, wind turbine noise was found more annoying than road traffic noise, which was the focus of several long-term studies, and about which there is a large body of data internationally. [Shepherd D, Welch D, Dirks KN, and Mathews R. Exploring the Relationship between Noise Sensitivity, Annoyance and Health-Related Quality of Life in a Sample of Adults Exposed to Environmental Noise. *International Journal of Environmental Research and Public Health* 2010;7:3579-3594]

The EU Noise Directive [END]:

> "recommends evaluating environmental noise exposures on the basis of estimated noise annoyance...People annoyed by noise may experience a variety of negative responses, such as anger, disappointment, dissatisfaction, withdrawal, helplessness, depression, anxiety, distraction, agitation or exhaustion. Furthermore, stress-related psychosocial symptoms such as tiredness, stomach discomfort and stress have been found to be associated with noise exposure as well as noise annoyance. Some public health experts feel that severe forms of noise-related annoyance should be considered a legitimate environmental issue affecting the well-being and quality of life of the population exposed to environmental noise."
> [WHO BDEN Report]

Indeed, recent research indicates that residents living near airports – with their loud and intermittent patterns of noise – do not become accustomed or inured to the noise over time, as one might presume. In fact, epidemiologic studies, with the data replicated across different teams of researchers, find that the annoyance increases over time for those people living near airports. In a study that included data from 34 separate airports, Janssen et al report that:

"No evidence was found for increased self-reported noise sensitivity... Annoyance due to aircraft noise has been recognized by policy makers as a harmful effect in itself that should be prevented or reduced... Furthermore, there is increasing evidence that exposure to aircraft noise contributes to cardiovascular diseases such as hypertension and may affect children's cognitive functioning."
[Janssen SA, Vos H; van Kempen EMM, Breugelmans ORP, and Miedema HME. Trends in Aircraft Noise Annoyance: The Role of Study and Sample Characteristics. *JASA Journal of the Acoustical Society of America* April 2011;129(4):1953-1962]

In the January 2011 issue of the European Heart Journal, Sorensen *et al* found that, in their Danish study population of more than 57,000 people ranging between the ages of 50 and 64:

> "exposure to loud traffic noise is strongly associated with stroke in people aged 65 and older."

The average follow-up time was 10 years. The authors used a noise calculation program that accounted for many factors including those that:

> "could amplify or blunt road noise, including traffic composition and speed, road surface and road type, nearby buildings and the position and heights of homes above the roads."

As noise increased by 10 decibels, a person's stroke risk rose 14% for all age groups. For those under 65 years old, the risk was not statistically significant. However, for those 64.5 and older, the rise was significant: the risk of stroke for this group rose 27% for every additional 10 decibels of noise. Although this was the first study to examine road noise and stroke, Sorensen *et al* were not surprised by the association between the two, because other studies have found traffic noise associated with other cardiovascular diseases.
[*Loud Road Noise Linked to Stroke in Older Adults*. US National Library of Medicine, National Institutes of Health, MedlinePlus, January 26, 2011]

Sorensen *et al* believe that noise provokes the stress response and disturbs sleep,

> "which might increase the risk for stroke, through mechanisms including increased level of stress hormones, increased heart rate and blood pressure and impaired immune system."
> [Sorensen M, Hvidberg M, Andersen ZJ, Nordsborg RB, Lillelund KG, Jakobsen J, Tjonneland A, Overvad K, and Raaschou-Nielsen O. Road Traffic Noise and Stroke: a prospective cohort study. *European Heart Journal* 2011 Mar;32(6):737-744]

As Sorensen *et al* note, other recent research does indicate an association between cardiovascular effects and environmental noise. The cardiovascular effects studied include hypertension, myocardial infarction, coronary heart disease (ischemic heart disease), and cardiac mortality. In a review of UK data and research on this issue, Stansfeld and Crombie found:

> "There is some evidence of an association among environmental noise exposure and hypertension and ischemic heart disease in the UK studies; further studies are required to explore gender differences, the effects of day and night time exposure, and exposure modifying factors."
> [Stansfeld S and Crombie R. Cardiovascular Effects of Environmental Noise: Research in the United Kingdom. *Noise and Health* 2011 May-June 2011;13(52):229-233]

Other studies have also found that noise "has an influence on the normal functioning of the cardiovascular, endocrinal, metabolic, gastrointestinal and neurological systems." [Goyal S, Gupta V, Walia L. Effect of Noise Stress on Autonomic Function Tests. *Noise and Health* 2010;12(48):182-186]

Stansfeld and Crombie concur that in the UK, as in other European countries,

> "environmental noise is a pervasive problem... the quiet period during the night, without transport noise, has become shorter as demonstrated in a comparison of recent national noise surveys... There were no differences between men and women for aircraft noise at night and risk of hypertension... people with an existing disease might be more vulnerable to noise effects and that higher annoyance responses in the absence of any disease may be a risk factor for hypertension...
>
> Although the auditory effects of noise on humans have been established, the non-auditory effects are not so well established. The emerging links between noise and cardiovascular disease [CVD] have potentially important implications on public health and policy."
> [Stansfeld S and Crombie R. Cardiovascular Effects of Environmental Noise: Research in the United Kingdom. *Noise and Health* 2011 May-June 2011;13(52):229-233]

Other researchers reiterate the significance of auditory stimuli and their impacts on sleep:

> "even if the incoming stimulus does not awaken the sleeper, it may produce a brief-lasting micro-arousal."
> [Muller-Gass A and Campbell K. The Processing of Infrequently-Presented Low-Intensity Stimuli during Natural Sleep: An Event-Related Potential Study. *Noise and Health* 2010;12(47):120-128]

This analysis has additional implications for wind turbine noise and health and public policy, because:

> "The extremely low-frequency nature of wind-turbine noise, in combination with the fluctuating blade sounds, also means that the noise is not easily masked by other environmental sounds."
> [Punch J, James R, and Pabst D. Wind-Turbine Noise: What Audiologists Should Know. *Audiology Today* 2010 Jul-Aug, pp 20 – 31]

What you cannot see may harm you: wind turbine noise has been a source of complaints for at least as long ago as 1993 (ergo, ETSU-R-97; and as described in the research of Shepherd *et al* for NASA, published in 1982). Yet, government and its teams of consultant acousticians have apparently made no effort to contact or interview victims, or those who would be affected by wind turbine schemes, or make any effort to devise even a pilot clinical study.

One might say that wind turbine noise is 'just' noise. That is, there is substantial evidence that wind turbine noise does not deserve special dispensation for more lenient guidance than other sources of environmental industrial noise pollution. This is especially important to note, because wind turbine noise contains several characteristics that make the noise particularly intrusive, especially during sleep, noise that WHO says merits 'special attention'. And more recent research suggests that rather than diminishing, annoyance caused by environmental noise sources increases over the years. Yet, the wind energy industry persists in refuting the link between wind turbine noise and health, even though ongoing research continues to support and reinforce the link between noise and its adverse effects on sleep and health.

### 3.2 WIND TURBINE NOISE: CLINICAL STUDIES AND COUNTERCLAIMS

This paper presents some of the available evidence-based research substantiating the negative impacts of noise on healthful sleep and other essential activities, e.g., cognition, learning, and performance of tasks. Moreover, continued interference with sleep disrupts important physiological functions, which over time may lead to chronic and long-term effects on the body, such as physiologic stress, anxiety, increased cortisol production, headache, elevated blood pressure, and cardiovascular diseases. Sleep disruption, fragmentation, and deprivation do not allow the body to benefit from essential restorative sleep.

Noise is frequently a causative factor in sleep disturbances; even if one sleeps through noise events, one's body still responds because the auditory system does not stop functioning during sleep, affected by the loudness and character of the noise, especially intermittent events or low frequency noise components.

Ever since industrial wind turbines were first sited near homes and other sensitive facilities, their noise has been a source of complaint. Shepherd *et al* addressed this issue as early as 1982, and more recently, presenters at the Fourth International Conference on Wind Turbine Noise focused on this very topic. [Fourth International Conference on Wind Turbine Noise, Rome 11—14 April 2011 www.windturbinenoise2011.org]

Although most research articles focus on noise from airports and roads, largely because of the urban impacts and the number of those affected, there is a growing body of research related specifically to wind turbine noise, appearing in the journal literature as well as at conferences. Van den Berg, Pedersen, Waye, Aitken, and others have published journal articles identifying some of the acoustic, psychological, and social factors that are as important as the political and climate issues. Unfortunately, with constraints on funding, with more limited populations affected (though arguably larger swathes of land per unit of electricity produced), wind turbine noise has not yet attracted the same funding opportunities as other types of environmental pollution. Moreover, because it can take years for epidemiologic research to provide results, studies relating to airport and road noise have a longer history of research projects and programmes, because these also have more impact on the economic implications for policy and planning on a national basis.

Because of renewable energy targets, wind turbine noise has benefitted from more lenient treatment and more generous allowances than other sources of industrial and environmental noise pollution. (Note that the renewable targets do not specify actual electricity production, only installed capacity.)

Even with these advantages, not to mention significant financial and tax incentives and subsidies, the wind energy industry contends that there is no evidence that wind turbine noise has adverse effects on health. The industry also suggests that any research of value would address wind turbine noise only and its effects on health, without generalisation from other noise sources. Yet, the industry is also quick to dismiss any efforts to provide clinically specific data about wind turbine noise.

However, several clinical studies that specifically address wind turbine noise are available, each building on, complementing, and expanding our understanding of the impact on people, their quality of life, and long-term effects on sleep and health. Drs Harry, Pierpont, Laurie, and Nissenbaum are among those who have studied the affected populations. Other experts have reviewed available research in order to analyse and summarise current knowledge, e.g., Drs Hanning, Shepherd, and Salt, and Mr James, all with expertise in relevant areas of medicine and psychoacoustics.

One of the first, if not the first, evolved from the clinical observations by a physician in Cornwall, UK, Dr Amanda Harry, observed a pattern of similar clinical issues emerging from a population living near recently commissioned wind turbines. Dr Harry was concerned not only with her patients' health; she also saw the public health issues involved, realising the ramifications for others, i.e., those already affected by wind turbine noise as well as those who live near proposed or potential sites and who might then experience diminished well-being and long-term health injury.

It is distressing to patients when they develop symptoms that occur suddenly and without identifiable causes or likely origin ('idiopathic'), and it is distressing to physicians who must respond to vague or diffuse or seemingly disconnected symptoms. If a patient presents with complaints of sudden onset sleep problems, fatigue, anxiety, inability to concentrate, and possibly depression, a physician may provide medication or other therapy, but neither patient nor physician is addressing the cause: continuous sleep deprivation and disturbance due to noise, in these cases, specifically wind turbine noise. Medication, which has its own side effects, merely masks the cause and exposes patients to unnecessary medications and potential side effects, yet the physician may have no option when the patient is in distress while living where wind turbine noise is unavoidable.

One must credit Dr Harry with identifying a pattern of complaints among those patients living near wind turbines and deciding to design a pilot study to test her hypothesis about wind turbine noise and its possible effects on people living nearby. As with most pilot studies, the Harry wind turbine noise study was limited in scope in order to determine if there was foundation to the premise and if further research was warranted. Dr Harry designed and administered a questionnaire as well as consulted with acousticians and engineers who measured and analysed noise data at wind turbine sites that had been subjects of complaint. The Harry pilot wind turbine noise study did indeed find a relationship between wind turbine noise and health complaints and sleep disturbance, for those within proximity of wind turbines to homes and other sensitive facilities. Dr Harry concluded that the health issues involved were not trivial and shared similarities with findings with more in-depth extensive epidemiological studies on the impacts of noise on health. Therefore, Dr Harry found that there was evidence that deserved further clinical study. [Harry A. *Wind Turbines, Noise and Health*. February 2007 http://www.wind-watch.org/documents/wind-turbines-noise-and-health/]

Although there was a flurry of media coverage about Dr Harry's study, there was no impetus from government environmental health officials or agencies to pursue the issue, i.e., to seek an independent clinical epidemiological study on an issue that might have a widening impact because onshore wind turbine arrays were important components of the then-government's renewable energy policy. The response from the wind energy industry was dismissive, citing that Dr Harry's study had a limited sample size, was not published in a journal, and was not 'peer reviewed'.

Instead, the wind energy industry and its trade association, BWEA (the British Wind Energy Association, now known as RenewableUK), cited the UK Dti report on wind turbine noise, ETSU-R-97, as rebuttal. Yet that guidance, authored by consultants to or employees of the wind energy industry reporting the UK Department of Trade and Industry, was designed to enhance wind turbine development, and did not address health effects, did not address inaudible noise, did not interview those affected by wind turbine noise, and did not include experts on the adverse effects of noise on health. Moreover, the guidance for wind turbine noise, ETSU-R-97, was not published in a journal, was not field or laboratory tested to ascertain actual responses by people, and was not peer-reviewed.

The Harry wind turbine noise study was intended as a pilot study to examine and analyse a clinical question. It was not designed as a full-fledged epidemiological study, which would require more funding and resources than Dr Harry could provide on her own as a concerned and public health orientated physician. Yet, Dr Harry's work was ignored, and government and the wind energy industry continued to pursue an aggressive onshore wind energy policy without consideration for health implications and policy.

Parallel to Dr Harry's observations in Cornwall, in upper New York State (USA), another physician had also identified a similar and perplexing pattern of health complaints. Dr Nina Pierpont, a physician (Johns Hopkins University), who also earned a PhD at Princeton University, did not realise where her problem-solving would lead her, but she, too, suspected recently commissioned wind turbines sites coincided with the onset of symptoms reported by her patients. Dr Pierpont became interested in the Harry wind turbine noise study and decided to design and conduct a study that took the next step, designing and conducting a more complex and extensive study in order to identify, if possible, the health impacts, their extent, and the relationship, if any, with the proximity of wind turbines to homes.

Dr Pierpont's study, *Wind Turbine Syndrome*, is a remarkable accomplishment for an independent researcher, who personally funded her work and conducted the interviews; though note that she did consult with experts as she devised her study and questionnaire designs and as she prepared her manuscript. Pierpont used a peer-reviewed case series cross over study; the data linked exposure to wind turbine noise with symptoms that included sleep disturbances (chronic sleep disruptions and fragmentation), among other adverse health effects. Dr Pierpont made the decision to identify the constellation of symptoms that she observed as 'wind turbine syndrome'. Whether or not one ascribes to wind turbine noise a pattern of symptoms that constitute a 'syndrome', it is undeniable that the clinical complaints she describes correspond with the observations and adverse health impacts experienced by those living near wind turbine sites internationally. Furthermore, the health impacts described and scrupulously analysed by Pierpont also align with other empirical studies on the impact of noise from other sources on sleep and health. [Pierpont N. *Wind Turbine Syndrome: a report on a natural experiment*. Santa Fe, NM: K-Selected Books, 2009]

Pierpont clearly explains the strengths and limitations of her study (qualities shared by all research studies), and her conclusions and recommendations do not overstep her findings. Indeed, Pierpont errs on the side of caution. Among Pierpont's recommendations, which clearly are motivated by ethical concerns for the public's health:

> Physicians practicing near wind turbine installations should incorporate "proximity to turbines into the personal and social history in a neutral and non-suggestive way, especially for the types of symptoms described" in Pierpont's report, *Wind Turbine Syndrome*.
>
> "All turbine ordinances, I believe, should establish mechanisms to ensure that turbine developers will buy out any affected family at the full pre-turbine value of their home, so that people are not trapped between unlivable lives and destitution through home abandonment. By shifting the burden of this expense to turbine developers, I would hope that developers might have a stronger incentive to improve their techniques for noise prediction and to accept noise level criteria recommended by such agencies as the World Health Organization and the International Standards Organization" among others. [Pierpont, 2009]

Pierpont's clinical study has been vigorously and negatively criticised by those in and consulting to the wind energy industry, in place of rational and logical scientific discourse and exchange. Instead of pursuing clinical data from studies in order to devise energy policy that also protects the public's health, government and industry have sought to negate Pierpont's effort to collect, organise, analyse, and study clinical data. Pierpont was criticised because her publication was not peer reviewed, but her study was published as a book, not as part of a journal; the publication process differs. Pierpont submitted her study design and then the manuscript to experts in epidemiology, sleep medicine, and other fields, for comments, critique, and recommendations.

Once again, the reports issued by those with vested interest in the wind energy industry criticised the absence of peer review, yet the authors of those reports – consultants to the wind energy industry – did not interview subjects and/or patients; they did not conduct clinical studies; and their papers were not peer-reviewed.

In the Canadian Wind Energy Association's statement, *Addressing Concerns with Wind Turbines and Human Health*, issued in April 2009, CANWEA said that Dr Pierpont's findings are

> "not supported by scientists who specialize in acoustics, low frequency sound and related human health impacts. It is important to point out that none of the work by Dr Pierpont – or others claiming similar impacts – has been published in peer-reviewed journals. This fact raises questions as to the scientific validity of these assertions."
> [Canadian Wind Energy Association (CWEA). *Addressing Concerns with Wind Turbines and Human Health*. Canadian Wind Energy Association CANWEA, April 2009]

These definitive statements overstep their bounds: first, although there are some scientists who specialize in acoustics, low frequency sound, and related human health impacts who disagree with Pierpont's findings, there are others who do agree; and no doubt there are some who are unsure,

but who would like to see more clinical field research before reaching a conclusion. As pointed out earlier in this paper, there is substantive evidence that noise affects sleep, health, and cognition. Therefore, it is egregious to presume that science has all the evidence it needs to pronounce that there is no peer-reviewed scientific evidence indicating that wind turbine noise adversely affects human health.

Moreover, although CANWEA places inordinate emphasis on the peer-review process, most of the documentation upon which it relies is itself not peer-reviewed, e.g., the reports by its consultants and reports by wind energy consultants in other countries, including the UK. The CANWEA document, for example, cites an article by Leventhall that appeared in a peer-reviewed journal, *Canadian Acoustics*. However, his article was a review article, and did not present the results of new research or clinical study results; moreover, this article was not peer-reviewed (confirmed by personal communication). [Leventhall G. Infrasound from Wind Turbines – Fact, Fiction, or Deception? *Canadian Acoustics* 2006;34(6):29-34,36]

Pierpont designed and executed a pilot clinical study to determine if health issues existed that were related to wind turbine noise and, once this was established, recommend further research to document and elucidate the relationship with larger data sets.

In 2009, also published in *Canadian Acoustics*, Harrison addresses the '*Inadequacy of Wind Turbine Noise Regulations and their Application'*. [Harrison JP (Physics Department, Queen's University, Ontario). Inadequacy of Wind Turbine Noise Regulations and their Application. *Canadian Acoustics* Sept 2009;37:156-158]

In a more recent article on this topic, Harrison notes that

> "... a noise limit of 40 dBA will result in annoyance (rather plus very annoyed) for about 20% of the population subject to that noise level... where rural populations are denser and where turbines are being 'shoe-horned' in, this is a problem...
>
> Noise regulation in the range 40 to 50 dBA allows turbines to be placed within 500 meters of homes and other sensitive receptors. Subsequently, in a significant fraction of such homes, residents are being annoyed, are suffering sleep deprivation and disturbance, and in many cases, are suffering adverse health effects. Yet for other noise sources the limit appears reasonable... there is no possibility of shielding the noise at source. Nevertheless, regulation without compliance testing is unethical.
>
> The characteristics of turbine noise that contribute to annoyance and sleep disturbance are as follows: The sound from turbines is amplitude modulated at the blade passage frequency... Two things arise: The peak sound is higher than the average used for noise regulation and the modulation enhances the audibility of the sound to such an extent that the turbine noise can be detected even when the sound is below ambient.
>
> The noise emitted by a turbine is broadband; however, at a distance of 500 meters and more, the higher frequencies have been absorbed by the atmosphere so that it is predominantly low-frequency noise that reaches a receptor. This low-frequency noise enhances annoyance and is more readily able to penetrate walls and resonate inside rooms."
> [Harrison JP. *Wind Turbine Noise*. *Bulletin of Science, Technology & Society* August 2011;31(4):256-261]

Harrison makes the important point, supported by peer-reviewed research, in contrast with the documents issued by RenewableUK, CANWEA, and AWEA, that

> "... the character of turbine noise makes it especially intrusive. This is exacerbated by the fact that wind turbines are sited in rural areas where the ambient noise level can be about 25 dBA. An intrusion of 15 DBA is too large. Germany has a nighttime noise limit of 35 dBA; this should be the international absolute maximum.
>
> Turbines leave behind them a turbulent wake and a wind speed deficit. Turbulence is known to exacerbate turbine noise... Turbulence occurs naturally in the

> atmosphere but the wake turbulence can equal this natural turbulence out to 5 blade diameters."
> [Harrison JP, *Bulletin of Science, Technology and Society*, 2011, p258-9]

Although ETSU accommodates background noise over which wind turbine noise is allowed, Denmark, The Netherlands, and New Zealand have dropped that allowance. Research has demonstrated that "*the turbine is generating power and noise while at ground level there is insufficient wind to generate masking noise."* [Harrison JP, Bull Sci Tech Soc, 2011, p258-9]

Regarding wind turbine noise and whether it is masked by background noise, the Danish Environmental Protection Act states:

> "In the outdoor areas most affected by the noise, such as residential areas, institutions, summer cottages, allotments, recreational areas and other areas sensitive to noise... limits are based on measurements and calculations of **the exact noise emission** from the wind turbine. **The background noise in not taken into consideration.**"
> [Mortensen BOG. '*Danish Rules on Noise and Related Issues'*, p 215, in Legal Systems and Wind Energy: a Comparative Perspective, eds. Anker HT, Olsen BE, and Ronne A. Energy and Environmental Law and Policy Series, v2. Alphen aan den Rijn: Kluwer Law International, 2009] (Emphasis added.)

Wind turbine noise causes annoyance in about 20% of residents living within the distance that regulations and authorities advise.

> "This is a far larger proportion than for those living with traffic and industrial noise at the same level. The annoyance and adverse health effects are attributable to the character of turbine noise and to deficiencies in noise regulations. Specifically, given the amplitude modulation, the allowed intrusion above ambient is far too high; there is no account taken of uncertainty in the prediction of noise at a home; there is no account taken for the excess noise caused by turbulent inflow, both natural and up-wind turbine wake; and the lack of compliance testing leaves the adverse health effects to compound from one completed wind farm to the next one being designed."
> [Harrison JP, Bull Sci Tech Soc, 2011, p260]

Thus, as counterpoint to the claims of the wind energy industry and its trade associations, Harrison provides a substantive, peer-reviewed discussion of current research that supports Pierpont's (and others) research indicating an association between wind turbine noise and health, based on the characteristics of their noise and the real-life responses of those living near wind turbines.

In 2009, the Public Health Subcommittee of the Maine Medical Association [USA] initiated the first controlled study of adverse health effects related to industrial wind turbines. Dr Nissenbaum, a physician who lead the research, acknowledged the pilot survey weaknesses (as does Pierpont with her pilot study), primarily, a small sample size. However, this is often the case with pilot studies; these types of studies are meant to offer guidance for future questions and directions in research. [Nissenbaum, MA. *Mars Hill Wind Turbine Project Health Effects: Preliminary Findings*. Maine Medical Association, March 2009; see also Nissenbaum MA. *Mars Hill Wind Turbine Project Health Effects: Pilot Study*. Rutland, Vermont, USA, Rutland Regional Medical Center, 6 May 2010; and Nissenbaum M, Aramini J, and Hanning C. *Adverse Health Effects of Industrial Wind Turbines: A Preliminary Report*. 10th International Congress on Noise as a Public Health Problem (ICBEN), London, UK, 24 – 28 July 2011.]

In December 2009, the American and Canadian Wind Energy Associations issued a report, '*Wind Turbine Sound and Health Effects: an expert panel review'*, which was prepared for and published by the AWEA and CANWEA. The authors found no substantive evidence for adverse health effects caused by wind turbine noise. Again, the lack of evidence published in peer-reviewed journals was emphasised. However, this report, albeit authored by physicians and acousticians, was not peer-reviewed; nor was anyone purportedly affected by wind turbine noise interviewed; nor was a basic initial pilot study devised and run. [American Wind Energy Association and the Canadian Wind Energy Association (A/CanWEA). *Wind Turbine Sound and Health Effects: an expert panel review*.

Panel: Colby WD, Dobie R, Leventhall G, Lipscomb DM, McCunney RJ, Seilo MT, and Sondergaard B. A/CanWEA, December 2009]

Meanwhile, physicians are working in communities where patients are experiencing similar and often newly reported problems with sleep and the effects that result from sleep fragmentation; wind turbine noise from newly commissioned wind turbine arrays are often implicated. Impelled by a concern for the health of those in their communities and for distant communities similarly affected, these physicians are making an effort to study and explain these problems.

Not to be discouraged by criticism leveled by the wind energy trade associations and their consultants, following the 2009 pilot study in Maine, *"a larger, more detailed, and standardized controlled study"* of wind turbine noise and its adverse effects on health was undertaken at Mars Hill and Vinalhaven, Maine, using validated questionnaires. Subjects ['exposed'] included 22 adults living within 3500 feet of 28 1.5MW wind turbines (389 feet to blade tip); these 'exposed' subjects were compared with 27 people of similar age and occupation living approximately 3 miles from the site ['non-exposed']. Of the exposed subjects, 82% reported new or worsened chronic sleep deprivation versus 4% (1 subject) in the non-exposed control group. Of those exposed subjects reporting sleep disturbances, 77% reported that they awakened during the night, while 45% had difficulty falling asleep (total of more than 100% due to some subjects problems with both). Of the exposed subjects, 95% perceived reduced quality of life, whereas none (0%) of the non-exposed subjects reported similar responses. [Nissenbaum M. *Wind Turbines, Health, Ridgelines, and Valleys*. Energize Vermont, Montpelier, Vermont, USA, May 7 2010 http://vimeo.com/11577982]

Of the exposed subjects, 100% reported that they had considered moving away. Among the non-exposed subjects, none reported considering a move during that same time. Nissenbaum concluded that based on the study's findings, *"significant risk of adverse health effects are likely to occur in a significant subset of people"* at a distance of at least 2000 metres from industrial wind turbines. As indicated by the results of this pilot study, these major health concerns emerged:

> "Sleep disturbances/sleep deprivation and the multiple illnesses that cascade from chronic sleep disturbance. These include cardiovascular diseases mediated by chronically increased levels of stress hormones, weight changes, and metabolic disturbances... Psychological stresses which can result in additional effects including cardiovascular disease, chronic depression, anger, and other psychiatric symptomatology... [and] increased headaches."
> [Nissenbaum MA. *Affidavit: David McKinnon (Plaintiff) and Red Lily Wind Power Ltd Partnership, Red Lily Energy Corp, Rural Municipality of Martin, and Rural Municipality of Moosomin (Defendants),* Queen's Bench, Judicial Centre of Saskatoon, Saskatchewan, Canada 2010]

The surveys of Mars Hill and Vinalhaven show that:

> "... those living within 1.4km of IWT (industrial wind turbines) have suffered sleep disruption which is sufficiently severe as to affect their daytime functioning and mental health... IWT noise has an impulsive character and is several times more annoying than other sources of noise for the same sound pressure level (Pedersen & Persson Waye 2004). It can prevent the onset of sleep and the return to sleep after a spontaneous or induced awakening. Road, rail and aircraft noise causes arousals, brief lightening of sleep which are not recalled. While not proven, it is highly likely that IWT noise will cause arousals which may prove to be the major mechanism for sleep disruption... The current ordinances determining setback are inadequate to protect the residents and setbacks of less than 1.5km must be regarded as unsafe. Further research is needed to determine a safe setback distance and to investigate the mechanisms of causation."
> [Nissenbaum M, Aramini J, and Hanning C. *Adverse Health Effects of Industrial Wind Turbines: A Preliminary Report.* 10th International Congress on Noise as a Public Health Problem (ICBEN), London, UK, 24 – 28 July 2011]

Dr Sarah Laurie, a physician in southern Australia, has made similar observations among those living near wind turbines in Australia. Although initially in favour of wind turbines because of concerns about man-made climate change, and in favour of the wind turbine development near her home, Laurie became concerned only when a neighbour alerted her to a report by Dr Harry, of the UK. As noted earlier, Harry identified a pattern of symptoms shared by patients who were

unaware of one another and who lived near newly operational wind turbine sites. Shortly thereafter, Laurie became aware of Dr David Iser, a rural Australian physician, from Toora in Victoria, who was inspired to conduct his own study when he identified a cluster of symptoms among his patients living near newly operational wind turbines. However, Laurie discovered that most of the affected subjects in Iser's study had left the area, because some of the former residents' health

> "had been particularly badly impacted" and were "bought out by the developer, but only if they signed confidentiality ("gag") agreements, which specifically prevented them from talking publicly about their health problems."
> [Laurie S. *Submission to the Australian Federal Senate Inquiry on Rural Wind Farms*. 10 February 2011]

Laurie's research and discussions with colleagues internationally revealed that this practice is widespread in countries with industrial wind turbine developments. In late July 2010, Laurie

> "was contacted by Mr Peter Mitchell, who had set up the structure of a not for profit organization he had called the Waubra Foundation, to help further the progress of facilitating and commissioning independent research into the adverse health effects being reported in residents adjacent to wind turbines in Australia."

Laurie joined and is now Waubra's Medical Director. As Medical Director, Laurie conducted interviews with more than 60 affected residents living near wind turbine developments in New South Wales (Cullerin, Crookwell and Capital), Victoria (Toora, Cape Bridgewater, and Waubra), and South Australia (Mt Bryan and Waterloo). Laurie had not read Pierpont's book, and most of the study subjects were unfamiliar with Pierpont and clinical studies on wind turbine noise. Laurie notes that these interviews "are an ongoing work in progress, and are being used to determine future research priorities for independent researchers to pursue."

Symptoms reported primarily include:

> "**Severe chronic sleep deprivation**:
> - from the audible turbine noise,
> - from waking up anxious and hyperalert, in a panicked state, for no good reason, and often a number of times a night. They describe being so instantly awake that it takes a long time to get back to sleep again. These residents often tell me that they cannot hear the audible turbine noise at the time
> - for parents, newly disturbed sleep of their children is an additional contributor to their own sleep deprivation...
> - trying to get to sleep, or back to sleep having been woken up during the night, in a bed which is literally vibrating

> **Severe frequent headaches**
> - describing their head feeling as if it was 'in a vice' [sic]...
> - significant exacerbation of the frequency and severity of their migraines, particularly but not exclusively from shadow flicker...
> - frequent severe headaches in children who have never previously complained of them..."

Laurie, who has visited wind turbine sites, concurs with the descriptions of those living nearby, e.g., *"a loud overhead jet engine, which doesn't ever leave"*; Laurie has observed this effect at a distance of 4 km from the nearest turbine. Laurie notes that the ear does not hear 'averages', it hears the peaks. [Laurie; also Harrison, Ontario Symposium 2010] Laurie's research corresponds with the findings in other studies; among her findings:

> - "Not all adjacent residents are affected
> - Some developments appear to have more seriously affected residents than others
> - Some residents are affected immediately, others are progressively affected over weeks to months of constant exposure
> - Chronic exposure appears to have a cumulative effect
> - Not all symptoms are reversible after chronic exposure, when affected residents move away
> - Elevations of blood pressure associated with proximity to operating turbines are an emerging issue."

> [Laurie S. *Submission to the Australian Federal Senate Inquiry on Rural Wind Farms*. 10 February 2011]

According to the WHO BDEN Report,

> "'No exposure data' does not mean 'no exposure', and 'no scientific evidence' does not mean 'no effect'."

These pilot clinical studies are a crucial step in understanding the impact of wind turbine noise not only on the health and well being of those now living near sites, but also in preventing adverse effects on those living near proposed sites. Rather than dismissing these initial pilot clinical studies as insubstantial, the wind energy industry and government agencies should recognise their usefulness as pilot clinical studies that offer guidance for larger, long-term epidemiological studies.

These initial findings are supported also by advances in the field of psychoacoustics, the scientific study of sound perception by the human auditory system, as reported recently in *The New York Times*. According to Dr Kyriakakis of the Viterbi School of Engineering at the University of Southern California,

> "It's about the human ear and the human brain, and understanding how the human ear perceives sound."

Dr Oxenham, of the University of Minnesota, concurs:

> "Psychoacoustics is fundamental. You need to know how the normally functioning auditory system works – how sound relates to human perception."

The New York Times article continues:

> "Pitch could be measured in hertz and loudness in decibels, but other phenomena were not so easily quantified. Human hearing can discern the movement of sound with a surprising degree of accuracy... Despite recent advances, however, psychoacoustics has shown engineers that they still have a long way to go." [Gugiotta G. Sound, the Way the Brain Prefers to Hear It. *The New York Times*, September 5 2011]

As Stansfeld and Crombie observe regarding the relationship between environmental noise and its impact on health, e.g., its implication in increased blood pressure,

> "There is a need for better, future prospective studies, to take this research forward, to gain a greater understanding of the underlying mechanisms." [Stansfeld S and Crombie R. Cardiovascular Effects of Environmental Noise: Research in the United Kingdom. *Noise and Health* 2011 May-June;13(52):229-233]

As an example, recently environmental noise – specifically road noise – has emerged as strongly associated with stroke for those over the age of 64.5 years in a prospective cohort study by Sorensen et al. [Sorensen M; Hvidberg M; Andersen ZJ; Nordsborg RB; Lillelund KG; Jakobsen J; Tjonneland A; Overvad K; and Raaschou-Nielsen O. Road Traffic Noise and Stroke: a Prospective Cohort Study. *European Heart Journal* 2011 Mar;32(16):737-744]

The State Government of Victoria, Australia, established wind turbine "no-go zones" in August 2011. The Government introduced policy that prohibits building wind turbines within 2km of houses, unless the homeowner consents to a reduced set-back, but some areas are strictly off limits. Not only does this reduce the potential for wind energy investment in Victoria by 50 to 70%, the policy may result in billions of dollars of lost investment. As wind turbines in Australia multiplied, with many built near homes, health issues emerged and noise complaints escalated. These changes in guidance and policy reflect the conclusions of Australian Government inquiries into evaluating current research on whether or not wind turbine noise constitutes environmental noise pollution that impacts adversely on health. The more stringent policy suggests that the committees found enough evidence to take a more cautionary approach than in the past and impose restrictions on wind turbine construction near homes and communities.

[Stewart A. *Wind Farm No-Go Zones to be Established*. ABC News (Australian Broadcasting Corporation), 29 August 2011; and State Government of Victoria. *Wind Energy Facilities, Amendment VC82*. Department of Planning and Community Development, State Government of Victoria, Australia, 29 August 2011, http://www.dpcd.vic.gov.au/planning/news-and-events/news/amendment-vc82-implements-new-policy-on-wind-energy-facilities-in-victoria]

As noted throughout this paper, there is enough evidence-based research that implicates environmental noise with adverse health impacts such as cardiovascular diseases, and our knowledge about these associations are enhanced each year because some of these relationships emerge only over long-term study, e.g., similar to recognising the danger of second-hand cigarette smoke. Thus, it is critical for public officials to address clusters of complaints about wind turbine noise. Although the clusters may not occur solely around one site, the fact that many sites in proximity to homes generate complaints should provoke a robust response by the government and its agents in order to protect those people and to ensure the protection of those living near proposed sites.

# *Appendix 3.1*

## Health: International Perspectives

**Ontario, Canada**
A report submitted as evidence in 2010 by the Ministry of the Environment to the Environmental Review Tribunal stated that:

> "The audible sound from wind turbines, at the levels experienced at typical receptor distances in Ontario, is nonetheless expected to result in a non-trivial percentage of persons being highly annoyed. As with sounds from many sources, research has shown that annoyance associated with sound from wind turbines can be expected to contribute to stress related health impacts in some persons."
> [Howe Gastmeier Chapnik Ltd. *Low Frequency Noise and Infrasound Associated with Wind Turbine Generator Systems: A Literature Review* (Rfp No. Oss-78696). Mississauga, Ontario, Canada: Ministry of the Environment, 2010]

Also in 2010, an internal memorandum within the Ministry of the Environment confirms that the current Ontario industrial wind turbine guidelines will cause adverse effects. This confirmation of the risk of industrial wind turbine noise problems for those living nearby, with noise within current guidelines, was obtained only via a Freedom of Information request:

> "It appears compliance with the minimum setbacks and the noise study approach currently being used to approve the siting of WTGs [wind turbine generators] will result or likely result in adverse effects contrary to subsection 14(1) of the EPA (Environmental Protection Act)."
> [Seglins D and Nicol J. *Ontario Wind Farm Health Risks Downplayed: Documents. CBC News*, 22 September 2011.
> http://www.cbc.ca/news/health/story/2011/09/21/wind-turbines.html]

Thus the Ministry of the Environment is clearly aware of the risk to health of wind turbine noise for those living nearby. In July 2011, the Environmental Review Tribunal found that industrial wind turbines can harm people:

> "While the Appellants were not successful in their appeals, the Tribunal notes that their involvement and that of the Respondents, has served to advance the state of the debate about wind turbines and human health. This case has successfully shown that the debate should not be simplified to one about whether wind turbines can cause harm to humans. The evidence presented to the Tribunal demonstrates that they can, if facilities are placed too close to residents. The debate has now evolved to one of degree."
> [Environmental Review Tribunal, Case Nos.: 10-121/10-122 Erickson v. Director, Ministry of the Environment, Dated this 18th day of July, 2011 by Jerry V. DeMarco, Panel Chair and Paul Muldoon, Vice-Chair, p 207]

Pursuant to these findings and analyses, Ontario has yet to assess further or to alter its policies regarding wind turbine construction near homes and communities.

# *Appendix 3.2*

## Health: Additional References


Bronzaft AL.
**The Noise from Wind Turbines: Potential Adverse Impacts on Children's Well-being.**
*Bulletin of Science, Technology and Society* 2011; 31(4):291-
http://bst.sagepub.com/content/31/4/291

McMurtry RY.
**Toward a Case Definition of Adverse Health Effects in the Environms of Industrial Wind Turbines: Facilitating a Clinical Diagnosis.**
*Bulletin of Science, Technology and Society* 2011; 31(4):316-
http://bst.sagepub.com/content/31/4/316

Phillips CV.
**Properly Interpreting the Epidemiologic Evidence about the Health Effects of Industrial Wind Turbines on Nearby Residents.**
*Bulletin of Science, Technology and Society* 2011; 31(4):303-
http://bst.sagepub.com/content/31/4/303

Salt AN and Kaltenbach JA.
**Infrasound from Wind Turbines Could Affect Humans.**
*Bulletin of Science, Technology and Society* 2011; 31(4):296-
http://bst.sagepub.com/content/31/4/296

Shain M.
**Public Health Ethics, Legitimacy, and the Challenges of Industrial Wind Turbines: The Case of Ontario, Canada.**
*Bulletin of Science, Technology and Society* 2011; 31(4):256-
http://bst.sagepub.com/content/31/4/256

Szalma JL and Hancock PA.
**Noise effects on human performance: a meta-analytic synthesis.**
*Psychological Bulletin* 2011 Jul;137(4):682-707.

Vanderburg WH.
**Assessing Our Ability to Design and Plan Green Energy Techologies.**
*Bulletin of Science, Technology and Society* 2011; 31(4):251-
http://bst.sagepub.com/content/31/4/251

**Windfarms, Communities and Ecosystems**. Part I (Special Issue).
*Bulletin of Science, Technology and Society* 2011; 31(4).
http://bst.sagepub.com/content/31/4

# *Chapter 4*

## Wind Turbine Noise and Human Rights

### 4.1 POTENTIAL VIOLATIONS

This paper presents evidence that noise from wind turbines, when built too close to homes and other sensitive facilities, may cause sleep deprivation and disturbances, with consequent health problems to families, children, the elderly, and the vulnerable. This is a public health issue caused by prolonged dosage and exposure to industrial environmental noise pollution. The problem is international in scope, occurring wherever wind turbines are constructed in close proximity to homes, affecting people living in varied landscapes and climates, although the wind energy industry persists in its claims that engineers and computer modelling have essentially eliminated wind turbine noise as a source of disturbance.

Yet noise problems persist. Evidence from many acousticians and their colleagues with medical expertise, and evidence from the World Health Organization reports on environmental noise and its relationship to disease, demonstrate that invasive noise pollution creates persistent sleep disturbances and other health issues. In this case, the cause is the close proximity of wind turbines to homes and sensitive facilities.

According to the National Renewable Energy Laboratory (NREL) of the US Department of Energy, as recently as 2010:

> "... engineers have been researching methods to reduce the sounds emitted by wind turbines".

Though there has been some success with reducing mechanical sound sources, such as gearboxes, NREL also noted that:

> "**other aeroacoustic emissions are not well understood or controlled**." [National Renewable Energy Laboratory (NREL). Wind Energy Aerodynamics/Aeroacoustics. NREL December 2010] [Emphasis added.]

NREL continues to conduct aeroacoustic tests in order to identify the physical causes of wind turbine noise.

The UK government's failure to introduce effective controls on wind turbine noise emissions allows developers to locate wind turbines too close to homes, exposing families to serious and material violations of family health, to loss of dignity, to inhumane treatment, and to loss of the amenity of family homes.

Thus, the adverse effects of wind turbine noise are likely to trigger human rights violations, engaging **Article 5 of the United Nations Universal Declaration of Human Rights:**

> **"No one shall be subjected to torture or to inhuman or degrading treatment or punishment."**
> [UN *Universal Declaration of Human Rights*, S.4.1, Article 5, December 1984 http://www.un.org/en/documents/udhr/]

There is also the potential for a violation of the **United Nations Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment** (1987), which says:

> **"Each State shall undertake to prevent in any territory under its jurisdiction other acts of cruel, inhuman or degrading treatment or punishment which do not amount to torture as defined in article 1, when such acts are committed by or at the instigation of or with the consent or acquiescence of a public official or other person acting in an official capacity.** In particular, the obligations contained in articles 10, 11, 12 and 13 shall apply with the substitution for references to torture of references to other forms of cruel, inhuman or degrading treatment or punishment."

> [UN *Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment*, Part 1, Article 16, June 1987 http://treaties.un.org/doc/Publication/UNTS/Volume%201465/volume-1465-I-24841-English.pdf] [Emphasis added.]

In the UK, the **Human Rights Act 1998, Article 3, Schedule 1, Part 1**, mirrors the UN Universal Declaration, and is phrased the same as **Article 4 of the European Convention Charter of Fundamental Rights of the European Union**:

> **"No one shall be subjected to torture or to inhuman or degrading treatment or punishment."**

**Article 3** of the **European Convention on Human Rights guarantees this right.**

The Strasbourg Court of the European Union distinguishes between 'torture' and 'inhuman and degrading treatment', but only in degree:

> "In the Court's view, this distinction derives principally from a difference in the intensity of suffering inflicted." (S.167 *Ireland v UK* 1978 24EHRR 423)

Article 3, of the UK Human Rights Act, is an absolute right and does not allow interference or mitigation by the State:

> "Article 3 makes no provision for exceptions and no derogation from it is permissible under Article 15, S.2... the Convention prohibits in absolute terms torture and inhuman or degrading treatment." (S.87 *Gafgen v Germany*)

Recognising that these rights derive from the inherent dignity of the individual, this right protects each person from cruel, inhuman, or degrading treatment.

State authorised (consent by a public official) sleep deprivation caused by noise is not new to the UK, as illustrated by *Ireland v UK ECHR 18.01.1978.* Noise and sleep deprivation were two of the five techniques used in order to 'encourage' admissions and to elicit information from prisoners and detainees. Although actual bodily injury was not charged, physical and mental suffering and acute psychiatric disturbances were inflicted on prisoners.

The five techniques in *Ireland v UK* consisted of:

- Wall standing;
- Hooding;
- **Subjection to noise;**
- **Deprivation of sleep**; and,
- Deprivation of food and drink.

Although these five techniques, applied in combination, undoubtedly amounted to inhuman and degrading treatment,

> "within the meaning of Article 3, the techniques were also degrading since they were such as to arouse in their victims feelings of fear, anguish and inferiority capable of humiliating and debasing them and possibly breaking their physical or moral resistance." (S.167 *Ireland v UK*) (S.89 *Gafgen v Germany*) (See also: S.79 *Chahal v UK* 1996; S.120 *Labita v Italy*; S.118 *Ramirez Sanchez v France*; S127 *Saadi v Italy* 2008.)

> "Mental harm in and of itself was a prevalent form of torture." (S86 *Gafgen v Germany*)

> "In order for ill-treatment to fall within the scope of Article 3 it must attain a minimum level of severity. The assessment of this minimum depends on all the circumstances of the case, such as the duration of the treatment, its physical or mental effects and in some cases, the sex, age, and state of health of the victim. Further factors include the purpose for which treatment was inflicted together with the intention behind it, as well as its context, such as an atmosphere of heightened tension and emotions." (S.88 *Gafgen v Germany*)

[European Court of Human Rights decisions may be found at:
http://www.echr.coe.int/ECHR/EN/Header/Case-Law/Decisions+and+judgments/HUDOC+database/]

**Despite the Edward Heath government announcement to the House of Commons, March 1972, banning the 5 techniques, the Report of the Baha Mousa Inquiry, September 2011, found the Heath declaration has now mainly "faded from policy" [p14]. Could this also mean Part 1, Article 16 of the UN Convention against Torture, and other Cruel, Inhuman, Degrading, Treatment, of June 1987, might also have "faded from policy" of government officials.**
[Gage Rt Hon Sir William, Chairman. *The Baha Mousa Public Inquiry Report*.
Presented to Parliament pursuant to Section 26 of the Inquiries Act 2005. The Stationery Office (UK), HC 1452, vols 1 – 3, 8 September 2011.
http://www.bahamousainquiry.org/report/index.htm]

In the context of the 'minimum level', an individual living near a wind turbine will experience prolonged exposure (duration) to environmental noise pollution that continues for years, often 24 hours per day, with a persistent continuous thumping, vibration, and periodic flicker. Those who are exposed endure fatigue and the concurrent effects of fatigue, e.g., disrupted concentration, followed by distress and feelings of powerlessness to protect themselves and their families from these untoward effects. Many victims are children who are highly sensitive to certain acoustic characters and who cannot escape the noise unless their parents take them elsewhere. With their sleep disturbed, children's schoolwork suffers; when tired, children do not perform as well on cognitive tasks as the other children in their class. Teachers may attribute their performance or attitude to causes other than fatigue. The elderly, the sick, those with limited mobility, and other vulnerable groups cannot escape the noise at night.

For what purpose are these prejudicial health injuries tolerated and even ignored by governments? The authorising agencies and public officials argue the need to achieve renewable energy goals as part of state policy. However, in pursuit of these worthwhile goals, the governing authorities condone a 'Machiavellian' approach (the end justifies the means) in order to attain those goals, violating the basic human rights of many people in order to achieve those goals, exposing families over a prolonged period to inhuman and degrading treatment. These problems were acknowledged years ago, when the Dti (now DECC) convened the Noise Working Group to write the wind turbine noise report known as ETSU-R-97, precisely because people were suffering from wind turbine noise when these were built near homes.

There is no doubt whatsoever that the State, the central government, and local government are fully aware that there are in excess of 27 wind turbine arrays in the UK that are the subject of complaints by families victimised by excessive noise. (27 HRPH10, 36 PHE03) The suffering of some of these families is well-documented, including articles in the national press; and there is evidence of similar problems in other countries. Consultants to government did not interview any of those reporting adverse effects. Government has sought to deny or downplay the problem. However, the national press has alleged that officials covered up findings for a wind farm noise report – an instance of 'the ends justifying the means' – in order to implement policy and targets rather than to consider the adverse health impacts on those families affected by their decisions.
[Leake J and Byford H. Officials Cover up Wind Farm Noise Report. *The Sunday Times,* 13 Dec 2009]

The intensity of suffering experienced by these individuals and families is well-documented, yet the UK government has failed to adopt maximum environmental noise protection standards as proposed by WHO, or even to conduct independent health research by recognised medical experts into the noise problem suffered by families and to make recommendations for improvement. Instead, the government persists in relying upon outdated Guidance (ETSU-R-97) prepared in the 1990s by a team drawn primarily from the wind energy industry.

While wind turbine noise may not inflict the intensity of suffering implied by the definition of 'torture' (*S.90 Gafgen v Germany: S167 & 168 Ireland v UK)*, there is little doubt that the duration and nature of the exposure does combine two of the five techniques identified and condemned in *168 Ireland v UK*: *'Subjection to noise'* and *'Deprivation of sleep'*. Both of these cause intense mental suffering and constitute inhuman and degrading treatment. Furthermore, the Court of Appeal in the Welsh Ministers Case, (C1/2010/1426/QBENF, Nov 2010) found that:

> "…duration of an interference is plainly a material consideration..."

In *S.89 Gafgen v Germany 2010*, the Court:

> "has considered treatment to be 'inhuman' because, inter alia, it was premeditated, was applied for hours at a stretch and caused either actual bodily injury or intense mental suffering, (see *Labita* S 120, and *Ramirez Sanchez* S.118). Treatment has been held 'degrading' when it was such as to arouse in its victims feelings of fear, anguish and inferiority capable of humiliating and debasing them and possibly breaking their physical or moral resistance, or when it was such as to drive the victim to act against his will or conscience."
> (See also *Keenan v UK* S.110, *Jalloh v Germany*, as well as S.89 *Gafgen v Germany*.)

The extent of the suffering from wind turbine noise is well illustrated by the records kept by families, e.g., that of Mr and Mrs Davis and family from Spalding, UK. These diaries document many days with unremitting thumping noise causing sleep deprivation, with no escape, and the consequent onset of serious health problems. (*S162 Ireland v UK, S88 Gafgen v Germany, S.67 Jalloh v Germany)* In July 2011, the High Court in London was asked to consider the suffering of Mr and Mrs Davis in *Davis and Davis v Tinsley, Watts and Fenland Windfarms and Fen green power Co-op, claim HQ 10X00900.* (The Case continues in the High Court, London, on 30 November 2011.)

In a premeditated decision, the State has opted to ignore WHO Guidelines, which if implemented would likely reduce the impact of the environmental noise immissions and thereby substantially reduce sleep disruption. There is no evidence of explicit authority from Parliament to permit public officials to endorse family suffering of this intensity and duration. Through planning controls and guidance, public officials, in preparing guidance to industry on the safe distance between homes and industrial wind turbines, have assigned more importance to renewable energy targets than to their duty to protect the health and inherent dignity of families.

The State's objectives are attainable by setting a safe distance between wind turbines and family homes, guided by medical experts and WHO reports on noise and health. Other renewable energy technologies are available, e.g., solar, hydroelectric, and nuclear energy. Unfortunately, in the Planning Act, Parliament has provided greater protection to UK landscapes rather than to the basic protection of the health and dignity of families. Public officials authorising schemes in the certain knowledge that nearby families will suffer from wind turbine noise and its adverse impact on sleep and well being, apparently see these complaints by families as a small cost against achieving renewable energy goals. It should be clear, it is not the 'ideology' of renewable energy being criticised; it is the intentional absence of effective control of the noise pollution as a means to better achieving goals, thus engaging a violation of one's basic human rights.

This problem is international in scope; e.g., a paper by Krogh examines "the loss of social justice reported by individuals living in the environs of industrial wind turbines" in Ontario, Canada. The experiences described by Krogh mirror a similar disregard for human rights as in the UK. Krogh concludes:

> "In Ontario, Canada, there is a suspension of critical appraisal and due process regarding IWTs. The lack of confidence in the political and regulatory systems will persist if governments and industry continue to deny the existence of adverse impacts from human exposure to IWTs.
>
> Societies concerned with health place value on the individual: 'A society that is concerned with health and health equity acknowledges the existence of all its citizens and the importance of their well-being' (WHO, 2008, p.177).
>
> Good governance implies that governments have a responsibility to correct policies that result in harm. Governments have the power to halt development of IWTs in close proximity to humans until authoritative human health research has been completed. Facilities where there are reports of adverse health effects should be decommissioned and health and quality of life restored.

> The negative psychological effect of disempowerment interacting with the adverse health effects attributed to IWTs has intensified the negative synergy of justice lost. Impact statements indicate that the violation of procedural justice will not be easily forgotten..."
> [Krogh C. Industrial Wind Turbine Development and Loss of Social Justice. *Bulletin of Science, Technology & Society* 2011;31(4):321-333]

There is no precondition to Article 3 of the Human Rights Act that its engagement requires detention. At this point, it is worth revisiting the description of the adverse physical health impacts, the anguish, and the humiliating and degrading experiences described by Mr and Mrs Davis from Spalding, as their character and motivations were impugned. Some families abandon their homes out of desperation, but most families cannot afford that cost. Is this the way a just and democratic society achieves its objectives?

In 2009, President Obama acknowledged that during the previous administration, the CIA had authorised inhuman treatment of some inmates at the Guantanamo Bay prison, and this mistreatment included, among other techniques, extended periods of sleep deprivation – kept awake for up to 11 straight days, in contravention of UN Resolution 3452, to which the UK is signatory. Many in the Obama administration as well as human rights organisations believe that these practices constitute torture. [Baldwin T. Barack Obama Releases Documents showing Harsh Bush-era CIA Interrogations. *The Times* (UK), 16 April 2009; see also renunciation of these techniques in the Transcript: Senate Confirmation Hearings Nominating Eric Holder as Attorney General. *New York Times*, 16 January 2009; and Burns JF. Britain Discloses Data on Ex-Detainee. *New York Times*, 11 February 2010]

Note that following the *Ireland v UK* decision and subsequent Inquiries, the UK promised the European Community that the State would never again authorise the inhuman and degrading treatment of individuals via sleep deprivation.

**The Charter of Fundamental Rights of the European Union, Chapter 1: 'Dignity', Article 1** states that:

> "The dignity of the human person is not only a fundamental right in itself but constitutes the real basis of fundamental rights. The 1948 Universal Declaration of Human rights enshrined this principle in its preamble. Whereas recognition of the inherent dignity and of the equal and inalienable rights of all members of the human family is the foundation of freedom, justice and peace in the world."
> [Charter of Fundamental Rights of the European Union, 11 October 2000 http://www.europarl.europa.eu/charter/pdf/text_en.pdf]

**The United Nations Universal Declaration of Human Rights** stipulates that:

> "No one shall be subjected to arbitrary interference with his privacy, family, home or correspondence, nor attacks upon his honour and reputation. Everyone has the right to the protection of the law against such interference or attacks." [S4.2, Article 12, December 10 1948]

and that:

> "Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing…"
> [Article 25, December 10 1948 http://www.un.org/en/documents/udhr]

**The UK Human Rights Act 1998, Article 8, Right to Respect for Private and Family Life** states that:

> **1) "Everyone has the right to respect for his private and family life, his home and his correspondence.**
>
> **2) There shall be no interference by a public authority with the exercise of this right except as in accordance with the law and as necessary in a**

**domestic society in the interests of... the economic well-being of the country for the protection of disorder or crime, or for the protection of health or morals, or for the protection of the rights and freedoms of others."**

Article 8 is a qualified right and may be interfered with by the State provided the interference
1) is lawful;
2) serves one of the legitimate aims; and
3) is proportionate.

Many European citizens look on Article 8 as a 'toothless tiger'. While part 1 protects the European family from poorly conceived State actions, part 2 essentially dilutes or removes that protection because the State contends that all its actions are lawful, legitimate, and proportionate, and the State always seeks to act in the interest of the majority of people, thereby its actions are protected by part 2. [UK Human Rights Act 1998 (HRA 1998)
http://www.legislation.gov.uk/ukpga/1998/42/contents ]

There is of course considerable case law on Article 8, particularly as the State invariably relies on the proportionality argument supported by State policy, which has left many citizens of the EEC believing the State can always sidestep Article 8. However, the following cases are significant to the ordinary citizen because the European Court of Human Rights [ECtHR] found for the individual, not the State:
*Lopez Ostra v Spain (1994) EHRR 2777, S.51 & S.58;*
*Guerra & Others v Italy (1998) 26 EHRR 3577, S.58 & S.60;*
*Fadeyeva v Russia (June 2005) ECHR 55723 S.64, S132, S133, & S.134;*
*Moreno Gomez v Spain (16 November 2004) 4143/02 S.57, S60, & S.62; and,*
*Geoffrey Wallace Andrews v Reading Borough Council (2005) EWHC 256 (QB).*
[European Court of Human Rights decisions may be found at:
http://www.echr.coe.int/ECHR/EN/Header/Case-Law/Decisions+and+judgments/HUDOC+database/]

Looking more closely at the UK Human Rights Act, Article 8, part 2:

**"There shall be no interference by a public authority...."**
The public authority includes all arms of central and local government and bodies authorised to make decisions on behalf of central government.

**"...with the exercise of this right except such as is in accordance with the law..."**
Acts of Parliament and specific authority flowing from an Act to make law is within the law. Case law authority is considered lawful until successfully challenged. A planning consent to undertake development makes that development lawful if constructed in accordance with the conditions of that consent.

**"... and is necessary in democratic society in the interests of:**
- National security
- Public safety."

**"The economic well-being of the country**
- For the prevention of disorder or crime
- For the protection of health or morals."

**"For the protection of the rights and freedoms of others."**
In considering the engagement of Article 8 by wind turbine noise and the consequent health impacts, this would normally apply only to wind farms where wind turbines are located so close to family homes that the privacy and amenity of the family home is violated by noise pollution.
[UK Human Rights Act 1998
http://www.legislation.gov.uk/ukpga/1998/42/contents]

Without part 2 of Article 8, there is little doubt that wind turbine noise would engage Article 8 and represent a serious violation of the basic human rights of individuals, families, and affected communities.

Considering part 2 of Article 8, the public authority will, in Town Planning terms, seek to balance the rights and freedoms of the site owner to develop the land in accordance with the Planning Act, County Development Plan, and Government Policy, against the rights of existing home owners on adjoining land to have their amenity reasonably protected. Evidence in previous chapters shows that the State is fully aware that the problems from wind turbine noise radiation impact heavily on families where wind turbines are built too close to homes. Yet, the public authorities continue to follow outdated guidance (ETSU-R-97) on noise that they know is no longer 'fit for purpose' in providing protection for families. [See Chapter 2.]

The developer will naturally seek to maximise the development potential of the site, which means building as many wind turbines as possible, on as many sites as possible, even if close to neighbouring homes or other sensitive facilities and communities. Thus, the public authority is failing in its duty to strike a fair balance between the conflicting interests when the authority decides that a small group of families must shoulder the burden of the nation's renewable energy policy. This group involuntarily suffers the inhuman treatment imposed by prolonged environmental noise pollution and its consequent injury to health. One may argue that the government is not acting proportionately, especially as the national renewable targets – a legitimate objective – are attainable by mechanisms that are less intrusive and cruel. The problems are fully in the public domain, and there can be no acceptable mitigation for public officials who clearly fail to exercise their duty of care to citizens.

If government considered maximising wind power as vital to the national interest, then why does government prohibit wind turbines in national parks (mainly uninhabited and large, high, open, windy landscapes) and other protected landscapes, all exempted on the grounds of protecting visual amenity. Has government decided that the protection of valuable landscapes is far more important than the protection of the lives of families? One may then argue that such government action is disproportionate to achieving the legitimate objective. It is difficult to find the lawful justification for public officials to authorize the sequestration by the State of basic protection of family amenity, health, and dignity, by claiming 'Policy of the State and the wider benefits of wind energy' as a defense against engaging Article 8. An article in the Independent, *Get Rich Quick,* illustrates the inducement for landowners to ignore the impact of their wind turbines on neighbours. The financial rewards to land owners who allow wind turbines originate with the generous financial incentives available from the State to wind farm developers.
[Blacker T. Get Rich Quick by being 'Green'. *Independent*, 12 July 2011]

As an example, consider the Planning Appeal Decision, 7 January 2011, for Tunstall, Roos, Hull. The Decision comprised 79 paragraphs, of which only two addressed wind turbine noise. In S.11, the Inspector observed there are about 22 homes between 710m and 1300m from the wind turbines in one direction and about a dozen homes between 840m and 1700m in the other direction. In S.55, the Inspector said:

> "It was concluded at the ES [Environmental Statement] stage that the proposed development would be able to comply with the relevant criteria included in ETSU-R-97... I have no reason to question the conclusions reached in the ES… There is no doubt the turbines would be readily audible at locations… But I consider this adverse effect of the project is incapable of outweighing the permissive stance of the policy." [That is, the government's renewable energy policy.]

In S.9, the Inspector stated:

> "The main issue in this case is whether any harm to landscape and visual amenity... would be sufficient to outweigh the presumption in favour of such proposals."
> [The Planning Inspectorate (UK). Appeal Decision: Tunstall, Roos, Hull. Inspector A Pykett. PINS Appeal Ref APP/E20001/A/10/2130670, 7 January 2011]

In contrast, the Court of Appeal, 24 November, 2010, held:

> "...that there was no such inconsistency and allowed an appeal against the Judge's decision. It held that while the ETSU-R-97 limits were a matter to which the Inspector was required to have regard, he was not bound by them. In particular, the ETSU-R-97 limits represented only one view as to the appropriate balance to be struck between the adverse effects of noise disturbance and the wider beneficial effects of wind farms, and it was for the Inspector to form his own planning judgement as to whether the noise generated by a particular proposal would be unacceptable, taking into account the evidence of local residents and his own experiences on site visits."
> [4-5 Gray's Inn Square. Court of Appeal Allow Windfarm Appeal. 4-5 News, 25 November 2005, i.e., The Welsh Ministers Appeal]

In many instances, interference from noise originates from maximising the development potential of a site. There are alternatives: setting greater distances from homes, e.g., a minimum of 2km with greater distances as conditions require, or promoting other renewable energy schemes, e.g., photovoltaic cells fitted to existing and all new construction. Another alternative is to shut down the wind turbines at night (*Hatton and others v UK*), with noise level controls enforced as necessary also during daytime hours. A third option is to adopt existing World Health Organization advice on maximum allowable noise immissions in the home, and to appoint an independent, impartial panel of medical experts and acousticians to advise on maximum wind turbine noise levels that allow families to live in their homes, free from health injury.

In *Hatton v UK (2003) 37 EHRR 288*, the decision in favour of the State was influenced by the economic necessity of Heathrow airport to the State. Moreover, the decision of the court was also influenced by the plan to introduce nighttime noise controls on aircraft movements (currently about 5% of daytime movements), which allows sleep at night between 22.30hrs and 07.30hrs, and the condition applies even though Heathrow airport is the State's international link with the world and is of national economic importance to the State.

While renewable energy is a part of overall State Policy, it cannot be said to be vital to national interest because, if that were the case, all moorland in the UK would be made available for turbines and all the coastal waters would be available, supported by financial subsidy, in order to maximise wind turbine installation. This is not the case. Yet, there is no effective control on wind turbine noise emissions at night.

However, in Japan, on 5 August 2011, Kansai Electric Power Company announced that it intended to respect residents' concerns about wind turbine noise. Kansai not only reduced the number of wind turbines on the site, it also limited nighttime operations. [*Kansai Electric Curbs Wind Farm over Noise Concerns*. Reuters, 5 August 2011, http://af.reuters.com/article/commoditiesNews/idAFL3E7J50F420110805] [See also Ito A and Takeda T. Sickness Claims Prompt Study of Wind Turbines. *The Asahi Shimbun*, 19 January 2010 http://www.asahi.com/english/Herald-asahi/TKY201001180410.html.]

Most families live in their homes before wind turbines are proposed or constructed. There can be no question of acquiescence, i.e., of families moving to the location with the knowledge of potential or actual wind farm development. Furthermore, the Valuation Tribunal decision in favour of Mr and Mrs Davis is only one example that demonstrates property values fall substantially if the homes are subject to wind turbine noise pollution, and it is not possible for families to move elsewhere without suffering significant financial loss. While in *Hatton v UK* the Court noted that although the homes are in proximity to Heathrow Airport, the location also makes the homes desirable for their proximity to London; thus, the homes more reliably maintain their value despite the noise (in contrast to homes near wind farms), which allows airport families to relocate if they choose to do so. In addition, because the airport (source of noise) has existed for several generations, families are aware of the airport's impact when buying their homes. However, wind turbines on a neighbouring property significantly reduce home values, limiting a family's options to relocate.

Contrast the European Court of Human Rights decision in the case of ***Moreno Gomez v Spain (2004) S.53 – 63****:*

> "In her additional observations of 14 Sept 2004, the applicant observed that the level of the night-time disturbance (from 10 pm to 6.30 am) caused by more than 127 nightclubs infringed the right to health, as indeed was confirmed by the World Health Organization's guidelines. Unlike the position in the case of Hatton & Others v UK, her home was neither within nor adjacent to an area of vital importance, such as an area relevant to a strategic transport or communications infrastructure. She stressed that her home was in an urban area, specifically, a residential one." [S.49]
>
> "The facts show that the applicant suffered a serious infringement of her right to respect for her home as a result of the authorities' failure to take action to deal with the night-time disturbances." [S.61]
>
> "In these circumstances, the Court finds that the respondent State has failed to discharge its positive obligation to guarantee the applicant's right to respect for her home and her private life, in breach of Article 8 of the Convention." [S.62]

Furthermore, the decision by Judge Buckley J in ***Dennis & Dennis v the Ministry of Defence (MOD)*** *([2003] EWHC 793 (QB))* is significant and relevant. The Justice found that the evidence of severe noise nuisance and consequent loss in value of the property established an interference with both Article 8 and Article 1 of the First Protocol. In these circumstances, the Justice held that the absence of compensation did not strike a fair balance:

> **"I believe it is implicit in the decision S. v France, that the public interest is greater than the individual private interests of Mr and Mrs Dennis but it is not proportionate to pursue or give effect to the public interest without compensation for Mr and Mrs Dennis...** in my view, common fairness demands that where the interests of a minority, let alone an individual, are seriously interfered with because of an overriding public interest, the minority should be compensated."
> [Dennis & Dennis v Ministry of Defence [2003] EWHC 793 (QB)
> http://www.bailii.org/cgi-bin/markup.cgi?doc=/ew/cases/EWHC/QB/2003/793.html

In ***Fadeyeva v Russia (2005)***, the Court found:

> "...the adverse effects of environmental pollution must attain a certain minimum level if they are to fall within the scope of Article 8 (Lopez Ostra v Spain 1994 S.51 and also Hatton and Others v UK 2003 S.118). The assessment of that minimum is relative and depends on all the circumstances of the case, such as **the intensity and duration of the nuisance, its physical or mental effects. The general environmental context should be also taken into account.** There would be no arguable claim under Article 8 if the detriment complained of was negligible in comparison to the environmental hazards inherent to life in every modern city. [S.69] [Emphasis added.]
>
> Thus, in order to fall under Article 8, complaints relating to environmental nuisances have to show, first, that there was an actual interference with the applicant's private sphere, and, second, that a level of severity was attained." [S.70]

In the case of Mr and Mrs Davis, the district Valuation Tribunal reduced the value of their home for Council Tax purposes to site value only, retroactive to the operation date of the wind farm. There are other contrasting principles with *Hatton*. [Bunyan N and Beckford M. Homeowners Living Near Windfarms See Property Values Plummet. *The Daily Telegraph*, 26 July 2008]

While some may see the *Hatton v UK* decision as contrary to European environmental law, the *Joint Dissenting Opinions of Judges Costa, Rees, Turmen, Zupancic and Steiner* is significant. In S.11, they state:

"Privacy is a heterogeneous prerogative. The specific contours of privacy can be clearly distinguished and perceived only when it is being defended against different kinds of encroachments. Moreover, privacy is an aspect of a person's general well-being and not necessarily only an end in itself. The intensity of the State's permissible interference with the privacy of the individual and his or her family should therefore be seen as being in inverse relationship with the damage the interference is likely to cause to his or her mental and physical health. The point, in other words, is not that the sexual life of the couple whose home reverberates with the noise of aircraft engines may be seriously affected.

The thrust of our argument is that "**health as a state of complete physical, mental and social well-being"** is, in the specific circumstances of this case, a precondition to any meaningful privacy, intimacy etc and cannot be unnaturally separated from it. To maintain otherwise, amounts to a wholly artificial severance of privacy and of general personal well-being. Of course, each case must be decided on its own merits and by taking into account to the totality of its specific circumstances. In this case, however, it is clear that the circles of the protection of health and of the safeguarding of privacy do intersect and do overlap."
[Hatton and others v United Kingdom decision and dissenting opinions: http://cmiskp.echr.coe.int/tkp197/view.asp?item=2&portal=hbkm&action=html&source=tkp&highlight="THE UNITED KINGDOM" | hatton&sessionid=668105&skin=hudoc-en]

The evidence provided in Chapters 1, 2, and 3 of this paper shows that the State is failing to honour its promises as a signatory to the United Nations under the 1948 Universal Declaration.

## 4.2 THE UNITED NATIONS UNIVERSAL DECLARATION OF HUMAN RIGHTS, DECEMBER 1948

Article 17:

1. Everyone has the right to own property alone as well as in association with others.
2. No one shall be arbitrarily deprived of his property.

[http://www.un.org/en/documents/udhr]

**The UK Human Rights Act 1998, Article 1 of the First Protocol, Protection of Property**, states:

**"Every natural or legal person is entitled to the peaceful enjoyment of his possessions. No one shall be deprived of his possessions except in the public interest and subject to the conditions provided for by law and by the general principles of international law.**

**The preceding provisions shall not, however, in any way impair the right of a State to enforce such laws as it deems necessary to control the use of property in accordance with the general interest or to secure the payment of taxes or other contributions or penalties."**
[UK Human Rights Act 1998
http://www.legislation.gov.uk/ukpga/1998/42/contents]

Article 1 is a qualified right, but the margin of appreciation afforded to the State depends upon the circumstances of the case. Noise is considered one of the most intrusive pollutants in the European environment; one may argue that the State should be afforded only a narrow margin of appreciation in the analysis.

Some have commented that *Hatton* makes Article 1 something of a 'toothless tiger', because of the balance in favour of the State. But David Hart, QC, wrote a heartening discussion of the recent case *Thomas v Bridgend County Borough Council (2011) EWCA Civ862, Court of Appeal:*

"Conventional wisdom has it that an Article 1 Protocol 1(the human right to peaceful enjoyment of property) environmental claim faces all sorts of difficulties. The claimants may have a right to the peaceful possession of property, but that right is immediately counter-balanced by the public interest of the scheme under challenge. Furthermore, the court does not look too closely at the detail when applying the proportionality test, as long as the scheme is lawful. Or does it?

> Our case is a refreshing example of where manifest injustice was avoided by a successful claim under Article 1 of the First Protocol of the ECHR. It also shows off the muscles of the duty to interpret legislation, under section 3 of the Human Rights Act 1998, in accordance with the ECHR. To find what it was about..."
> [Hart D. *Just When You Thought They Were Extinct: Human Rights Environmental Case Succeeds*. 1COR- 1 Crown Office Row, 27 July 2011 http://ukhumanrightsblog.com/2011/07/27/just-when-you-thought-they-were-extinct-a1p1-environmental-case-succeeds/]

Evidence in this paper and in the authors' 2007 paper shows that the value of family homes declines where wind turbines are built nearby. The value of a residential property is the price achieved in a free and open market between a willing seller and a willing buyer. It also assumes full exposure to the market. Many factors influence value, but normally these include: location, size, appearance, views, character of the area, being capable of beneficial occupation, and family enjoyment and security.

The primary impact on the open market value of a residential property with wind turbines built nearby arises from the invasive noise pollution emitted by the wind turbines. For this reason, wind turbines usually affect home values in a rural community rather than in town or urban settings. Common features of countryside properties are often the scenery and the tranquil environment. A property that enjoys a special view that potential buyers perceive as more attractive than other property in the area will command an additional value. Evidence shows that this value is removed when a wind turbine is erected nearby. However, the major value, apart from size and location is the 'amenity value' of the home. Presuming that the property provided family privacy, amenity, and quiet enjoyment, when one or more wind turbines are built nearby, then the landowners of that wind turbine array release environmental noise pollution that pervades adjoining properties and homes for prolonged periods. Thus, the adjoining property loses its amenity, and the value attached to its amenity.

Chapters 1, 2, and 3 make it evident that the environmental noise pollution released into the atmosphere by land owners building wind farms is, in principle, no less invasive and injurious to health than if a chemical works built nearby emits toxic fumes into the atmosphere inducing serious health impacts on neighboring families. One would not willingly move one's family to a house that is subject to an ongoing environmental pollution problem that triggers serious sleep and health problems for one's family.

The suggestion that families suffering a material loss of value to their homes because of the noise pollution should sell and move to a quiet area is unviable and callous. First, most families will have invested their life savings in their home, and they may find either that their life savings are wiped out and they have nothing left to buy another home, or that their savings are so depleted that what remains will not buy a home. Those who find they have little value left are likely to find this relates especially to homes in the countryside.

The State cannot justify a national interest argument because **wind turbine arrays cannot provide a predictable flow of electricity to the National Grid that ensures a secure and reliable energy supply.** A secure, predictable, reliable energy supply is fundamental to the economy as a whole and to sustainable development. Wind energy cannot provide a predictable, sustained level of energy security, which must be constant, responsive, and robust at all times, in both the short and long term. On 11 December 2010, Christopher Booker reported:

> "Last Tuesday evening when many places in Britain were registering their lowest temperatures on record, UK electricity demand was a staggering 60 gigawatts. But the amount coming from wind turbines was just 0.2per cent – one 500$^{th}$ of what we were using. Ten times as much was coming from nuclear reactors in France, through the interconnector under the channel".
> [Booker C. Climate Change: the Warmist Demands Heat up as 'Green' Costs Soar. *Daily Telegraph* 11 December 2010]

On 2 January 2011, Booker noted:

> "Last Thursday night the amount of electricity supplied to the grid by wind turbines was again a mere one thousandth of the total. Again we were importing 40 times that much power from France, generated by nuclear reactors."
> [Booker C. What We Need in 2011 is an Opposition. *Daily Telegraph* 1 January 2011]

Booker's articles, supported by statistics and reports generated by the National Grid, are but two examples of wind turbine ineffectiveness in times of need. They are also important reminders that when high-pressure weather systems prevail over the UK, which often coincides with high demand for electricity by the nation, there is not enough wind for wind turbines to make a meaningful contribution to those electricity demands. Therefore, wind turbines are not critical to the national interest, especially when compared to other energy supplies, which are predictable, sustained, and reliable.

Professor James Lovelock, CH, CBE, FRS, in his book warning of the consequences of climate change, *The Revenge of Gaia: Why the Earth is Fighting Back,* comments:

> "According to the Royal Society of Engineers 2004 report, onshore European wind energy is 2-5 times, and offshore wind energy over 3 times, more expensive per kilowatt hour than gas or nuclear energy. No sensible community would ever support so outrageously expensive and unreliable an energy source were it not that the true costs have been hidden from the public by subsidies and the distortion of market forces through legislation."
> [Lovelock J. *The Revenge of Gaia: Why the Earth is Fighting Back*. London: Penguin, 2006, p 83]
> (See also Lipton E and Krauss C. A Gold Rush of Subsidies in Clean Energy Search. *New York Times* November 11, 2011 http://www.nytimes.com/2011/11/12/business/energy-environment/a-cornucopia-of-help-for-renewable-energy.html?scp=1&sq=gold%20rush&st=cse.)

The closure of an onshore wind farm would have no economic impact on the national economy and no significant impact on the National Grid. Contrast this with the *Hatton and others v UK* decision that underscored the significant economic and commercial necessity of Heathrow Airport, one of the world's busiest, to the UK national economy; therefore, the State was granted a wide margin of appreciation. This argument is not justified when applied to onshore wind turbines.

Clearly, Article 1 is engaged where homes suffer from wind turbine noise pollution, but this Article can provide for pecuniary damages to compensate families for the depreciation in the value of their homes equivalent to the value without the scheme, less the present sale value of the home (if it can be sold). Compensation should include the costs of moving to an equivalent location and for the market value of a home not exposed to wind turbine noise. In some cases, the home will be unsaleable and the present value would be £0. The limited number of families affected (e.g., living within 3km of industrial wind turbines) would be deminimus in the macroeconomic scale of the national economy.

Even if a slight margin of appreciation is afforded to the State, as with *Dennis and Dennis v MOD (2003),* Judge Buckley J held that a fair balance would not be struck in the absence of compensation:

> "I believe it is important in the decision of S v France that the public interest is greater than the individual private interests of Mr and Mrs Dennis but it is not proportionate to pursue or give effect to the public interest without compensation for Mr and Mrs Dennis... in my view, common fairness demands that where the interests of the minority, let alone an individual, are seriously interfered with because of an overriding public interest, the minority should be compensated."
> [Dennis & Dennis v Ministry of Defence [2003] EWHC 793 (QB) http://www.bailii.org/cgi-bin/markup.cgi?doc=/ew/cases/EWHC/QB/2003/793.html]

Homes in the UK, elsewhere in Europe, the USA, and Australasia, show the consistent experience of families who, when living near wind turbines, suffer noise pollution. Family homes incur severe reductions in market value, reflecting the health injury and loss of amenity that the family is likely to suffer or is suffering. There are examples of families who cannot sell their homes, which means the property no longer has a residential value, perhaps only 'land value'. Families who find their homes unsaleable become prisoners in their homes. The noise pollution severely compromises and even destroys their right to respect for private and family life, and this is authorised by the State.

Families living in rural areas often have all their wealth tied up in their homes, e.g., in the family farm. It is their security, which they have built upon with many years – possibly generations – of toil; and it is also often the family lifeline to securing a loan to expand their business, or to take loans to buy fertiliser and feed for animals, or to pay emergency medical bills. If money becomes tight, the home is a valuable route to releasing capital in order to get through difficult times, and for many families this is their only realistic mechanism. The State has sequestrated their security by authorising persistent, continuous, prolonged environmental noise pollution that makes their homes unsaleable, or reduces their values to the point at which families cannot derive any benefit from their sales.

There is extensive documentation on this issue, several examples of which follow:

**Homeowners Living Near Wind Farms See Property Values Plummet**

> "Thousands of homeowners may see the value of their properties plummet after a court ruled that living near a wind farm decreases house prices. In a landmark case, Jane Davis was told she will get a discount on her council tax because her £170,000 home has been rendered worthless by a wind turbine 1,000 yards away [i.e., 1 km]... Local estate agents have acknowledged that the house, worth £170,000 before the wind farm was built in 2006, is now so severely blighted that no one is likely to buy it." [Bunyan N and Beckford. Homeowners Living Near Windfarms See Property Values Plummet. *Daily Telegraph* 26 July 2008]

**J Davis, Appendix 1 Property Values and House Prices**

> "(1) Mounton & Russell 29.04.08 to Davis family re Grays Farm; (2) Brockington Wade 05.03.02 to Bambridges family re Reeds Cottage; (3) Ashdales 31.03.99 to Cuthbert family re Mill Cottage; (4) Russell Baldwin & Bright 30.05.00 not disclosed; (5) F P D Savills 06.05.98 to Henry family re wind turbines." [Davis J and Davis J. Appendix 1: Property Values and House Prices. Public Consultation on The Economics of Renewable Energy to the Select Committee on Economic Affairs, The House of Lords, June 2008]

**Gwen Burkhardt letter, "Wind farm illness", 6 June 2005**

> "Racing pulse, heart palpitations, a strange churning in my head, a feeling of nausea, a terrible unease and a need to escape. Sleep became difficult too... I did not want to leave home but eventually, after talking to another women who had suffered the same symptoms as me, living near other turbines, I eventually had to face the fact the wretched things were there to stay and that we would have to move." [Burkhardt G. Wind Farm Illness (letter). *WalesOnline* 6 June 2005 www.walesonline.co.uk]

**Bradleys Surveyors, Exeter, Letter to Hancock Family, North Tawton, Devon**

> "My professional opinion is that property values will fall within an area where wind turbines are to be or have been constructed. In fact I cannot imagine anything other than a detrimental effect to any neighbouring property resulting from a new wind farm development." [Davies T. Response to Enquiry regarding Devaluation of Property from Mr P Hancock. Bradleys Chartered Surveyors, Exeter, UK, 30 August 2005]

**Windfarm blows house value away**

> "A Furness couple have won a legal ruling proving that the value of their home has been 'significantly diminished' by the construction of a wind farm nearby...." [Hawkins J. Windfarm Blows House Value Away. *The Westmorland Gazette* 9 January 2004]

**Bradleys Chartered Surveyors letter to Den Brook Valley Action Group**

"Under certain circumstances it would be possible for a property within 600 – 800 meters to be devalued by some 30%, property within 1 mile possibly 20%, and property 2 miles possibly 10%. It is important to stress that each individual property would be affected in a different way." [Davies T. Letter to Denbrook Valley Action Group. Bradleys Chartered Surveyors, Exeter, UK, 5 November 2004]

**Turitea Man Fears He'll Have to Go**

"A Turitea man says he will be forced from his home because Mighty River Power told him noise from wind turbines in the reserve will make his house uninhabitable... An Ashhurst family had to leave their house last year because noise and vibration from the Te Apiti wind farm made it impossible for them to stay." [Harvey H. Turitea Man Fears He'll Have to Go. *New Zealand News* 10 November 2006 http://stuff.co.nz]

**Testimony of Russell Bounds, Railey Realty, Maryland**

**Question**:"What is their (people living in vicinity of wind turbine) primary complaint?"

**Answer**: "The primary complaint is noise. Second is the visual impact of the turbines. Going into the house and closing the door eliminates the view. It does not eliminate the sound. The constant drone cannot be escaped. The quiet mountain living is gone. The greatest concern is the substantial loss of value of their property. They do not believe they can sell without substantial loss and cannot afford to sustain the loss and move." [Bounds R. Testimony re: Garrett County Wind Turbine Application. Public Services Commission, Maryland, USA, 31 August 2006, pp 7-11 http://docs.wind-watch.org/russellboundstestimony.pdf]

**Giant Blades Are Slicing Prices**

"If the experience of Cumbrian homeowners is anything to go by residents within a mile or so of the proposed Romney Marsh wind farm will have an uphill struggle selling their properties from now on… Kyle Blue, a Penrith estate agent… Yet when his company auctioned Bretherdale Hall, a semi-derelict farmhouse half a mile from the proposed turbines, it fetched £200,000 - £80,000 less that its valuation before the plans for the wind farms were announced. Another nearby property, a freshly restored £340,000 farmhouse, found a buyer who said the wind farm wouldn't bother him because he was keen on renewable energy. Then he went away, did some research and changed his mind, says Blue. The house remains unsold." [Clark R. Giant Blades are Slicing Prices. *Sunday Telegraph* 17 October 2004]

**Property Valuation Report on a Number of Affected Properties**

"Given a sample of properties inspected and reported as above, this represents an immediate loss of £1,528,000 for the 8 properties mentioned, let alone all those which may be affected by the turbines..." [Scourfield G. Report on a Sample of Properties Inspected near a Proposed Wind Farm at Esgairwen Fawr nr Lampeter (Wales, UK). RG Lewis & Company Estate Agents, Auctioneers and Property Valuers, T/A ReMAX Estate Agents, Carmarthen, Summary, 11 July 2005, p 6]

**Turbine Plan Cut Value of Our Home by a Third**

"Two independent agricultural valuers, which visited the large four bedroom bungalow in East Allington last week, both calculated that since planning application for the turbines at Goverton was submitted earlier this year, the price of the Lethbridge's near £500,000 home had fallen by £165,000." The wind turbine will be 540mtrs from their home." [Kirk J. Turbine Plan Cut Value of Our Home by a Third. *Western Morning News* 9 December 2004] [See also: Webb C. My Property Nightmare: Wind Farm. *Sunday Telegraph* 26 January 2005 http://www.telegraph.co.uk/property/mypropertynightmare/3338689/My-property-nightmare-wind-farm.html#disqus_thread]

**Clouds Gathering over Wind Farm Plan**

" 'Almost every property in their street, apart from those of farmers on whose land the turbines are built, is for sale. I've watched my husband work all his life to build this home,' Mrs Cicero said. The Ciceros had their home valued at $410,000 before the wind farm was taken into account. Afterwards, the estimated value

dropped to $270,000. They have not received one offer for their property in two years." [Clouds Gathering over Wind Farm Plan. *Australian News* 9 January 2006]

**Wind Concerns Ontario: Self-Reporting Survey** [later renamed the WindVOiCe survey]

"Some of these families have been forced to abandon their homes in order to protect their health. This phenomenon is occurring worldwide, not just Canada." [Wind Concerns Ontario. A Self-Reporting Survey: Adverse Health Effects with Industrial Wind Turbines and the Need for Vigilance: Abstract and Participant Comments. Wind Concerns Ontario Community-based Health Survey, July 2009. Presented on April 22 2009, by Dr Robert McMurtry to the Ontario Government's Standing Committee re: Bill 150, the Green Energy Act, S.2 http://windconcernsontario.wordpress.com/health/health-survey-information/]

**McCann Appraisal, LLC, to the Ottawa Citizen.com**

"For example, numerous families have been forced to abandon their homes due to the factual impacts to health, sleep disturbances and the like, which the Canadian Wind Energy Association and the American Wind Energy Association prefer to dismiss as 'concerns'. Many others have been unable to sell their homes due to the presence of nearby turbines, and which a growing list of realtors and estate agents report as being the deciding factor in would-be buyers decisions to look elsewhere. There is a measurable and significant loss of values within 2 to 3 miles..." [McCann MS of McCann Appraisal, LLC (Real Estate Appraisal & Consulting), Chicago, Illinois (USA). There is a Measurable and Significant Loss of (Property) Values within 2 to 3 Miles (letter). *Ottawa Citizen* (Canada) 25 January 2011]

**It's an Ill wind that Threatens Peatlands**

"The estate agent says it would knock £100,000 off the value of the property if the turbines get built. My view is that we won't be able to sell it at all." (Note: The property is 560 metres from the nearest wind turbine.) [It's an Ill wind that Threatens Peatlands. *Yorkshire Today* 12 March 2005]

**Council Tax Discount when Property is affected by Proximity of a Wind Turbine**

"Mr Pickles: To ask Secretary of State Local Government if she would **list each type of local council tax discount introduced by billing authorities under Local Government Act 2003**."

Mr Healey responded with a list that included:
**"Property affected by the proximity of a electricity generating wind turbine."** [Hansard. Pickles E (Brentwood and Ongar, Con) and Healey J (Wentworth and Dearne, Lab). Council Tax: Tax Allowances, 13 May 2008, c1442W, http://www.publications.parliament.uk/pa/cm200708/cmhansrd/cm080513/text/80513w0004.htm] [Emphasis added.]

**Buyers Clearly Wind Resistant (Toora, Australia)**

"No one could have done more to try to sell our property... The capital-improved value of our property fell 7 per cent in the same period in which the average CPI value in the shire rose 18 per cent. Now, this seems to me to be an admission of a decrease of 25 per cent... As well as having the enormous visual impact to contend with, we also had to hope for a calm day so that the not inconsiderable noise did not put people off.."
[Hurst T. Buyers Clearly Wind Resistant (letter). *Weekly Times* (Australia) 23 April 2003]

**Turbines Cast Shadow Over Land Values**

"The arrival of wind farms in South Gippsland threatens to seriously erode property values, according to real estate agents. [Sellars P. Turbines Cast Shadow over Land Values. *Weekly Times* (Australia) 16 April 2003]

**Testimony to Adams County Board, Illinois, USA, by McCann Appraisal, LIC**

"Summary of Opinions, 1 – 9:

(1) Residential property values are adversely and measurably impacted by close proximity of industrial-scale wind energy turbine projects to the

residential properties, with value losses measured up to 2 miles from the nearest turbines in some instances.

(9) A market value reduction of $6.5 million is projected for the residential property located in the footprint and within 2-miles of the pending Prairie Mills project located in east Adams County."

(Recommendations: These are detailed and worthy of note.)

[McCann MS. Testimony to Adams County Board, Illinois, USA, 8 June 2010]

**Letter from Green & Ribnick after visiting Waubra, Australia**

"So when we asked about real estate values the people in Waubra laughed. They said the real estate values have not declined, because the wind developers have bought some properties. Therefore the statistics say that real estate values have not declined. But the reality is something else. The only real estate that is selling is the houses that are purchased by the wind energy industry… There are for sale signs all over the area in Waubra. No one can sell, is what we were told." [Green PG and Green LA. Adverse Impacts from Wind Turbines in Waubra, Australia and Surrounding Area. Green & Ribnick, Professional Resource Group (PRG), Wellfleet, Massachusetts, USA, 14 January 2011]

## 4.3 STATE INDIFFERENCE TO HUMAN RIGHTS: THE UK PLANNING BILL AND THE UK EQUALITY AND HUMAN RIGHTS COMMISSION [EHRC]

In 2008, a draft of the proposed Planning Bill included new government policy that might potentially trigger a Human Rights violation. A clause, inserted several days before Parliament's summer recess, suggested that the executive of government planned to withdraw the legal option for citizens to seek judicial protection when their rights are threatened or abrogated by industrial environmental pollution. [UK Planning Bill 2008 http://services.parliament.uk/bills/2007-08/planning.html]

The proposed clause in question, 151, included in the draft Planning Bill, 28 July 2008, stated:

**151 Legal challenges relating to nuisances etc.**

"No proceedings, whether criminal or civil, in nuisance and no civil proceedings in respect of the escape of things from land, other than proceedings for breach of statutory duty, may be brought in relation to development, works or operations authorised by an order granting development consent."

This clause appeared to represent an attempt by the Secretary of State to deprive the historic authority of the Judiciary over the control of Nuisance emitted from adjoining premises and the impact on the lives of families because of that nuisance. The clause is fundamentally undemocratic and represents 'Regulatory Expropriation' of the basic property rights of ordinary people and families.

The frontispiece to the Bill read:

"EUROPEAN CONVENTION ON HUMAN RIGHTS
Baroness Andrews has made the following statement under section 19(1)(a) of the Human Rights Act 1998:
'In my view the provisions of the Planning Bill are compatible with the Convention rights.'"

This assurance was questionable in light of the wording of Clause 151. Hansard includes these references to Clause 151 and Clause 236, both late additions to the Planning Bill very shortly before the summer recess:

"House of Commons, 25 June 2008, Column 327 – 330, Orders of the Day, Planning Bill
The Secretary of State for Communities and Local Government (Hazel Blears):
I beg to move, That the clause be read a Second time.

New Clause 39 Legal challenges relating to nuisance etc.

> 'No proceedings, whether criminal or civil... order granting development consent.' (Mr. Betts)
> Brought up, read the First time, and added to the Bill**."**

> "House of Lords, 27 June 2008
> Part 7, Chapter 3: General
> Clause 151: Legal challenges relating to nuisance
> 236. **This clause confirms that no legal proceedings either for nuisance, or in respect of the escape of things from land, can be brought in relation to a development authorised by a development consent order. An exception is made for proceedings for breach of statutory duty. "** [Emphasis added.]

The last-minute inclusion of Clause 151 suggests that the Secretary of State was concerned about the consequences of allowing people recourse to the judiciary when developments cause environmental pollution, rather than the potential impact on the affected families.

Instead, the Secretary of State (at that time, Hazel Blears), should have addressed the issues of balance and proportionality, as posed by Lord Wolf in his book, *The Pursuit of Justice*:

> **'Is the reaction of Parliament proportionate to the perceived threat?'**
> [Lord Woolf. *The Pursuit of Justice*. Campbell-Holt C, ed. Oxford University Press, March 2008]

Evidence of State indifference to Human Rights is illustrated by an appeal to the UK Equality and Human Rights Commission (EHRC) to investigate this potential violation. In response to the major sequestration of citizens' rights available to citizens represented by clause 151, in August 2008, a UK citizen – for the sake of confidentiality, Mr Z – wrote to the Equal and Human Rights Commission (EHRC), the arm of the State charged with monitoring UK government compliance with Human Rights obligations. Mr Z wrote to alert the Commission that the proposed Town Planning Bill 2008, (2nd reading before the House of Lords), contained Section 151, which sought to eliminate the basic Human Rights of people and disallow their recourse to the judiciary in cases of nuisance caused by State authorised infrastructure projects.

Because of complaints brought forward, the EHRC provided a briefing note to the House of Lords advising:

> "The proposed wording of clause 151 is too extensive in scope and is contrary to the provisions of the Human Rights Act and the Commission (EHRC) calls for its removal from the Bill."
> [UK Equality and Human Rights Commission (EHRC)
> http://www.equalityhumanrights.com/]

In a letter dated 16 October 2008, the EHRC advised Mr Z that section 151 had been withdrawn.

In another letter, dated 16 October 2008, the EHRC informed Mr Z that:

> "Having considered the content and context of the proposed provision, the Commission raised concerns regarding its compliance with the Human Rights Act 2000 with the Government. Attached, for your information, is a copy of the briefing that we prepared for second reading in the House of Lords. We have now been informed that the clause has been withdrawn but we will continue to monitor the passage of the Bill in the light of those concerns."

**The EHRC 'Planning Bill Parliamentary Briefing', October 2008, advised the House of Lords:**

> "8. Civil rights protected by the HRA are recognised under domestic law. In the event of a genuine and serious dispute over one of those rights arising out of development, works or operations authorised by an order granting development consent, there is a right of access to a court. Clause 151 would significantly limit that right as well as the right to an effective remedy guaranteed by Article 13 ECHR (though not contained in the HRA this is guaranteed by the ECHR). Even if ultimately on the facts of the case, no violation of a substantive right were to be found, the absence of an effective remedy to establish that would in itself amount to a violation of the ECHR.

11. The proposed clause is unduly broad and represents a material change from the status quo in a number of ways, for example:
'Currently planning legislation sets out a system for appealing planning decisions and development orders, including the ability to judicially review such decisions or orders. Though 'development control' under the town and country planning legislation is supposed to be separate from environmental control, it is recognised that there are overlaps and so environmental issues can be valid planning reasons to object to and appeal against planning decisions and development orders. Once the appeal was unsuccessful, a development can proceed. However, currently, the failure of any appeal process does not restrict a parties rights in relation to nuisance claims under the Environmental Protection Act 1990 the Local Government Act 1972 and the common law.

12. There is a line of case law that basically states that a planning permission can change the character of a locality and that may impact on whether a nuisance is committed or not – but that is a line of case law, not a provision under statute, and it deals with whether a claim is successful as opposed to restricting the bringing of such a claim.

13. The current wording removes the power of any regulatory authority or court from requiring the developer to take any mitigation measures – even if such measures could be easily taken.

14. During the course of the development should any unforeseen consequences arise, no entity will be able to require the developers to reassess the situation."

Subsequently, in a letter dated 4 January 2010, Mr Z alerted the EHRC that S.151 had indeed survived in the Planning Act (2008), (Royal Assent 26 November 2008):

"In a letter dated 16 Oct 2008 you responded to my concern that Section 151 of the Planning Bill 2008, as drafted, would be a violation of the ECHR... Unfortunately, the spirit of that clause (S.151 Planning Bill) survives in the Planning Act 2008, S.152 and 158.
To compound the loss by citizens to seek redress, this grievance is further underscored with the consultation draft of National Policy Statement EN-1. Specifically, Section 4.14, which derives from Sections 152 and 158 of the Planning Act 2008, restricts these rights more decisively. Section 4.14 as proposed in EN-1 will trigger a failure by the State in its basic human Rights responsibilities to protect citizens.

To review the relevant Sections mentioned above:

**The Planning Act 2008, Section 158 Nuisance; statutory authority states:**
This section provides a defence of statutory authority in proceedings for nuisance if a person carries out development for which consent is granted by an order granting development consent. Such defence is available in respect of anything else authorised by an order granting development consent.
[http://www.legislation.gov.uk/ukpga/2008/29/contents]

**The Planning Act 2008, Section 152: Compensation in case where no right to claim in nuisance, states:**
This section confers a right to compensation in cases where, as a result of section 158 or the terms of a development consent order, a person would not be able to succeed in a claim for nuisance in respect of works authorised by a development consent order. Compensation is available in relation to injurious affection to a person's land or depreciation in its value.
[http://www.legislation.gov.uk/ukpga/2008/29/contents]

**Furthermore National Policy Statement draft NPS (EN-1) section 4.14: Common law nuisance and statutory nuisance states: (2010)**
4.14.1 Applicants may include in their application, a request for the grant of a defence of statutory authority against nuisance claims. In particular, the application may make reference to the provisions of section 158(1) and (2) of the Planning Act 2008, which confers a defence of statutory authority for the purpose of providing a defence in any civil or criminal proceedings for nuisance arising from

> infrastructure for which development consent has been granted. For the purpose of Section 158, the term 'nuisance' takes its common law definition. The defence is also available for statutory nuisances under Part 111, Environmental Protection Act 1990."
> [Department of Energy & Climate Change (DECC). Revised Draft Overarching National Policy Statement for Energy (EN-1). DECC (UK), October 2010. http://www.official-documents.gov.uk/document/other/9780108509346/9780108509346.pdf]

The letter from Mr Z of 4 January 2010, alleged that Section 4.14 of NPS (EN-1) is a violation of:

> **Article 30, The United Nations Universal Declaration of Human Rights 10 Dec 1948:**
> "Nothing in this Declaration may be interpreted as implying for any State, group or person any right to engage in any activity or to perform any act aimed at the destruction of any of the rights and freedoms set forth herein."
>
> **Article 8, The United Nations Universal Declaration of Human Rights 10 Dec 1948:**
> "Everyone has the right to an effective remedy by the competent natural tribunals for acts violating the fundamental rights granted him by the constitution or by law."
> [http://www.un.org/en/documents/udhr/]
>
> **Article 17, Convention for the Protection of Human Rights and Fundamental Freedoms 1959, (amended by Protocol No.11):**
> "Nothing in this Convention may be interpreted as implying for any State, group or person any right to engage in any activity or perform any act aimed at the destruction of any rights and freedoms set forth herein or at their limitation to a greater extent than is provided for in the Convention."
>
> **Article 13, Convention for the Protection of Human Rights and Fundamental Freedoms 1959, (amended by Protocol No 11):**
> "Everyone whose rights and freedoms as set forth in this Convention are violated shall have an effective remedy before a national authority notwithstanding that the violation committed by persons acting in an official capacity."
> [http://conventions.coe.int/treaty/Commun/ListeTraites.asp?CM=8&CL=ENG]
>
> **Article 54, Charter of Fundamental Rights of European Union July 2003:**
> "Nothing in this Charter shall be interpreted as implying any right to engage in any activity or to perform any act aimed at the destruction of any of the rights and freedoms recognised in this Charter or at their limitation to a greater extent than is provided for herein."
> [European Union. The Charter of Fundamental Rights of the European Union. http://www.europarl.europa.eu/charter/default_en.htm]

When the Planning Act 2008 was published, clauses 152 and 158 were included, apparently derived from Section 151 of the Planning Bill: these two clauses were just as destructive to basic human rights and removed the ordinary citizen's right to seek redress in the courts if a nuisance was caused by a State authorised infrastructure project.

Hitherto, the law of 'strict liability' has allowed injured families to apply to the Court for relief. In the Rule of *Rylands v Fletcher*, Blackburn J said,

> "The person who for his own purposes brings on his lands and collects and keeps there anything likely to do mischief if it escapes, must keep it in at his peril, and if he does not do so, is prima facie answerable for all the damage which is the natural consequence of its escape."
> [Rylands v Fletcher, 3 HL 330, (1868) LR 3 HL330, [1868] UKHL 1 http://www.bailii.org/uk/cases/UKHL/1868/1.html]

The definition of 'non natural' use of land has included the production of electricity. As an example, if a wind turbine, intended to generate electricity on an industrial scale or to feed domestic production into the National Grid, is built on land too close to adjoining homes, the by-product of the manufacturing process may create noise pollution. This noise pollution, if allowed

to escape in sufficient volumes, is likely to cause nuisance and perhaps serious health consequences to those living nearby.

The Planning Act 2008 provides the Secretary of State with the power to prepare 'National Policy Statements' (NPS) that set the framework for decisions by the 'Infrastructure Planning Commission'. The Department of Energy and Climate Change (DECC) issued the first NPS, *'Overarching NPS for Energy (EN-1)',* which is currently following the consultation procedure provided in the Planning Act 2008. The draft was referred to in a letter to Chief Planning Officers from Communities and Local Government, dated 9 November 2009.

The *National Policy Statement draft EN-1*, in Section 4.14, triggers a failure by the State in its basic human rights responsibility. In a letter to the EHRC dated 4 January 2010, Mr Z drew attention to this position (keeping in mind that the EHRC called for the removal of such powers because of their infringement on citizens' recourse to the judiciary).

Hitherto, a citizen could have claimed protection under the existing Environmental Protection Act 1990:

> "Section 79 EPA 1990:
> 'Noise emitted from premises so as to be prejudicial to health or a nuisance."
> [UK Environmental Protection Act 1990
> http://www.legislation.gov.uk/ukpga/1990/43/section/79]

Yet the Planning Act 2008, Sect. 158 extends to the State expanded and new powers that may instead prohibit a citizen from seeking redress when faced with a noise nuisance:

The EPA interprets: **'prejudicial to health'** as **'likely to cause injury to health'**.

However, the Planning Act 2008 and the initial draft NPS EN-1 make no mention of the need to protect health and human dignity.

Yet, Article 1, Chapter 1 of the Charter of Fundamental Rights of the European Union states clearly:

> **"The dignity of the human person is not only a fundamental right in itself but constitutes a real basis of fundamental rights. The 1948 Universal Declaration of Human Rights enshrined this principle in its preamble. Whereas recognition of the inherent dignity and of the equal and inalienable rights of all members of the human family is the foundation of freedom, justice and peace in the world."**
> [European Union. The Charter of Fundamental Rights of the European Union.
> http://www.europarl.europa.eu/charter/default_en.htm]

Mr Z provided evidence to the EHRC that illustrated how families were suffering severe noise disturbance, leading to sleep deprivation and sleep disturbances, and the adverse health effects that ensued. The EHRC was also alerted to a report from the Legislative Council of the New South Wales Parliament acknowledging that the problem with noise pollution from wind turbines does exist. [Letter to EHRC, 20 February 2010]

After weeks without response from the EHRC, Mr Z contacted the Commission by letter on 24 April 2010:

The EHRC were reminded that the new NPS EN-1 appeared to remove basic human rights protection from families when large infrastructure projects are proposed for locations in proximity to homes, schools, and other sensitive facilities.

The EHRC were advised of the stark inequality for rural families on limited income who would have to raise large sums of money in order to seek professional advice, while the infrastructure developers have substantial financial backing, in terms of millions of GBP, to oppose any objection brought by the affected families, as well as government carte blanche via legislation.

Moreover, people are also up against false claims by wind energy developers; e.g., the UK Advertising Standards Authority [ASA] partially upheld a complaint against Volkswind Ltd UK for

misleading information in a brochure promoting a wind farm application. [Advertising Standards Authority (ASA). Adjudication on Volkswind UK Ltd. Complaint Ref 104318, 31 March 2010 http://www.asa.org.uk/ASA-action/Adjudications/2010/3/Volkswind-UK-Ltd/TF_ADJ_48283.aspx#]

EHRC attention was also drawn to a *Daily Telegraph* article that discussed revelations that one in six wind farms had complaints about noise. With greater than 16% of sites incurring complaints, one might inquire if the same disinterest would extend to failure rates in schools or rates of cancellation for scheduled public transport. [Gray L. Noise complaints about one in six wind farms. *Daily Telegraph* 6 March 2010]

Once again, because Mr Z had not yet had any response from the EHRC, in a letter dated 8 June 2010, the EHRC was asked again whether it intended to intervene in the potential violation brought to their attention in the letter of 4 January 2010, regarding clauses 152 and 158 of the Planning Bill, particularly as the EHRC had initially objected to their inclusion.

Finally, in a letter dated 19 July 2010, the EHRC responded:

> "From an assessment of the information that you have sent us it has been decided that taking action in this matter would not meet our current strategic objectives"

The letter made no comment upon the potential Human Rights violation by the UK Government.

In reply, Mr Z expressed disappointment and in his reply, referred to the EHRC *Strategic Plan 2009-2012*, 5 strategic priorities. Priority 1 states:

> **"Protecting, promoting and mainstreaming human rights.**
> **To promote and protect the provisions of the Human Rights Act and ensure they are applied across government and public services, implementing the findings of the HR Inquiry.**
>
> **Findings of the Human Rights Inquiry (HRI) for England and Wales published Q1 2009/10.**
> **Implementation of the HR recommendations and promotion of awareness and understanding of human rights working with Inspectorates, public bodies and service providers."** [p 57]
> [UK Equality and Human Rights Commission (EHRC).
> http://www.equalityhumanrights.com/]

Mr Z challenged the EHRC:

> "...when the State authorises industrial development near family homes, despite the evidence of a high potential risk for health injury, I would have thought it reasonable to expect that the arm of the State charged with monitoring compliance with Human Rights obligations, would feel a duty to intervene and ensure that the rights of these families were properly protected. For a government that openly proclaims a policy based on '*Freedom, Families, and Responsibility*', it is essential that the State agency charged with the responsibility of ensuring that other departments of State properly respect the international conventions on Human Rights, the EHRC would have wished to intervene by reminding decision makers and the Inspectorate about the potential for violation."

Mr Z then asked for full disclosure of information under the *'Freedom of Information Act'*, in order to understand the change in the EHRC approach and the reasons for this change. [Letter to the EHRC dated 23 July 2010]

The EHRC replied on 20 August 2010:

> "We do not consider it appropriate to disclose the information you have requested under the Freedom Of Information Act 2000 (FOIA) as this is comprised of internal documentation that is caught by the exemption under section 42 of the FOIA (Legal Professional Privilege)."

In response to this refusal without explanation to disclose information on a potential environmental pollution matter, Mr Z requested that all correspondence proceed to the next stage, which is an internal review. [Letter to EHRC, 23 August 2010]

On 10 November 2010, the EHRC responded and upheld its previous decision:

> "Moreover, we must draw your attention to the EHRC's complaint policy which states that we do not undertake reviews of decisions by the Commission (EHRC), in which we have decided not to use our legal powers...
>
> We refer you back to our response dated 11 October 2010, in which we provided an explanation as to why your case did not meet our strategic priorities.
>
> Our strategic priorities are dictated by the levels of inequality such as those reported in our Triennial review and by our duties as a National Human Rights institution to deal with serious breaches of Human Rights.
>
> As you have now exhausted our review procedure and we have now closed your file, if you remain dissatisfied with our response, we would respectfully suggest that you contact the Parliamentary and Health service..."

On 8th December 2010, an Appeal on the decision by the EHRC not to release information was made to the Information Commissioners Office (ICO) under the Freedom of Information Act (FOI). The ICO was also asked to consider the request for information that related to the release of environmental pollution under the provisions of the Aarhus Convention (1998), to which the UK is a signatory.

The Aarhus Convention says:

> "The preamble connects the concept that adequate protection of the environment is essential to the enjoyment of basic human rights with the concept that every person has the right to live in a healthy environment and the obligation to protect the environment."
> [Aarhus Convention: Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters. UN Economic Commission for Europe (UN-ECE), Aarhus Denmark, 25 June 1998 http://ec.europa.eu/environment/aarhus]

The Aarhus preamble then concludes that to assert this right and meet this obligation, citizens must have access to information, are entitled to participate in decision-making, and must have access to justice in environmental matters.

Eventually, on 22 June 2011, the EHRC responded to Mr Z, enclosing the *"Notes of Meetings"* in which all the information had been redacted. However, one document, entitled *"Initial Scope",* appeared to advise a committee. It appeared to Mr Z that the *"Initial Scope"* failed to address the 'Complaint', which related to Planning Act 2008, S.152 and 158, and subsequent draft Planning Policy EN-1. The EHRC document stated that:

> "This complaint is low risk, it does not have the potential to influence systemic, widespread change given that the number of wind farms is fairly small with several based in Scotland, Wales and Ireland."
>
> "**There isn't any apparent risk to the Commission's reputation** and the complaint does not fit any of the strategic priorities as set out in the Legal or Human Rights strategies." [Emphasis added.]

It took nearly one year to get this ineffectual (and self-serving) explanation from the EHRC to justify its inaction. Moreover, it was only as a result of the effective intervention by the Information Commissioners Office that the EHRC released this information. In July 2010, the new government decided to remove the Infrastructure Planning Commission and transfer the task of considering large infrastructure schemes to the Planning Inspectorate. For this reason Mr Z continued with efforts to pursue the right of UK citizens to seek judiciary recourse when State

authorised large infrastructure schemes, proposed or built near homes, might trigger an environmental pollution nuisance prejudicial to health. The developers can rely on the defence of 'Statutory Authority' against legal action (Statutory or Civil nuisance actions), yet the ordinary person would have no recourse for protection or amelioration.

This exchange illustrates just how long it can take the ordinary citizen to seek explanation and/or protection from government departments, even those that purport to protect the interests of the individual. The process is time-consuming, tedious, frequently costly, and often unproductive.

In November 2009, the Government published draft National Policy Statement for Renewable Energy Infrastructure EN-3. Section 2.7.65 "IPC Decision Making" states:

> "The IPC should use ETSU-R-97 to satisfy itself that the noise from the operation of the wind turbines is within acceptable levels."
>
> S.2.7.66 continues: "Where the correct methodology has been followed and a wind farm is shown to comply with ETSU-R-97 it should be reasonable for the IPC to conclude that **it may give little or no weight to adverse noise impacts from the operation of wind turbines."**
> [Department of Energy & Climate Change (DECC). Draft National Policy Statement for Renewable Energy Infrastructure (EN-3). DECC (UK), November 2009 http://www.official-documents.gov.uk/document/other/9780108508516/9780108508516.pdf]
> [Emphasis added.]

Despite evidence-based research articles in health sciences journals about the impact of noise on sleep and health, as well as the evidence presented in the authors' 2007 paper, *'Noise Radiation from Wind Turbines Installed Near Homes: Effects on Health'*, the evidence presented in this paper, WHO reports, and other documentation, already well known by Government, the provisions in EN-3 must be regarded as the UK Government's disinterest in protecting the basic human rights of ordinary people – families, children, the elderly, the vulnerable – who are destined by Government authorisation to suffer the consequences of a Guidance (ETSU-R-97) that does not provide adequate health protection to families when wind turbines are built near homes and other sensitive facilities.

On 24 January 2011, the Renewable Energy Foundation published its response to the DECC consultation on the revised draft National Policy Statement EN-3:

> "We conclude that EN-3 is still not fit for the purpose it is intended, and should not be formally approved. (2) While we have not repeated our criticisms of first iteration of EN-3, those observations still stand. Indeed, it is difficult to believe that any of the previous criticisms, from REF or others, have been addressed. (7)
>
> It is also clear that the authors of EN-3 have not read or understood ETSU R 97. For example, para 2.7.56 states that ETSU R 97 'recommends noise limits that seek to protect the amenity of wind farm neighbours'. This is incorrect. (8) In fact, ETSU R 97 specifically does not seek to protect neighbours amenity and the authors are clear that the noise limits suggested exceed the levels necessary to preserve amenity (see page 62 ETSU R 97)." [REF p 2/9 Introduction (1)]
>
> "Further Comments on EN-3
> (20). Returning to EN-3, the statement at para 2.7.58 at the IPC (Infrastructure Planning Commission) 'should use ETSU R 97 to satisfy itself that the noise from the operation of the wind turbines is within acceptable levels' is irrational and meaningless. There is no guidance in ETSU R 97 about determining operational noise. ETSU R 97 gives information on how to quantify pre-existing background noise over a range of wind speeds.
>
> (21). Similarly, paragraph 2.7.59 remarks that 'Where the correct methodology has been followed and the wind farm has been shown to comply with ETSU R 97... etc,' but this is empty of meaning since there is no correct methodology for establishing wind farm noise levels, as ETSU R 97 is silent on the key issue of noise predictions. Without guidance on a methodology for predicting turbine noise,

there is inevitable ambiguity on whether a wind farm can be shown to comply with any levels or not."
[Renewable Energy Foundation. Response to DECC Consultation on the Revised Draft National Policy Statement EN-3 Renewable Energy Infrastructure and related documents. REF, 24 January 2011 http://www.ref.org.uk/publications/218-ref-response-to-re-consultation-on-nps-en-3]

When considered in the light of the Court of Appeal decision [*EWCA Civ 1635* (2010)], the 'Welsh Ministers Case', REF's evidence and arguments show how the administration of Government – DECC (previously BERR, and before, Dti) – seeks to circumvent Case Law.
[Department of Energy & Climate Change (DECC), NPS EN-3, S.2.7.66 http://www.official-documents.gov.uk/document/other/9780108508516/9780108508516.pdf]

# *Appendix 4.1*

## Proximity to Homes: Additional References

**Council Ruling to Change Future of Windfarm Plans (Carmarthenshire, Wales).**
*ThisIsSouthWales*, 23 March 2011.
http://www.thisissouthwales.co.uk/Council-ruling-change-future-windfarm-plans/story-12461867-detail/story.html

Crosby D.
**Legal Challenge against Wind Turbines Moves Forward with Appeal (Prince Edward County, Canada).**
*The Sun Times* (Canada), 20 March 2011.
http://www.owensoundsuntimes.com/ArticleDisplay.aspx?e=3036164

Edwards J.
**Calls for Alltwalis Wind Farm to be Shut Down, 7 July 2010.**
http://www.jonathanedwards.org.uk/calls-for-alltwalis-wind-farm-to-be-shut-down

Hammonds LLP.
**Letter re: Impact of Green Rigg Wind Turbines on Waterfalls, Birtley Wark, Hexham, 11 June 2010.**
http://docs.wind-watch.org/Hammonds_Northumberland_CC_100611.pdf

Johansson M.
**We Now See Families Leaving Their Homes (Denmark).**
Letter to Editor, 26 May 2011.
http://www.windturbinesyndrome.com/news/2011/we-now-see-families-leaving-their-homes-reports-physician-denmark/print/

Leslie K.
**Ontario Unable to Tell if Wind Farms Exceed Noise Limits, Activists Say.**
*The Globe and Mail* (Toronto, Canada), 15/16 June 2011.
http://www.theglobeandmail.com/news/politics/ontario-unable-to-tell-if-wind-farms-exceed-noise-limits-activists-say/article2062789/

Mann T.
**Blumenthal Urges Tough Standards for Siting of Wind Power Projects.**
*The Day* (New London, Connecticut, USA), January 4 2011.
http://www.theday.com/article/20110104/NWS12/301049915/1069/rss

Oike YT.
**Japanese Conference on Big Wind: Presentations by Victims. (excerpts), 30 April 2010.**
http://www.epaw.org/documents/Japanese%20Conference%20against%20Big%20Wind.pdf

Ontario Environmental Review Tribunal (ERT).
***Erickson v Director, Ministry of the Environment*: Decision, 18 July 2011.**
Ontario, Canada.
http://www.ert.gov.on.ca/english/decisions/index.htm
(See also **Summary of Case and Decision,**
**First Appeal of Renewable Energy Approval Dismissed.**
Torys on Environmental, Health and Safety 19 July 2011;18(7)
http://www.torys.com/Publications/Documents/Publication%20PDFs/EHS2011-7.pdf ; and
Chamberlain A.
**First Appeal Decision on Renewable Energy Approval for a Wind Farm Rendered by Ontario Environmental Review Tribunal.**
*Energy Markets Bulletin* July 2011
http://www.martindale.com/members/Article_Atachment.aspx?od=1081999&id=1318358&filename=asr-1318360.First.pdf .)

Ray P.
**Charges against Wind Companies Upheld.**
*Altoona Mirror*, 27 March 2009.
http://www.altoonamirror.com/page/content.detail/id/517439.html

Shreve E.
**Turbines Get Louder at Night, Hearing Told.**
*Chatham Daily News*, 25 January 2011.
http://www.chathamdailynews.ca/ArticleDisplay.aspx?e=2959622

Spears J.
**Legal Challenge Could Stall Ontario Wind Projects.**
*The Star* (Ontario, Canada), 5 January 2011.
http://www.thestar.com/news/ontario/article/916620--legal-challenge-could-stall-ontario-wind-projects

Spears J.
**Top Court Rejects Wind Turbine Challenge.**
The Star (Ontario, Canada), 21 June 2011.
http://www.thestar.com/business/companies/article/1012641--top-court-rejects-wind-turbine-challenge

**Turbine Noise a Wind Developer Finds Objectionable.**
Industrial Wind Action Group, 15 June 2010.
http://www.windaction.org/faqs/27803

Turkel T.
**Turbines Turn into Headache for Vinalhaven; Noise Complaints Energize Opponents of Wind Power and Complicate Maine's Renewable Energy Efforts.**
*Portland Press Herald*, 24 January 2010.
http://www.pressherald.com/archive/turbines-turn-into-headache-for-vinalhaven_2010-01-24.html?searchterm=headache+for+vinalhaven

Zeller, T Jr.
**For Those Near, the Miserable Hum of Clean Energy.**
*New York Times*, 5 October 2010.
http://www.windturbinesyndrome.com/news/2010/for-those-near-the-miserable-hum-of-clean-energy-ny-times/

# *Appendix 4.2*

## Human Rights: General Issues, Specific Cases, and Property Values (International): Additional References

### General Issues


Adams N and Neil R.
**Wind Power: Planning Permission**, 11 November 2010, c461w.
Hansard: House of Commons. Official Publication of the UK Parliament.
http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm101111/text/101111w0003.htm#10111183000025

Coffman M.
**Wind Turbine Syndrome Prompts State Lawmakers to Propose 2-Year "Wind Farm" Moratorium.**
*Idaho Reporter* (USA), 18 March 2011.
http://www.idahoreporter.com/2011/house-committee-considering-moratorium-on-wind-turbine-construction/

Crum S.
**Strict Standards Vital for Whitley Wind Plant.**
*Journal Gazette* (Fort Wayne, Indiana, USA), 10 December 2010.
http://www.journalgazette.net/article/20101210/EDIT05/312109993/1021/EDIT

Gage Rt Hon Sir William, Chairman.
**Statement on the Baha Mousa Public Inquiry Report, 8 September 2011.**
http://www.bahamousainquiry.org/linkedfiles/baha_mousa/report/2011-09-08-chairmansstatement.pdf
See also:
Gage Rt Hon Sir William, Chairman.
**The Baha Mousa Public Inquiry Report.**
Presented to Parliament pursuant to Section 26 of the Inquiries Act 2005.
The Stationery Office (UK), HC 1452, vols 1 – 3, 8 September 2011.
http://www.bahamousainquiry.org/report/index.htm

Hart D.
**Anemometers, Environmental information, and Legal Advice: the Planning Inspectorate's Duty to Disclose?**
UK Human Rights Blog, 1 Crown Office Row (1COR), 25 August 2011.
http://ukhumanrightsblog.com/2011/08/25/anemometers-environmental-information-and-legal-advice-the-planning-inspectorates-duty-to-disclose/

Hart D.
**Just When You Thought They Were Extinct: Human Rights Environmental Case Succeeds.**
UK Human Rights Blog, 1 Crown Office Row (1COR), 27 July 2011. [re: Thomas v Bridgend CBC]
http://ukhumanrightsblog.com/2011/07/27/just-when-you-thought-they-were-extinct-a1p1-environmental-case-succeeds/

Parry S and Douglas E.
**In China, the True Cost of Britain's Clean, Green Wind Power Experiment: Pollution on a Disastrous Scale.**
*Daily Mail*, 29 January 2011.
http://www.dailymail.co.uk/home/moslive/article-1350811/In-China-true-cost-Britains-clean-green-wind-power-experiment-Pollution-disastrous-scale.html

## Specific Cases

**European Court of Human Rights (ECHR).**

S.167 ***Ireland v UK*** 1978 24EHRR 423
***Ireland v UK*** *ECHR 18.01.1978*
***Lopez Ostra v Spain****, 9 December 1994*
***Guerra and Others v Italy****, 19 February 1998*
S.87 ***Gafgen v Germany****, 1 June 2010*
S.88 ***Gafgen v Germany***
S.89 ***Gafgen v Germany****, 2010*
***Moreno Gomez v Spain****, 2004*
***Fadeyeva v Russia****, 2005*
***Hatton v UK****, 8 July 2003*
(*For Hatton, see also* the Joint Dissenting Opinions of Judges Costa, Rees, Turmen, Zupancic and Steiner, *Hatton and others v United Kingdom* decision and dissenting opinions: http://cmiskp.echr.coe.int/tkp197/view.asp?item=2&portal=hbkm&action=html&source=tkp&highlight=%22THE%20UNITED%20KINGDOM%22%20|%20hatton&sessionid=668105&skin=hudoc-en.)
(*See also*: S.79 *Chahal v UK* 1996; S.120 *Labita v Italy*; S.118 *Ramirez Sanchez v France*; S127 *Saadi v Italy* 2008; *Keenan v UK* S.110; S.67 *Jalloh v Germany.*)
(To read the decisions on ECHR cases, find these decisions at http://www.echr.coe.int/ECHR/EN/Header/Case-Law/Decisions+and+judgments/HUDOC+database/.)

English R.
**Slow but Steady on Access to Environmental Justice from Supreme Court.**
UK Human Rights Blog, 1 Crown Office Row (1COR), 13 April 2011.
http://ukhumanrightsblog.com/2010/12/20/slow-but-steady-on-access-to-environmental-justice-from-supreme-court/

## Property Values (International)

Nicol J and Seglins D.
**Ontario Wind Power Bringing Down Property Values.**
CBC News (Canada), 1 October 2011.
http://www.cbc.ca/news/canada/windsor/story/2011/09/30/ontario-wind-power-property-values.html

> 'However, last February, before an environmental review tribunal in Chatham, Environment Ministry lawyer Frederika Rotter said: "We will see in the course of this hearing that lots of people are worried about windmills. They may not like the noise, they may think the noise makes them sick, but really what makes them sick is just the windmills being on the land because it does impact their property values.
> "That's what makes them sick is that, you know, they'll get less money for their properties, and that's what's causing all this annoyance and frustration and all of that." '

These were comments made by the Counsel for the Director, Ministry of the Environment, during an Environmental Review Tribunal. [Environmental Review Tribunal. Appeal of Renewable Energy Approval, Kent Breeze Corporation and MacLeod Windmill Project Inc. (Kent Breeze Wind Farms) c/o Suncor Energy Services Inc. Case Nos.: 10-121 and 10-122, Counsel for the Ministry of Environment, Ontario, Canada http://www.ert.gov.on.ca/english/decisions/index.htm]

# *Chapter 5*

## David v Goliath

When industrial wind turbines are built in close proximity to existing family homes, the duration and dosage of the environmental noise pollution emitted by the wind turbine(s) causes families intense suffering, mental stress, sleep deprivation, fear, anguish and feelings of powerlessness.

Chapter 3 of this paper, regarding health, presents evidence that noise can interfere with a person's sleep, interfere with cognition and learning, adversely affect physiological and psychological functions, and may even lead to an increase in accidents. The problem is international in scope, and although governments of the UK, Denmark, Germany, Canada, Europe, Japan, Australia, and New Zealand, are all aware of the issue with wind turbine noise, most have not provided robust protection to those families affected or at risk, with the notable exceptions of Denmark and Victoria, Australia, mentioned earlier in this paper, which have altered policy in response to complaints and problems with noise.

UK politicians expound on 'true democracy', the participatory process, the importance in our society of basic human rights, and the importance of the family. Yet, the veneer shields large business interests and public officials acting on behalf of the State against whom the ordinary citizen has little power or protection. Wind energy developers and their powerful influence on government agencies and policies surely represent Goliath's seemingly unlimited resources to lobby on their behalf, compared to the ordinary family's 'David' of considerably modest resources. Unfortunately, slingshots do not work well in a highly bureaucratic society. (See also the discussion about Aitken's and Ellis *et al*'s research on wind turbine planning decisions, pp 17-20.)

While many families might willingly move home in order to escape a wind turbine scheme if they were compensated for the market value of their home before the scheme (plus moving and related expenses), such compensation is never available unless the land on which the home is built is required as part of the development. Instead, as chapter 4 (Article 1 First Protocol) shows, their homes devalue immediately with the announcement of the scheme, because of public awareness of the noise pollution emitted by the wind turbines. Even so, many people would prefer to stay in their homes and rely on public officials to take the precautionary steps to ensure that wind turbine schemes are not sited near homes, communities, and other sensitive facilities.

It is easy to dismiss the problem by saying that the family should resort to judicial protection. Yet it is unlikely that a family, brought to despair by the inhuman and degrading treatment authorised by "Goliath", undermining their confidence, health and well being, and their life savings, can then raise the substantial financial sums necessary to initiate legal proceedings. Furthermore, as described in Chapter 4.3, "Goliath" removed the option of judicial protection from "David", via S.152 and S.158 of the UK Planning Act, an action that appears to be in violation of "David's" human rights.

A family can report apparent environmental noise pollution to the local authority, which under Section 80 of the Environmental Protection Act 1990, can serve an abatement notice where a statutory nuisance exists. However, evidence shows that the local authority is unwilling to take action when a wind farm is the cause, because of the vastly complicated 'Noise Condition' in the Planning Permission, which requires the co-operation of the wind turbine owners and operators before on site noise measurements are taken. Wind turbines operate at several different 'modes', controlled by remote computer, so there is no provision to identify at which running mode the wind turbine is set during periods of extreme noise and periods when onsite noise measurements are being taken. Furthermore, the standard noise condition is highly complicated, which makes it easy for wind energy acousticians to argue that even substantial and debilitating noise nuisance comply with the standard Planning Condition on noise. (See Appendix 5.1, Mr and Mrs J Davis.) (See also *Hulme v Secretary of State* 2010 EWHC 2386 (Admin), CO/977/2010.)

By way of Section 82 of the EPAct, the family could set down proceedings if aggrieved by a statutory nuisance, but first this requires finance from the family for legal and acoustic engineer fees, and a number of days onsite by an acoustician to measure noise. But again, the site owner will argue that the noise levels recorded are within the scope of the planning condition set down by the authorising public officials.

A family may also proceed by way of a private nuisance; the well-known case of *Rylands v Fletcher* (3 HL 330, (1868) LR 3 HL330, [1868] UKHL 1) is the textbook example. However, as previously noted, the costs are prohibitive for the average family, especially for a family when the State has already effectively authorised the confiscation of the family lifetime savings largely via property devaluation. In contrast, the 'Goliath' wind energy industry has substantial financial, staff, and consultant resources, and can enter a protracted battle knowing it has this critical tactical advantage. Furthermore, for the wind energy industry, this is 'business'; for the families involved, this is 'personal'; thus, the toll exacted is more than financial.

*'Rylands v Fletcher'* found that:

> "The person who for his own purposes brings on his land and collects and keeps anything likely to do mischief if it escapes, must keep it in at his peril, and if he does not do so, is prima facie answerable for all the damage which is the natural consequence of its escape."
> [Rylands v Fletcher, 3 HL 330, (1868) LR 3 HL330, [1868] UKHL 1 http://www.bailii.org/uk/cases/UKHL/1868/1.html]

Thus, the Rylands v Fletcher principle provides that if a landowner introduces onto the premises an industrial wind turbine for the purpose of generating electricity by collecting and then processing the wind, and if during this process, creates an industrial and/or environmental noise pollution that discharges over neighbouring property, causing nuisance and health injury to neighbouring families where the industrial site has failed to contain the pollution, then the landowner is responsible for these consequences.

In theory, the family has recourse to the Human Rights Act 1998, Article 3, Schedule 1, Part 1, and Article 8 and Article 1 of the First Protocol. However, prohibitive costs make this option unrealistic and unfeasible for the average family living and working in the countryside. [Human Rights Act 1998 http://www.legislation.gov.uk/ukpga/1998/42/contents]

The UN Economic Commission for Europe (UN-ECE) authored the "Aarhus Convention 1998", which came into force in the UK in May 2005, soon after ratification. The Convention sets out rules on access to information, public participation, and access to justice in environmental matters.

On 25 August 2010, the Aarhus Compliance Committee issued draft rulings on two environmental challenges against the UK:

(1) ACCC/C/2008/27
(2) ACCC/C/2008/33

In both cases, the Committee found breaches by the UK of the Aarhus Convention.
(See more detail at: Hart David, QC. *Aarhus Breaches All Round*. UK Human Rights Blog, 1 Crown Office Row, 13 April 2011, http://ukhumanrightsblog.com/2011/04/13/aarhus-breaches-all-round/.)

The UK is signatory to the United Nations Convention on Human Rights and the UN Aarhus Convention. These Conventions protect basic human rights and the recourse to the judiciary – **at reasonable cost** – for families to seek protection from environmental nuisance.

In practice, most in the Planning Inspectorate are reluctant to acknowledge that Human Rights are engaged or require other than cursory attention, when the question of the potential impact on family life of wind turbine noise is raised as an issue at a Planning Inquiry. (See evidence (p 31), (Hulme) Planning Appeal Decision, North Tawton, 11 December 2009, APP/Q1153/A/06/2017162.)

Yet, on 24 November 2010, the Court of Appeal allowed the Welsh Minister's appeal against a judgment of Wyn Williams J concerning a wind farm development in North Wales. [Tegni Cymru Cyf Respondent - And - The Welsh Ministers & ANR Appellant. S.24, Case No: C1/2010/1426/QBENF, Lord Justice Carnwath, Lord Justice Elias and Lord Justice Pitchford between: Tegni Cymru Cyf Respondent - And - The Welsh Ministers & ANR Appellant, 24 November 2010] (The fact that TAN8 is marginally less 'instructive' than PPS22 S22, is not

relevant in terms of Human Rights.) [Planning Policy Statement 22 (PPS22): Renewable Energy, 10 August 2004. http://www.communities.gov.uk/publications/planningandbuilding/pps22]

In the January 2011 Planning Appeal decision at 'Tunstall, Roos', which was rejected on landscape grounds, only 2 paragraphs of the 79 paragraph decision considered the noise impact on nearby families (S54 – S55). Yet, in one direction some 22 homes were between 710m – 1300m from the wind turbines, and in another direction about a dozen homes were 840m – 1700m from the wind turbines. The developer's Environmental Statement predicted compliance with ETSU-R-97, and that seemed to satisfy the Inspectorate. In (S.9) the Inspector stated that:

> "The main issue in this case is whether any harm to landscape and visual amenity... would be sufficient to outweigh the presumption in favour of such proposals."
> (Note: There was no mention of the importance of protecting the health and amenity of neighbouring families.)
> [The Planning Inspectorate (UK). Tunstall, Roos, Hull. Appeal Decision. Inspector A Pykett. PINS Appeal Ref APP/E2001/A/10/2130670, 7 January 2011]

The Inspector amplifies his "presumption in favour" of renewable energy and wind farm development by reference to the development plan, energy policy, and regional targets, and to the European renewable energy targets for the UK and the Climate Change Act 2008. He also referred to the draft energy 'National Policy Statements'. (See Appendix 4.2.) One can only conclude that public officials have decided that in the UK, the Human Rights of ordinary families, even though the Human Rights Act 1998 is Parliamentary Law, have *deminimus* weighting in the context of national policy in order to meet arbitrary renewable energy targets. This underscores the importance of an impartial and accessible judiciary to the ordinary citizen, with its ability to weigh the overall balance of individual protection v state authority. But "Goliath" knows accessibility to judicial protection for "David" is beyond any realistic financial resources.

When a State professes to be a democracy that staunchly upholds Human Rights, how can that State allow a situation to evolve, and even deteriorate, when less protection is extended to ordinary families than e.g., to foxes, badgers, and protected landscapes (e.g., National Parks, Areas of Outstanding Natural Beauty), though these efforts are highly commendable. How has the 'Goliath' State become so intertwined with the big business of wind turbine developers (business seeking to maximise profit, civil servants seeking to maximise targets), that the Civil Service suppresses wind turbine noise recommendations by expert acousticians, thus allowing wind turbine construction to continue in close proximity to homes? [Leake J and Byford H. Officials cover up Wind Farm Noise Report. *The Sunday Times* (UK), 13 December 2009]

UK Civil Servants have a code of conduct that includes:

**"Integrity, honesty, objectivity and impartiality."**

[http://www.civilservice.gov.uk/about/values/cscode/index.aspx]

How can the Civil Service justify ignoring the mental stress, severe sleep deprivation, fear, anguish, and the consequent health problems experienced by those living with prolonged exposure to wind turbine noise pollution, all because a Guidance (ETSU-R-97) permitting wind turbines near homes has not been properly updated to ensure that this serious health risk does not persist? Do civil servants and the Energy Minister feel secure in the knowledge that nearly all families find litigation too daunting and forbiddingly expensive to contemplate this course of action? It appears that Ministers of State condoned public officials who concealed the results of their consultants' wind turbine noise report. [Leake Jand Byford H. Officials cover up Wind Farm Noise Report. *The Sunday Times* (UK), 13 December 2009; and Hansard, items dated 27 July 2010, c888w, c889w, c893w]

In Toronto, Canada, while seeking key information about adverse health effects and safety issues from eleven families who formerly lived near two different wind farms, the Drennan family learned that as part of the residents buy-out agreement with the wind farm owner, they were prohibited from discussing any negative experiences (a "gag" clause) relating to the wind turbines, including any adverse health effects. Supported by their community group, the family is asking the Court to invalidate the non-disclosure clause as fundamentally against the public interest. [Family

Takes Wind Turbine Companies to Court Over Gag Clauses on Health Effects of Turbines. *Digital Journal* 12 September 2011 http://www.digitaljournal.com/pr/417812. See also Couple Settle with Wind Farm Operators over 'Unbearable Hum'. *Telegraph* (UK) 30 November 2011, in which the November 2011 terms of settlement between Mr and Mrs Davis and a subsidiary of EDF 'are strictly confidential'; in the initial court session in July 2011, "the operators were accused of trying to impose a 'code of silence'." http://www.telegraph.co.uk/earth/environment/8925467/Couple-settle-with-wind-farm-operators-over-unbearable-hum.html]

By allowing construction of wind turbines in pursuit of renewable energy targets meant to control anthropogenic global warming (AGW), it is tempting for any Democratic State to move robustly toward those objectives even if at times the process rides roughshod over the democratic process. The UK has endorsed this approach concerning the development of onshore wind turbines by allowing these built in proximity to homes; promoting a dysfunctional noise guidance; encouraging self-regulation by the wind energy industry; doctoring a consultant's report; refusing to commission expert medical advice on the health implications of environmental noise caused by the turbines; and encouraging public officials to permit wind turbines as part of public policy and to consider landscape and wildlife above the health and welfare of those living.

Additionally, the UK Government endorses legislation that allows wind turbine developers "statutory authority" protection from nuisance claims caused by environmental noise pollution, disallowing those affected access to judicial recourse. The apparent inattention by public officials to breaches of the Aarhus Convention is yet another instance of insensitivity to the human rights of those affected.

All these conjoin to create a Goliath State, intent on its goals, sweeping aside the welfare of those who are unfortunate to discover that a wind turbine or wind turbines will be constructed near their homes. United with the Goliath wind energy industry, the two are a politically and financially powerful force that David would find daunting to confront. The prospect of the sequestration of family lifesavings and homes by the State, without precautionary legally binding protection or even of fair compensation to those affected, represents an imbalance in the system that is, in a cruel irony, undemocratic.

# *Appendix 5.1*

## David v Goliath

**Mr and Mr Davis, Grays Farm, Spalding, Lincolnshire**

We are Jane and Julian Davis, we farm (on a county council smallholding) in Spalding, South Lincolnshire. Julian has always farmed, in the place that is our home, and is also an agronomist. Jane is a Nurse, Midwife and Health Visitor (retired) and has been involved with mainly rural communities since 1980.

Our house, which we own, on our tenanted arable farm, is 930m from a wind farm, and is downwind of the prevailing wind. The wind farm, comprised of 8 wind turbines, each 100m high at blade tip with 2 MW capacity, became operational in the summer of 2006. Immediately we started having problems with the noise and hum coming from the wind turbines.

By May 2007 we were forced to abandon our home as a place in which to sleep and live; we currently rent a property 5 miles away so that our family can live as near a normal life as possible. Our house is now likely to have a value of just the land - £35K-£50K and is no longer marketable as a home for people to live in. [1]

We did not object to the wind farm in the planning stage as we had no reason to think that there would be any issues for us and we believed, at that time, that wind power was a good way of meeting the energy gap.

The government has found it necessary to set a specific measurement for wind turbine noise (ETSU-R-97) and has publicly acknowledged that aerodynamic modulation is not fully understood by scientists. This means that no developer can categorically state that there will not be a noise problem.

We know that not every wind farm creates noise issues but those that do make life impossible for those who live near them. By near we mean within 1.5 miles, or 2 km.

Noise, with possible consequential health effects,[2] and flicker from the blades, combine to diminish significantly, and even eradicate, the ability to enjoy the amenity of one's home, loss of value of the home itself, all these increasingly justifiable fears make people very worried. Increasing knowledge is demonstrating that Wind Turbine Syndrome does exist, and emerging evidence from across the world does demonstrate the devastating effects that this can have[3]. A study into flicker and association with photosensitive epilepsy has recently been published.

As far as our issues with noise are concerned, various investigations have been carried out. The Local Government Ombudsman has been involved. Her conclusion is that the noise planning condition (which is the same as, or similar to, every other noise condition imposed in the country for Wind Farms, based around ETSU-R-97, the so called industry standard) is **"vague, open to interpretation immeasurable and thus unenforceable".** In our case planning conditions were approved by the Planning Inspectorate, which is outside the jurisdiction of the Local Government Ombudsman, so the matter of a non specific planning condition is now being investigated by the Parliamentary Ombudsman.

We know that 20% of all current wind farms have some noise problems, and at the moment at least 5% of the total operational numbers cause problems that are as bad as ours.

However no-one really knows why, or appears interested in researching and finding out ways to solve an issue which clearly has the capacity to increase, if more wind turbines are built too close to homes. Because the wind energy industry cannot accurately predict if a site will experience problems with noise, and because ETSU-R-97, the guidance used by BERR for planning applications offers no protection to families, wind turbines should never be sited near homes.

**Time and money.** We are quite sure that the Government has no concept of the immense amount of time, money and emotional energy expended by villagers, in the vicinity of each inappropriate application. People are trying not only to protect the visual amenity of the area in which they live, but also not to lose the very thing which they have spent their lives working and saving for, notably an environment that promotes the health and well-being of families, as well as the peace, tranquillity and amenity of their homes and gardens. The financial cost to us so far has been: £250,000 was our estimated loss up to April 2008. Our home to-day would have been worth about £... if it were not for the noise from the wind farm, but Agents advise it is unsaleable because of the close proximity of the wind farm.

We have been informed that in order to seek judicial help in resolving the environmental noise pollution we are suffering, we will need to appoint experts in environmental law, expert acousticians and perhaps other experts. We would have to raise finance in the order of £... plus be able to meet costs awarded to the other side if our case fails. To an ordinary UK family the prospect of raising such finance in a personal capacity is out of the question which effectively prevents families being able to seek judicial help to restore the amenity of family life. This fact is clearly recognised by the State and big business who seem comfortable in continuing to support a Guidance (ETSU-R-97) which they know will cause health and financial injury to families if wind turbines are built too close to family homes, but retaining ETSU-R-97, as drawn, will help the State achieve its renewable energy targets but at a cost borne by individual families who happen to live in the wrong place at the wrong time.

In our experience, each anti-wind turbine campaign (or 'pro community and local environment campaign'), costs villages about £100,000 in real terms. If the matter goes to a public inquiry, then this amount can be tripled. This tremendous unseen cost represents the loss of important resources to local government and the communities. Moreover, these processes and inquiries also breed significant distrust, dislike, and disbelief in those who set our planning policies, as many appear to accept as de facto the reports produced by the wind turbine developers to support their applications, without further investigation or independent analyses**.** In today's national economic problems, it is reasonable to observe that local government, keen to save on expenditure are unlikely to refuse the grant of Planning Permission for wind turbines if by so doing it results in the local authority having to fight a financially expensive Planning Appeal.

The emotional distress experienced by these families is, we understand, mirrored in cases up and down the country.

The developers persist because there is so much profit to be made with ROC's. They employ barristers and their legal teams, in addition to an array of planning consultants, often for extended periods.

Local authorities and campaign groups struggle to represent local concerns and protect community well-being, even though financial resources are stretched and strained to accommodate this process. Such unequal financial burdens may already be affecting the ability of many councils to address such responsibilities. Many will be unable to fund proper defence of decisions through the Appeal Courts. 

## Update on the Davis Family, November 2011

The following provides an update of the Davis family's situation, with a resolution to their ordeal after prolonged bureaucratic and legal battles: a strictly confidential settlement. Their pursuit of fairness and recognition of the wind turbine noise problems at their home are also instructional in terms of the Aarhus Convention (see p 124 of this paper). Families and individuals do not usually have access to the financial or personnel resources – not to mention the stamina – required to pursue lengthy bureaucratic and judicial proceedings.

**Telegraph** (UK) 30 November 2011

# Couple settle with wind farm operators over 'unbearable hum'

A couple have settled a High Court damages action against the owners and operators of a wind farm they say drove them from their farmhouse home with its ''unbearable'' noise.

A judge was told today the terms of the settlement agreed by tenant farmers Sarah Jane and Julian Davis were strictly confidential.

The couple moved out of Grays Farm in Deeping St Nicholas, near Spalding, Lincolnshire, in December 2006 six months after the eight-turbine wind farm began operating about half a mile from their home.

They blamed the ''whoom whoom whoom'' and the low frequency ''hum'' of giant turbine blades for their exile in a case that was closely watched by the wind farm industry.

They said the ''intolerable'' noise disrupted their sleep, made them feel ill and was so severe that it warranted a reduction in council tax and rendered the £2.5 million farmhouse no longer marketable as a family home.

Mr and Mrs Davis were accused of being ''over-sensitive'' to the noise and ''exaggerating and overreacting''.

The couple launched a claim for damages and an injunction against defendants including Fenland Windfarms Ltd and Fenland Green Power Co-operative Ltd.

The long-running hearing was due to resume today, but trial judge Mr Justice Hickinbottom was told the case was settled.

Both sides said in a joint press release: ''The terms of that settlement are strictly confidential, and the parties will not be answering any questions about the terms of that agreement.''
The case was described as being of general importance because hundreds of other families say they have suffered similar disturbance from wind farms up and down the country.

The operators were accused at the start of the High Court hearing earlier this year of trying to impose "a code of silence" on those examining or recording the noise the turbines caused.

The terms of today's settlement mean that details of the how the settlement was reached will remain secret.

The judge said he had been given a copy of the signed agreement - "nobody has seen it other than me, and I am giving it back to you".

When the case was before the court in July, Peter Harrison QC, appearing for former nurse Mrs Davis, 55, and her husband, 46, told the judge: "Wind farms have emphatically not been the source of trouble-free, green renewable energy which the firms promoting and profiting from wind energy would have the general public believe."

The court heard research suggested the complaints relate to the "amplitude modulation" (AM) of the aerodynamic noise from the turbine blades in certain conditions.

Mr and Mrs Davis, who have two grown-up children, were seeking an injunction to bring about modification of the operation of the wind farm, plus £400,000 damages to compensate them for the noise nuisance.

Mr Harrison said: "Their lives have been wholly disrupted by that noise."

Alternatively the couple asked for damages plus a "like for like" replacement for their farm home they estimate is worth about £2.5 million.

Mrs Davis emphasised that her wish was to move back from rented accommodation into her home.

The couple said the "horrible" noise problem caused by the 320ft (100m) high turbines could be resolved by removing two of the turbines and limiting the hours of operation of a third.

Their QC told the court that, instead of experiencing trouble-free, green renewable energy when the wind farm started operations, Mr and Mrs Davis faced "an industry operator - a subsidiary of EDF - which has refused to acknowledge the noise their turbines make and the effect that has had on the lives of these claimants".

Instead, the main operator "appears to have tried to impose a code of silence on those examining or recording the noise that these turbines in this location have caused".

Mr Harrison added: "Further, at least until recently when their own recordings and monitoring have finally forced the defendants to acknowledge they are causing problems, their approach has been to try and shoot the messenger".

http://www.telegraph.co.uk/earth/environment/8925467/Couple-settle-with-wind-farm-operators-over-unbearable-hum.html

# *Appendix 5.2*

## David v Goliath

**From Mr and Mrs Hulme, Den Brook, North Tawton, Devon**

Our self-built, environmentally low impact home of 36 years lies a little over 1km downwind of the proposed Den Brook industrial wind turbine development. Renewable Energy Systems (RES, Sir Robert McAlpine Ltd.) plans to construct 9 wind turbines, each 120m high, on this rural, sequestered site.

RES initially claimed the wind farm would not create a noise nuisance, a claim it later moderated to creating no '*statutory*' noise nuisance. The insertion of this single word, '*statutory*', not only provides the developer with a defence of 'best practice', but also provides RES a loophole, which will leave neighbours with little possibility for any abatement in event of the likely acoustic intrusion from health-threatening noise pollution.

In January 2006, the local Planning Authority refused permission to build the wind turbines on grounds that omitted any reference to noise impacts other than a misconceived submission claiming the developer's proposed levels of predicted noise immissions permitted more noise at night than during day times. The Council's observation, albeit commonsense, was subsequently dismissed as a rather alarming misunderstanding of government recommended NIA guidelines. ETSU-R-97, the document relied upon by decision makers and the Planning Inspectorate, was uniquely devised specifically to allow wind farm development and more noise much closer to human habitation than any conventional industrial noise impact assessment procedure could permit.

As a neighbour of the proposed site, my concern also focused on an acoustic phenomenon known as amplitude modulation [AM], a wind turbine noise that RES (Sir Robert McAlpine Ltd) and, indeed, the wind industry in general, either deny as a possibility or minimise its impact on residents living near operating wind farms that emit AM. Consequently, the occurrence of AM continues to lack empirical field research despite ever increasing reports testifying to and demonstrating its occurrence and its adverse impact on people's well-being.

Thus, the addition of the word '*statutory*' by RES created more alarm. Wind turbine heights now far exceed those described in ETSU-R-97 (published in 1997), approaching and even exceeding 125m high. Thus, the rotation and breadth of the blades reach further into the varying characteristics of atmospheric layering not considered in 1997, though the wind turbine height and extent of the blade sweep are now widely thought to be a defining factor leading to the impacts of AM noise.

Amplitude Modulation of the aerodynamic noise from wind turbines (AM) is similarly repetitive but marginally asynchronous with human heart rhythms; a deeply irritating low frequency noise is radiated, often compared to the dripping tap torture techniques sometimes utilised by wartime interrogators. These taller industrial wind turbines create AM that fails to attenuate in the same way as the limited spectrum of wind turbine noise considered within the ETSU-R-97 guidelines. AM can affect much larger ground areas surrounding wind farms than the government and wind industry currently acknowledge.

Independent and impartial acoustic experts, such as MAS Environmental http://www.masenv.co.uk/noise, have placed reports on the public record that detail alarming measured levels of AM more than 1km from numerous modern wind turbine arrays. And yet, separation distances of less than 500 metres between the nearest wind turbine to a family home continue to be proposed by wind turbine developers, and, perhaps more worryingly, appear acceptable to decision makers. As more wind turbines are constructed near people's homes, the AM phenomenon is increasingly devastating many people's lives, with numerous reports of disruption from around the world; distressingly, many families are left with no other option and forced to vacate their homes in order to recover their well-being and their dignity, even though they may endure serious financial sacrifices.

For my part, I have spearheaded a lengthy campaign with the Den Brook Judicial Review Group (DBJRG) aimed at addressing the AM problem through challenging shortfalls within the developer's NIA, and errors within unlawful decisions by those seemingly struggling with the confusion and misunderstandings created by the difficult complexities and technical nature of the problem, and the fact that ETSU-R-97 is no longer 'fit for purpose' as a noise guide for modern wind turbines.

In line with the views of Rt. Hon. Judge Mitting (Hulme v Secretary of State, CO/2449/2007 S.7; http://www.richardbuxton.co.uk/v3.0/node/350), my efforts have encountered, amongst others, unwarranted withholding of vital evidence by the wind farm developer. RES (Sir Robert McAlpine Ltd), refused for more than two years to provide the data for independent analysis of the raw noise and wind speed data collected by them at my property. At huge personal expense, and with donations from local families and people nationwide, we have fought through two Public Inquiries, where noise was examined for only half an hour at the first and then four days during the latter; and two High Court Judicial Reviews, followed by two corresponding appeals through the Court of Appeal.

Our search for the basic protection of our dignity and for my family being able to sleep at night rolls on. DBRG needed to raise in the region of £40,000 from private donations, and my own personal loss in income must now be well in excess of £70,000. These figures, although huge amounts for individuals and community groups, represent not only the will of a community to protect itself from inappropriate industrial development, it is also a mere pittance compared to the 'Goliath' resources expended by wind farm developers in pursuit of planning approval; the irony being that costs to the developers are subsequently paid by the unspecified subsidies imposed on all our electricity bills.

I have been compelled to re-mortgage our home which was to have been relied upon for our pension. Moreover, my time devoted to income generating business activities has been severely curtailed. The all consuming hard work and research are essential requirements for seeking justice, which appears ever more elusive.

Vested interests thwart our efforts every step of the way. An unprecedented but, alas, imprecisely worded Excess Amplitude Modulation (EAM) noise condition won from the last Public Inquiry was described by the developer's advocate as likely to devastate the UK's wind farm industry. At the time of writing, RES (Sir Robert McAlpine Ltd) is currently engaged in attempts to downsize the parameters set out for EAM within the imposed noise condition. RES is thus trying to gain consent for inflicting greater noise impacts on neighbouring families than was clearly intended by the Inspector.

As the Den Brook Planning Inspector concluded, although AM is somewhat unpredictable, it is a distinct possibility. Even if that is not entirely the case, the current acoustical methodology for assessing and predicting wind turbine noise that may damage one's health remains, at best, overly generalized and inaccurate; at worst, it is deeply flawed. In this context, DBJRG seeks only that the 'Precautionary Principle' be properly invoked and applied, so that ordinary families are duly protected when onshore wind turbine developments are promoted by an industry well-versed in the art of smoke and mirrors.

Mike Hulme 26 January 2011
Den Brook Judicial Review Group
www.denbrookvalley.co.uk

# *Conclusions*

The experiences of families internationally show conclusively that when wind turbines are built in proximity to homes, the environmental noise pollution adversely impacts on people's health.

Wind turbines emit noise with many characteristics – pulsating noise, intermittency, tonal qualities, amplitude modulation, and low frequency noise – which singly or in combination merit special attention and limits because of observed, unwanted impacts on health, according to the World Health Organization's guidelines.

These findings are reflected also in the pilot studies conducted during the past few years by physicians in the UK, the USA, and Australia, where results indicated that families are suffering various degrees of negative health and sleep issues because of environment noise from wind turbines.

Despite evidence-based research studies that demonstrate a relationship between the adverse impacts of environmental noise on health, some governments – including that of the UK – have instead opted to follow the advice of acoustic engineers from the wind energy industry. This approach favours industrial development, constructing wind turbines in proximity to homes and other sensitive facilities, to the detriment of the public health.

Although acoustic engineers and engineers involved with wind turbine design acknowledge that predicting acoustic radiation from wind turbines is imprecise, with variable and often doubtful results, the UK Government continues to foster self-regulation by the wind energy industry. This has led to the current situation, with inadequate standards of protection from environmental noise pollution for neighbouring families.

As governments encouraged more wind turbine installations, and with more constructed near homes and communities because of inadequate guidance, complaints about noise increased. Several governments have responded and recently imposed stricter regulation on the wind energy industry after assessing community and family complaints and health issues, as well as by assessing current evidence-based research and reports on environmental noise and its injuries to health: Denmark lowered allowable wind turbine noise emissions, including stricter regulation on low frequency noise, both outside and inside homes and other facilities and areas (http://www.mst.dk/English/Focus_areas/low_frequency_noise_from_wind_turbines_FAQ.htm); the State Government of Victoria, Australia, increased set-back distances to a minimum of 2km between a wind turbine and a residence; and Japan has initiated an epidemiological study of the impacts of wind turbine noise on people. [State Government of Victoria. Wind Energy Facilities, Amendment VC82. Department of Planning and Community Development, State Government of Victoria, Australia, 29 August 2011.]

Moreover, the WHO reports – Guidelines for Community Noise, Night Noise Guidelines for Europe, and the Burden of Disease from Environmental Noise, along with evidence-based medical research findings, indicate that the inaudible effects of noise (e.g., low frequency noise), as well as the audible, may have significant impacts on people. Current UK guidance is not only out-dated, it does not include these recent guidelines from the World Health Organization. Indeed, UK guidance does not incorporate methods that reflect how humans perceive and react to sounds and noise, especially dose-exposure-response relationships. These have a relationship to how noise affects health and sleep and a sense of well-being.

Furthermore, because the UK Government, through its agencies, ministers, and civil servants, is aware of issues with wind turbine noise guidance, there are potential human rights violations, because those with health complaints apparently related to wind turbines constructed in proximity to their homes have been ignored in their efforts to seek changes, controls, or redress. Furthermore, recent UK Planning Legislation closed a route that had been available to ordinary families seeking recourse in order to protect themselves from environmental pollution. Noise conditions are unwieldy, and difficult and expensive to enforce; thus, people are exposed to unremitting environmental noise, with the consequent injuries to health and loss of amenity, through no faults of their own.

Meanwhile, the World Health Organization reports and medical evidence offer methods and guidance that deal effectively with industrial environmental noise and offer a degree of protection to the public's health, if Government would choose to respond to the science of the matter, rather than to political and economic expediency.

## *Recommendations*

Although the underlying mechanisms are not yet fully understood, when wind turbines are built near homes, it is undeniable that their noise causes a constellation of unwelcome effects, with varying degrees, on health, sleep, and health quality of life.

Further study may reveal the cause/effect, dose/exposure relationships, but as these are undetermined, the precautionary principle should apply in order to protect the public health. Preventive proactive policy functions to preserve the public's health, whereas reactive palliative responses are often inadequate, not to mention, too late.

Although government agencies and the wind energy industry and their consultants contend that the adverse health effects are conjecture or negligible or 'mere' annoyance, one may also argue that their calculations are based on models that make unproven presumptions about what sounds are or are not annoying to people. Wind turbine noise calculations were not tested on subjects in field study scenarios. Furthermore, leading acousticians disagree on the methodologies to measure, analyse, predict, and prevent wind turbine noise. Current guidelines rely on calculations that are based on variables that result in imprecise and inaccurate predictions of actual wind turbine noise and how people living nearby perceive the noise.

Therefore, wind turbines should not be sited near homes communities, or other sensitive facilities, e.g., schools and residential homes for special populations, such as the chronically ill aged. The precautionary principal should apply.

The guidance for and the methodology to measure wind turbine noise should be straightforward and easily applied by local planning authorities and environmental health officers, and – importantly – enforceable by them without delays. Denmark has introduced guidelines for wind turbine noise that reduces previous allowable levels; noise must now remain below limits both indoors and outdoors, and the guidance includes audible noise as well as inaudible noise, such as low frequency noise. Denmark's guidance also acknowledges that background noise does not mask wind turbine noise. Therefore, background noise is not a basis for setting audible noise levels. These standards comply with the WHO reports and their findings; the UK should do no less.

The dBA measure noise from the wind turbine(s) should not exceed levels in the bedroom at night with the window partly open, of not more than 30dBA LAmax, nor within amenity areas around the home where the limit will be L night, outside, 30dBA, or as prescribed by the World Health Organization's research updates on environmental noise.

Regarding amplitude modulation (AM), the guidance must not exceed the parameters set in Planning Appeal Decision APP/Q1153/A/06/2017163, S.20:

> "20.a. A change in the measured LAeq, 125 milliseconds turbine noise level of more than 3dB (represented as a rise and fall in sound energy levels each of more than 3dB) occurring within a 2 second period.
>
> 20.b. The change identified in (a) above shall not occur less than 5 times in any one minute period provided the LAeq, 1 minute turbine sound energy level for that minute is not below 28dB.
>
> 20.c. The changes identified in (a) and (b) above shall not occur for fewer than 6 minutes in any hour."
> [See Hulme, APP/Q1153/A/06/2017163]

Public health policy for the environmental noise of wind turbines should link directly to the EC Environmental Noise Directive, and the WHO Guidelines for Community Noise, Night Noise Guidelines for Europe, and the Burden of Disease from Environmental Noise. These are reports by independent, international, multidisciplinary panels with expertise in their fields. As guidance is updated, national guidance should change to reflect current knowledge and practice.

To evaluate these guidelines and their implementation for national application, the UK Government should empanel an independent committee, based on the WHO model, i.e., comprised

of medical experts independent of the wind industry, in sleep medicine, physiology, psychoacoustics, and epidemiology, and to consult with acousticians as deemed necessary. Although acousticians or medical experts working within or as consultants to the wind energy industry would be welcome to submit comments, they would have to recuse themselves from participation in devising guidance and methods. The panel should be led by the Public Health department of State, not by an agency such as DECC, whose objectives differ from those departments whose primary objectives are health protection and disease prevention.

Because prediction of wind turbine noise is an uncertain process, the principles within Lord Reay's bill, "Wind Turbine Minimum Distances from Residential Premises", presented to the House of Lords, should be adopted as a matter of urgency, but with these reduced set-backs, which accommodate more recent research and guidance, e.g., the Danish EPA guidance 2011, the State of Victoria, Australia guidance, and the WHO Burden of Disease from Environmental Noise 2011.

| **Wind turbine heights (to blade tip)** | **Set-back between nearest residence to the wind turbine** |
|---|---|
| up to 25m | 1km |
| 25m – 35m | 1.5km |
| 35m – 100m | 2km |
| Greater than 100m | 3km |

[Lord Reay. Wind Turbines (Minimum Distances from Residential Premises) Bill [HL] 2010-11 http://services.parliament.uk/bills/2010-11/windturbinesminimumdistancesfromresidentialpremiseshl.html]

These should be considered minimum setback distances depending upon, e.g., local terrain, the size of the array, terrain, blade flicker, and agricultural and community needs. As part of the application process, noise background levels should also be measured indoors, in rooms used by families or other sensitive facilities, e.g. the sitting/living room, other communal rooms, the study, as well as bedrooms, with the window of that room open.

Compliance testing and enforcement of conditions are essential; it is common practice in industrial situations. This is vital because noise prediction may need recalculation. The hours of operation may require limits or possibly shutdown during the night or in certain meteorological conditions.

Ongoing compliance with guidance and conditions is the responsibility of the wind turbine owners. A warranty should be provided to the local authority that certifies that the wind turbines will not exceed the prescribed noise immission levels. If the turbine noise exceeds the allowable limit, then the wind energy company must close down the site until the Environmental Health Officer approves a plan for amelioration that will most likely meet the original conditions. Alternatively, the developer may arrange to purchase all neighbouring properties exposed to the environmental noise pollution, at their fair market value prior to the wind turbine scheme, plus compensation for moving home.

The local authority must also accept responsibility to investigate noise complaints.

To reiterate, the precautionary principle should prevail. Either locate wind turbines further away from homes and communities, or invoke a moratorium, in order to protect the public's health. The policy and the practice should be proactive, not reactive.

## First, Do No Harm

# *Bibliography*

Please note:
Items online were accessed within the past six months, with only several exceptions. Websites archive material or change links according to their own guidelines and capacity; some sites or links may be defunct. Therefore, current access cannot be guaranteed by the authors. Some materials are available online but require a fee to access; libraries are an excellent resource for these materials. The bibliography includes items in the text; additional references noted in appendices at the end of each chapter.

Moreover, some very worthwhile reports and documentation are not included in the paper and the bibliography. This in no way diminishes their importance in educating us further about the effects of wind turbine noise on health; there were limitations on the amount of material we were able to include. However, many of the items in the bibliography will lead you to these additional resources.

**Aarhus Convention**:
**Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters.**
UN Economic Commission for Europe (UN-ECE), Aarhus Denmark, 25 June 1998.
http://ec.europa.eu/environment/aarhus

Advertising Standards Authority (ASA) (UK).
**Adjudication on Volkswind UK Ltd.**
Complaint Ref 104318, 31 March 2010.
http://www.asa.org.uk/ASA-action/Adjudications/2010/3/Volkswind-UK-Ltd/TF_ADJ_48283.aspx#

Aitken M.
**Wind Power Planning Controversies and the Construction of 'Expert' and 'Lay' Knowledges.**
*Science as Culture* March 2009; 18(1): 47-64.

Aitken M.
**Why We Still Don't Understand the Social Aspects of Wind Power: A Critique of Key Assumptions within the Literature.**
*Energy Policy* 2010; 38: 1834-1841.

Alayrac M, Marquis-Favre C, Viollon S, Morel J, and Le Nost G.
**Annoyance from Industrial Noise: Indicators for a Wide Variety of Industrial Sources.**
*JASA Journal of the Acoustical Society of America* Sept 2010;128(3):1128-1139.

Alleyne R.
**Wind Farm Forced to Close after Complaints over the Noise (Scotland).**
*Daily Telegraph*, 16 June 2011.
http://www.telegraph.co.uk/earth/environment/8579747/Wind-farm-forcedto-close-after-complaints-over-the-noise.html]

Alteri B.
**Does Wind Turbine Noise Affect Your Sleep or Health?**
*WLBZ Channel 2*, Bangor Maine, USA, 14 May 2009.
http://www.wlbz2.com/news/local/story.aspx?storyid=104717&catid=3

American National Standard.
**Quantities and Procedures for Description and Measurement of Environmental Sound - Part 6: *Methods for Estimation of Awakenings Associated with Outdoor Noise Events Heard in Homes*.**
ANSI/ASA S12.9 - 2008 / Part 6.

American Wind Energy Association and the Canadian Wind Energy Association (A/CanWEA).
**Wind Turbine Sound and Health Effects, an Expert Panel Review.**
Panel: Colby WD, Dobie R, Leventhall G, Lipscomb DM, McCunney RJ, Seilo MT, and Sondergaard B. A/CanWEA, December 2009.
http://www.canwea.ca/pdf/talkwind/Wind_Turbine_Sound_and_Health_Effects.pdf

**Analysis of Wind Farms with Noise Complaints based on the Salford Report.**
Xcel spreadsheet, personal communication, 2006.

***Andrews GW v Reading Borough Council.***
High Court of Justice, Queen's Bench Division, [2004] EWHC 970 (QB), 29 April 2004.
http://www.bailii.org/ew/cases/EWHC/QB/2004/970.html

The Australia Senate: Community Affairs References Committee.
**The Social and Economic Impact of Rural Wind Farms.**
Commonwealth of Australia, June 2011.
http://www.aph.gov.au/senate/committee/clac_ctte/impact_rural_wind_farms/report/index.htm

Babisch, W.
**The noise/stress concept, risk assessment and research needs.**
*Noise and Health* 2002; 4(16): 1–11.

Baldwin T.
**Barack Obama Releases Documents showing Harsh Bush-era CIA Interrogations.**
*The Times* (UK), 16 April 2009

BBC News | Health.
**Sleeping Longer 'Helps Athletes Reach Peak Performance'**, 1 July 2011.
http://www.bbc.co.uk/news/health-13974130

Basner M; Griefahn B; and Hume K.
**Comment on 'The State of the Art of Predicting Noise-Induced Sleep Disturbance in Field Settings'.**
*Noise and Health* 2010; 12(49):283-285.

Bender S.
**Medical Officer of Health Believes Wind Turbine Setbacks should be Longer.**
*Lucknow Sentinel,* 25 August 2010. www.lucknowsentinel.com

BERR (UK; became Dti; now DECC).
**New Report Eases Concerns over Wind Turbine Noise. Press Release.**
Department for Business, Enterprise & Regulatory Reform (BERR), 1 August 2007.
http://www.gov-news.org/gov/uk/news/new_report_eases_concerns_over_wind_turbine/40357.html

Black R.
**Fukushima: As Bad as Chernobyl?**
*BBC News*, 12 April 2011.
http://www.bbc.co.uk/news/science-environment-13048916

Blacker T.
**Get Rich Quick by being 'Green'.**
*Independent*, 12 July 2011.
http://www.independent.co.uk/opinion/commentators/terence-blacker/terence-blacker-get-rich-quick-by-being-green-2312068.html

Booker C.
**Climate Change: the Warmist Demands Heat up as 'Green' Costs Soar.**
*Daily Telegraph*, 11 December 2010.
http://www.telegraph.co.uk/comment/columnists/christopherbooker/8196382/Climate-change-the-warmist-demands-heat-up-as-green-costs-soar.html

Booker C.
**What We Need in 2011 is an Opposition.**
*Daily Telegraph*, 1 January 2011.
http://www.telegraph.co.uk/comment/columnists/christopherbooker/8235238/What-we-need-in-2011-is-an-opposition.html

Booker C.
**Proof that the PM is Tilting at Windmills.**
*Sunday Telegraph*, 3 July 2011.
http://www.telegraph.co.uk/comment/columnists/christopherbooker/8612716/Proof-that-the-Government-is-tilting-at-windmills.html

Bounds R.
**Testimony re: Garrett County Wind Turbine Application.**
Public Services Commission, Maryland, USA, 31 August 2006, pp 7-11.
http://docs.wind-watch.org/russellboundstestimony.pdf

Bray WR.
**Measurement and Sound Quality Issues Concerning Low-Frequency Noise.**
Noise-Con 2007, Reno, Nevada, October 22-24 2007.

Bray W and James R.
**Dynamic Measurements of Wind Turbine Acoustic Signals, Employing Sound Quality Engineering Methods Considering the Time and Frequency Sensitivities of Human Perception.**
Noise-Con 2011, Portland, Oregon, USA, July 25-27, 2011.

British Wind Energy Association (BWEA, now known as RenewableUK).
**Letter to members from the Director of programme Strategy**, 5 August 2007.

Bryce R.
**The Brewing Tempest over Wind Power: People Living near Turbines Increasingly Report Sleep Deprivation, Headaches and Vertigo. The Wind Lobby says There's No Proof.**
*The Wall Street Journal*, 1 March 2010.

Bunyan N and Beckford M.
**Homeowners Living Near Windfarms See Property Values Plummet.**
*The Daily Telegraph*, 26 July 2008.
http://www.telegraph.co.uk/earth/earthnews/3348084/Homeowners-living-near-windfarms-see-property-values-plummet.html

Burkhardt G.
**Wind Farm Illness** (letter).
*WalesOnline*, 6 June 2005.
http://www.walesonline.co.uk/news/letters-to-the-editor/western-mail-letters/tm_objectid=15595663&method=full&siteid=50082&headline=wind-farm-illness-name_page.html

Burns JF.
**Britain Discloses Data on Ex-Detainee.**
*New York Times*, 11 February 2010.
http://www.nytimes.com/2010/02/11/world/europe/11britain.html

Calaf M, Meneveau C, and Meyers J.
**Large Eddy Simulation Study of Fully Developed Thermal Wind-Array Boundary Layers.**
*Geophysical Research Abstracts* 2010, Vol 12 EGV.

Calaf M, Meneveau C, and Meyers J.
**Large eddy simulation study of fully developed wind-turbine array boundary layers.**
*Physics of Fluids* 2010;22(1):015110-01--115110-16.

Canadian Wind Energy Association (CWEA).
**Addressing Concerns with Wind Turbines and Human Health.**
Canadian Wind Energy Association, April 2009.
http://www.canwea.ca/pdf/CanWEA%20-%20Addressing%20concerns%20with%20wind%20turbines%20and%20human%20health.pdf

Ceranna L, Hartmann G, and Henger M.
**The Inaudible Noise of Wind Turbines.**
Infrasound Workshop, November 28 – December 2, 2005, Tahiti.
http://docs.wind-watch.org/The_inaudible_noise_of_Wind_Turbines-infrasound.pdf

Clark R.
**Giant Blades are Slicing Prices.**
*Sunday Telegraph*, 17 October 2004.
http://www.telegraph.co.uk/property/propertyadvice/propertymarket/3336030/Giant-blades-are-slicing-prices.html

**Clouds Gathering over Wind Farm Plan.**
*Australian News*, 9 January 2006.

Cocks D.
**Closing Submission to the Three Moors Planning Inquiry on behalf of the Technical Report on Environmental Aspects (TREA):**
**Closing Submissions on Behalf of the Rural Exmoor Alliance: Summary.**
PINS Ref: APP/X1118/A/08/2083682, LPA Ref 45489, and
PINS APP/Y1138/A/08/2084526, LPA Ref 07/02262/MFUL, 24 November 2009.
http://www.twomoorscampaign.co.uk/TREA-Closing-Submissions-Summary.pdf

Coffman M.
**Wind Turbine Syndrome Prompts State Lawmakers to Propose 2-Year "Wind Farm" Moratorium.**
*Idaho Reporter* (USA), 18 March 2011.
http://www.idahoreporter.com/2011/house-committee-considering-moratorium-on-wind-turbine-construction/

Colten HR and Altevogt BM, eds.
**Sleep Disorders and Sleep Deprivation: an Unmet Public Health Problem.**
Committee on Sleep Medicine and Research, Institute of Medicine of the National Academies.
Washington, DC: The National Academies Press, 2006.
http://books.nap.edu/openbook.php?record_id=11617

Constable, J and Moroney L.
**Data obtained under the Freedom of Information Act: Wind Turbine Noise Complaint Survey Data** Collected by the University of Salford under contract to the Department of Business, Enterprise and Regulatory Reform: Research into Aerodynamic Modulation of Wind Turbine Noise URN 07/1235. Renewable Energy Foundation (REF), London, UK, 6 Februrary 2009
http://www.ref.org.uk/publications/151-ref-publishes-data-on-wind-farm-noise-obtained-under-the-freedom-of-information-act and
http://www.ref.org.uk/attachments/article/151/jc.lm.salford.data.comment.07.02.09.c.pdf

Constable J and Moroney L.
**Low Wind Power Output in 2010: An Information Note.**
Renewable Energy Foundation (REF), 2 February 2011.
http://www.ref.org.uk/publications/217-low-wind-power-output-2010
http://www.ref.org.uk/attachments/article/217/ref%20on%202010%20wind%20performance%2002%2002%2011.pdf

**Consultant: Vinalhaven Wind Turbines Too Noisy.**
*Portland Press Herald, Maine*, USA, 13 September 2010.
http://www.pressherald.com/news/Consultant-says-Vinalhaven-wind-turbines-too-noisy.html?searchterm=headache+for+vinalhaven

Copping J and Gray R.
**Switch-off for Noise Wind Farms.**
*Telegraph* (UK), 19 November 2011.
http://www.telegraph.co.uk/earth/energy/windpower/8901431/Switch-off-for-noisy-wind-farms.html

**Council Ruling to Change Future of Windfarm Plans (Carmarthenshire, Wales).**
*ThisIsSouthWales*, 23 March 2011.
http://www.thisissouthwales.co.uk/Council-ruling-change-future-windfarm-plans/story-12461867-detail/story.html

**Couple Settle with Wind Farm Operators over 'Unbearable Hum'.**
*Telegraph* (UK), 30 November 2011.
http://www.telegraph.co.uk/earth/environment/8925467/Couple-settle-with-wind-farm-operators-over-unbearable-hum.html

Crosby D.
**Legal Challenge against Wind Turbines Moves Forward with Appeal (Prince Edward County, Canada).**
*The Sun Times* (Canada), 20 March 2011.
http://www.owensoundsuntimes.com/ArticleDisplay.aspx?e=3036164

Crum S.
**Strict Standards Vital for Whitley Wind Plant.**
*Journal Gazette* (Fort Wayne, Indiana, USA), 10 December 2010.
http://www.journalgazette.net/article/20101210/EDIT05/312109993/1021/EDIT

Dang-Vu TT; McKinney SM; Buxton OM; Solet JM; and Ellenbogen JM.
**Spontaneous Brain Rhythms Predict Sleep Stability in the Face of Noise.**
*Current Biology* 10 August 2010; 20(15): R626-627

Danish Ministry of the Environment. Environmental Protection Agency.
Rules on Noise from Wind Turbines.
http://www.mst.dk/Virksomhed_og_myndighed/Stoej/Vindmoeller/regler_for_stoj_fra_vindmoller/reglerforstoejfravindmoeller.htm

Danish Ministry of the Environment. Environmental Protection Agency.
**Q&A: Low Frequency Noise from Wind Turbines.**
Environmental Protection Agency, Danish Ministry of the Environment, August 2011.
http://www.mst.dk/English/Focus_areas/FAQ_low_frequency_noise_from_wind_turbines.htm?wbc_purpose=b%23%23Top

Davies T.
**Letter to Denbrook Valley Action Group (Devon).**
Bradleys Chartered Surveyors, Exeter, UK, 5 November 2004.

Davies T.
**Response to Enquiry regarding Devaluation of Property from Mr P Hancock (North Tawton, Devon)(Letter).**
Bradleys Chartered Surveyors, Exeter, UK, 30 August 2005.

Davis J and Davis J.
**Appendix 1: Property Values and House Prices.**
Public Consultation on The Economics of Renewable Energy to the Select Committee on Economic Affairs, The House of Lords, June 2008.
http://www.publications.parliament.uk/pa/ld200708/ldselect/ldeconaf/195/195we18.htm

***Davis and Davis v Tinsley, Watts and Fenland Windfarms and Fen green power Co-op***, *claim HQ 10X00900*
(Case continues in the High Court, London, on 30 November 2011; check court schedule to verify dates.)
http://docs.wind-watch.org/Davis-Particulars-of-claim.pdf

Davis J and Davis J.
**General Statement of Jane & Julian Davis, 16 April 2009.**
http://www.windaction.org/stories/24572

Davis J and Davis J.
**Letter to MP Re: Deeping St Nicholas Windfarm noise nuisance, 17 May 2010.**

Davis J.
**Personal Communication from Jane Davis**, 13 April 2009.

Den Brook Valley Wind Turbines: see **Hulme**.

***Dennis & Dennis v Ministry of Defence*** [2003] EWHC 793 (QB).
http://www.bailii.org/cgi-bin/markup.cgi?doc=/ew/cases/EWHC/QB/2003/793.html

Department for Environment, Food and Rural Affairs (Defra).
**Noise Policy Statement for England (NPSE).**
Defra (UK), March 2010.
http://www.defra.gov.uk/environment/quality/noise/

Department of Energy & Climate Change (DECC).
**Revised Draft Overarching National Policy Statement for Energy (EN-1).**
DECC (UK), October 2010.
http://www.official-documents.gov.uk/document/other/9780108509346/9780108509346.pdf

Edwards J.
**Calls for Alltwalis Wind Farm to be Shut Down, 7 July 2010.**
http://www.jonathanedwards.org.uk/calls-for-alltwalis-wind-farm-to-be-shut-down

Edwards J.
**Plaid Call for 2km Wind Farm Buffer Zone, 9 April 2010.**
http://www.jonathanedwards.org.uk/plaid-call-for-2km-wind-farm-buffer-zone

Ellis G; Barry J; Robinson C.
**Many ways to say 'no', different ways to say 'yes': Applying Q-Methodology to understand public acceptance of wind farm proposals.**
*Journal of Environmental Planning and Management* July 2007; 50(4): 517-551.

Ellis G; Cowell R; Warren C; Strachan P; Szarka J; Hadwin R; Miner P; Wolsink M; and Nadal A.
**Wind Power: Is there a "Planning Problem"?**
*Planning Theory & Practice* Dec 2009; 10(4): 521-547.

Elmenhorst E-M; Elmenhorst D; Wenzel J; Quehl J; Mueller U; Maass H; Vejvoda M; and Basner M.
**Effects of nocturnal aircraft noise on cognitive performance in the following morning: dose-response relationships in laboratory and field.**
*International Archives of Occupational and Environmental Health* Oct 2010; 83(7):743-751.

English R.
**Slow but Steady on Access to Environmental Justice from Supreme Court.**
UK Human Rights Blog, 1 Crown Office Row (1COR), 13 April 2011.
http://ukhumanrightsblog.com/2010/12/20/slow-but-steady-on-access-to-environmental-justice-from-supreme-court/

Environmental Noise Directive (END).
**Directive 2002/49/EC of the European parliament and of the Council relating to the Assessment and Management of Envrionmental Noise, 25 June 2002.**
*Official Journal of the European Communities* 1.189/12 EN, 18.7.2002.
http://ec.europa.eu/environment/noise/directive.htm

Environmental Review Tribunal, Case Nos.: 10-121/10-122 Erickson v. Director, Ministry of the Environment, Dated this 18th day of July, 2011 by Jerry V. DeMarco, Panel Chair and Paul Muldoon, Vice-Chair. Ontario, Canada.

**Equality and Human Rights Commission (EHRC):**
*See* UK Equality and Human Rights Commission (EHRC).

ETSU for the Dti (UK): The Working Group on Noise from Wind Turbines.
**ETSU-R-97: The Assessment & Rating of Noise from Wind Farms: Final Report.**
Dti, September 1996.
http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/energy/sources/renewables/explained/wind/onshore-offshore/page21743.html
***The Working Group on Noise (NWG)***: Meir R (Dti); Legerton ML (ETSU); Anderson MB (RES Renewable Energy Systems); Berry B (National Physical Laboratory); Bullmore A (Hoare Lee & Partners); Hayes M (Hayes McKenzie Partnership); Jiggins M (Carrick District Council; now Hoare Lee & Partners); Leeming E (The Nautral Power Co Ltd); Musgrove P (National Wind Power Ltd); Spode DJ (North Cornwall District Council); Thomas HA (Isle of Anglesey County Council); Tomalin E (EcoGen Ltd); Trinick M (Bond Pearce Solicitors); and Warren J (National Wind Power Ltd).

**European Court of Human Rights (ECHR).**
S.167 ***Ireland v UK*** 1978 24EHRR 423
***Ireland v UK*** *ECHR 18.01.1978*
***Lopez Ostra v Spain****, 9 December 1994*
***Guerra and Others v Italy****, 19 February 1998*
S.87 ***Gafgen v Germany****, 1 June 2010*
S.88 ***Gafgen v Germany***
S.89 ***Gafgen v Germany****, 2010*
***Moreno Gomez v Spain****, 2004*
***Fadeyeva v Russia****, 2005*
***Hatton v UK****, 8 July 2003*
(*For Hatton, see also* the Joint Dissenting Opinions of Judges Costa, Rees, Turmen, Zupancic and Steiner, *Hatton and others v United Kingdom* decision and dissenting opinions: http://cmiskp.echr.coe.int/tkp197/view.asp?item=2&portal=hbkm&action=html&source=tkp&highlight=%22THE%20UNITED%20KINGDOM%22%20|%20hatton&sessionid=668105&skin=hudoc-en.)
(*See also*: S.79 *Chahal v UK* 1996; S.120 *Labita v Italy*; S.118 *Ramirez Sanchez v France*; S127 *Saadi v Italy* 2008; *Keenan v UK* S.110; S.67 *Jalloh v Germany.*)
(To read the decisions on ECHR cases, use the ECHR HUDOC database: http://www.echr.coe.int/ECHR/EN/Header/Case-Law/Decisions+and+judgments/HUDOC+database/.)

European Environment Agency (EEA).
**About Noise.**
EEA, 2011.
http://www.eea.europa.eu/themes/noise/about-noise

European Environment Agency (EEA).
**Good Practice Guide on Noise Exposure and Potential Health Effects.**
EEA Technical Report No 11/2010.
http://www.eea.europa.eu/publications/good-practice-guide-on-noise

European Union.
**The Charter of Fundamental Rights of the European Union.**
http://www.europarl.europa.eu/charter/pdf/text_en.pdf

**Family Takes Wind Turbine Companies to Court Over Gag Clauses on Health Effects of Turbines.** *Digital Journal*, 12 September 2011.
http://www.digitaljournal.com/pr/417812

Felton JS.
**Classical syndromes in occupational medicine: phosphorus necrosis -- a classical occupational disease.**
*American Journal of Industrial Medicine* 1982; 3(1): 77-120.

Fitzpatrick K.
**'Noise from Windfarm is Affecting My Health. '**
*Manchester Evening News*, 22 January 2011.
http://menmedia.co.uk/rochdaleobserver/news/s/1406002_noise_from_windfarm_is_affecting_my_health

Forsdick D.
**Noise and Wind Turbine Proposals.**
Landmark Chambers (London): Renewable Energy Seminar, 1 October 2008.
http://www.landmarkchambers.co.uk/__data/assets/pdf_file/0004/32539/3.2_Noise__and__Wind_Turbines.pdf

**Fourth International Conference on Wind Turbine Noise, Rome, 11 – 14 April 2011.**
Sponsored by INCE/Europe and CNR-Institute of Acoustics and Sensors-IDASC, with the Acoustical Society of Italy and the International Solar Energy Society-sezione italiana.
www.windturbinenoise2011.org
(As a biennial event, the next conference is scheduled for 2013.)

4-5 Gray's Inn Square.
**Court of Appeal Allow Windfarm Appeal.**
*4-5 News*, 25 November 2005.
http://www.4-5.co.uk/news/index.cfm?id=2552

Frey BJ and Hadden PJ.
**Noise Radiation from Wind Turbines Installed near Homes: Effects on Health.**
June 2007 (Available from many web sites including
http://www.wind-watch.org/documents/noise-radiation-from-wind-turbines-installed-near-homes-effects-on-health/ )

Gage Rt Hon Sir William, Chairman.
**Statement on the Baha Mousa Public Inquiry Report, 8 September 2011.**
http://www.bahamousainquiry.org/linkedfiles/baha_mousa/report/2011-09-08-chairmansstatement.pdf
*See also:*
Gage Rt Hon Sir William, Chairman.
**The Baha Mousa Public Inquiry Report.**
Presented to Parliament pursuant to Section 26 of the Inquiries Act 2005.
The Stationery Office (UK), HC 1452, vols 1 – 3, 8 September 2011.
http://www.bahamousainquiry.org/report/index.htm

Glen Dhu Power – Wind Project (Shear Wind Inc.).
**Environmental Assessment: Proximity and Noise.**
Nova Scotia, Canada, February 2008; February 2009.
http://www.gov.ns.ca/nse/ea/glen.dhu.wind.farm/glen.dhu.wind.farm.Addendum.Section02.Proximity.and.Noise.pdf

**Good Practice Guide on Noise Exposure and Potential Health Effects:**
*See* European Environment Agency (EEA).

Goyal S, Gupta V, Walia L.
**Effect of Noise Stress on Autonomic Function Tests.**
*Noise and Health* 2010;12(48):182-186.

Gray L.
**Noise Complaints about One in Six Wind Farms.**
*Daily Telegraph*, 6 March 2010.
http://www.telegraph.co.uk/earth/earthnews/7377641/Noise-complaints-about-one-in-six-wind-farms.html

Gray L.
**Wind farms becalmed just when needed the most.**
*Daily Telegraph*, 2 January 2011.
http://www.telegraph.co.uk/earth/energy/windpower/8234616/Wind-farms-becalmed-just-when-needed-the-most.html

Gugiotta G.
**Sound, the Way the Brain Prefers to Hear It.**
*New York Times*, September 5 2011.
http://www.nytimes.com/2011/09/06/science/06sound.html?pagewanted=all

Haas A.
**To the PSC Commissioners.**
Malone, Wisconsin. August 2010.
http://psc.wi.gov//apps35/erf_search/content/homesearch.aspx?part1=1&part2=AC&part3=231&type=Comments and
http://www.wind-watch.org/documents/to-the-psc-commissioners/

Hammonds LLP.
**Letter re: Impact of Green Rigg Wind Turbines on Waterfalls, Birtley Wark, Hexham, 11 June 2010.**
http://docs.wind-watch.org/Hammonds_Northumberland_CC_100611.pdf

Hanning C and Nissenbaum M.
**Selection of Outcome Measures in Assessing Sleep Disturbance from Wind Turbine Noise.**
Fourth International Meeting on Wind Turbine Noise, Rome, Italy, 12-14 April 2011.

Hanning C.
**Wind Turbine Noise, Sleep and Health.**
Society for Wind Vigilance, April 2010.
http://www.windvigilance.com/about-adverse-health-effects/wind-turbine-noise-sleep-and-health-by-dr-hanning

**Hansard: House of Commons. Official Publication of the UK Parliament:**

- Cox G and Wicks M. **Turbines: Health Hazards**, 18 May 2007, c1003W
  http://www.publications.parliament.uk/pa/cm200607/cmhansrd/cm070518/text/70518w0014.htm

- Cox G and Wicks M. **Turbines: Health Hazards**, 15 June 2007, c1418w
  http://www.parliament.the-stationery-office.co.uk/pa/cm200607/cmhansrd/cm070615/text/70615w0018.htm#07061543000199

- Pickles E (Brentwood and Ongar, Con) and Healey J (Wentworth and Dearne, Lab)
  **Council Tax: Tax Allowances**, 13 May 2008, c1442W
  http://www.publications.parliament.uk/pa/cm200708/cmhansrd/cm080513/text/80513w0004.htm

- Davies P and Hendry C, **Noise: Wind Farms**, 27 July 2010, c888w-c 889w
  http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm100727/text/100727w0001.htm

- Edwards J and Barker G. **Wind Power**, 27 July 2010, c893w
  http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm100727/text/100727w0001.htm#10072751003207

- Stephenson A and Hendry C. **Wind Power: Noise**, 27 July 2010, c888w-c889w
- http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm100727/text/100727w0001.htm

- Heaton-Harris C and Barker G. **Wind Power**, 18 October 2010, c482w
  http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm101018/text/101018w0003.htm

- Adams N and Neil R. **Wind Power: Planning Permission**, 11 November 2010, c461w.
  http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm101111/text/101111w0003.htm#10111183000025

To search Hansard: http://www.parliament.uk/business/publications/hansard/

Harrison JP.
**Inadequacy of Wind Turbine Noise Regulations and their Application.**
*Canadian Acoustics* Sept 2009;37:156-158.

Harrison JP.
**Wind Turbine Noise.**
*Bulletin of Science, Technology and Society* 2011;31:256-261.

Harry A.
**Wind Turbines, Noise and Health.**
February 2007.
http://www.wind-watch.org/documents/wind-turbines-noise-and-health/

Hart D.
***Aarhus Breaches All Round*.**
UK Human Rights Blog, 1 Crown Office Row (1COR), 13 April 2011.
http://ukhumanrightsblog.com/2011/04/13/aarhus-breaches-all-round/

Hart D.
**Anemometers, Environmental information, and Legal Advice: the Planning Inspectorate's Duty to Disclose?**
UK Human Rights Blog, 1 Crown Office Row (1COR), 25 August 2011.
http://ukhumanrightsblog.com/2011/08/25/anemometers-environmental-information-and-legal-advice-the-planning-inspectorates-duty-to-disclose/

Hart D.
**Just When You Thought They Were Extinct: Human Rights Environmental Case Succeeds.**
UK Human Rights Blog, 1 Crown Office Row (1COR), 27 July 2011.
http://ukhumanrightsblog.com/2011/07/27/just-when-you-thought-they-were-extinct-a1p1-environmental-case-succeeds/

Harvey H.
**Turitea Man Fears He'll Have to Go.**
*New Zealand News*,10 November 2006.
http://stuff.co.nz

Hawkins J.
**Windfarm Blows House Value Away.**
*The Westmorland Gazette*, 9 January 2004.
http://www.thewestmorlandgazette.co.uk/news/447706.print/

Hayes M and McKenzie A. (Hayes McKenzie Partnership Ltd.).
**Measurement of Low Frequency Noise at Three UK Wind Farms.**
Department of Trade and Industry (Dti)(UK), August 2006.
http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/energy/sources/renewables/explained/wind/onshore-offshore/page31267.html

Heaton-Harris C.
**Onshore Wind Turbines (Proximity of Habitation).**
House of Commons Debates, HC Deb 17 November 2010, c900.
(Second reading rescheduled for 20 January 2012.]
http://services.parliament.uk/bills/2010-11/onshorewindturbinesproximityofhabitation.html

Hessling K.
**Residents Sue Wind Companies.**
*Huron Daily Tribune* (Michigan, USA), 29 May 2010.
http://www.michigansthumb.com/articles/2010/05/29/news/local_news/doc4c0117f48d12c257748685.txt

Howe Gastmeier Chapnik Ltd.
**Low Frequency Noise and Infrasound Associated with Wind Turbine Generator Systems: A Literature Review** (Rfp No. Oss-78696).
Mississauga, Ontario, Canada: Ministry of the Environment, 2010.

Hubbard HH.
**Noise induced house vibrations and human perception.**
*Noise Control Engineering* 1982;19(2):49-55.

*M Hulme v Secretary of State & RES* 2010 EWHC 2386 Admin, 19 August 2010.
http://www.bailii.org/ew/cases/EWHC/Admin/2010/2386.html

*MW Hulme v Secretary of State & RES*, 2011 EWCA Civ 638, 26 May 2011.
http://www.bailii.org/ew/cases/EWCA/Civ/2011/638.html

***Hulme MW*: Appeal Decision permitting the Den Brook Wind Farm.**
Inspector A Pykett; PINS, APP/Q1153/A/06/2017162, 11 December 2009.
http://www.denbrookvalley.co.uk/resources/Denbrook+APPEAL+DECISION-1.pdf

Hurst T.
**Buyers Clearly Wind Resistant (letter).**
*Weekly Times* (Australia), 23 April 2003.

ICT (Information and Communications Technologies) Regulation Toolkit.
**Decision-making Process and Consultation Framework. S.7.2. 16**
Information for Development Program (infoDev) and the International Telecommunication Union (ITU), June 2011
www.ictregulationtoolkit.org .

**It's an Ill wind that Threatens Peatlands.**
*Yorkshire Today*, 12 March 2005.
http://www.yorkshirepost.co.uk/news/features/it_s_an_ill_wind_that_threatens_peatlands_1_2556729

Ito A and Takeda T.
**Sickness Claims Prompt Study of Wind Turbines.**
*The Asahi Shimbun*, 19 January 2010.
http://www.asahi.com/english/Herald-asahi/TKY201001180410.html

Jacobsen J.
**Infrasound Emissions from Wind Turbines.**
*Journal of Low Frequency Noise, Vibration, and Active Control* 2005;24:145–155.

James R.
**Surrebuttal Testimony of Richard R James on Behalf of the Coalition for Wisconsin Environmental Stewardship.**
Wisconsin Public Service Commission, docket 6630-CD-302: Wisconsin Electric Power Company (WEPCO), 28 October 2009, pp SR9.16 – SR9.22.
http://docs.wind-watch.org/James-Glacier-Hills-Surrebuttal.pdf

Janssen SA, Vos H; van Kempen EMM, Breugelmans ORP, and Miedema HME.
**Trends in Aircraft Noise Annoyance: The Role of Study and Sample Characteristics.**
*JASA Journal of the Acoustical Society of America* April 2011;129(4):1953-1962.

Johansson M.
**We Now See Families Leaving Their Homes (Denmark).**
Letter to Editor, 26 May 2011.
http://www.windturbinesyndrome.com/news/2011/we-now-see-families-leaving-their-homes-reports-physician-denmark/print/

Jones D; Hughes R; Macken W.
**Auditory Distraction and Serial Memory: the Avoidable and the Ineluctable.**
*Noise and Health* 2010; 12(49): 201-209.

**Kansai Electric Curbs Wind Farm over Noise Concerns.**
Reuters, 5 August 2011.
http://af.reuters.com/article/commoditiesNews/idAFL3E7J50F420110805

Keeble A.
**Our Sleepless Nights with the Wind Turbines.**
*North Devon Gazette*, 8 June 2011.
http://www.northdevongazette.co.uk/news/our_sleepless_nights_with_the_wind_turbines_1_914875

Kim R and van den Berg M.
**Summary of Night Noise Guidelines for Europe.**
*Noise and Health* 2010; 12(47): 61-63.

Kirk J.
**Turbine Plan Cut Value of Our Home by a Third.**
*Western Morning News*, 9 December 2004.
http://www.dartdorset.org/pdf/WMN%20TURBINE%20PLAN%20CUT%20VALUE%20091204.pdf

Kroesen M; Molin E; and Wee B.
**Determining the direction of causality between psychological factors and aircraft noise annoyance.**
*Noise and Health* Jan-Mar 2010; 12(46): 17-25.

Krogh CME.
**Industrial Wind Turbine Development and Loss of Social Justice.**
*Bulletin of Science, Technology & Society* 2011;31(4):321-333.
http://bst.sagepub.com/content/31/4/321

Krogh CME; Gillis L; and Kouwen N.
**A Self-Reporting Survey: Adverse Health Effects with Industrial Wind Turbines and the Need for Vigilance.**
WindVOiCe Wind Vigilance for Ontario Communities, Ontario, Canada, July 2010.
http://windconcernsontario.wordpress.com/health/health-survey-information/

Krogh CME, Gillis L, Kouwen N, and Aramini J.
**WindVOiCe, a Self-Reporting Survey: Adverse Health Effects, Industrial Wind Turbines, and the Need for Vigilance Monitoring.**
*Bulletin of Science, Technology & Society* 2011;31:334-345.
http://bst.sagepub.com/content/31/4/334

Laurie S.
**Submission to the Australian Federal Senate Inquiry on Rural Wind Farms.**
**10 February 2011.**
http://docs.wind-watch.org/Laurie-Australia-Senate-submission-final.pdf or
http://www.aph.gov.au/senate/committee/clac_ctte/impact_rural_wind_farms/submissions.htm

Leake J and Byford H.
**Officials Cover up Wind Farm Noise Report.**
*Sunday Times* (UK), 13 December 2009.

Leslie K.
**Ontario Unable to Tell if Wind Farms Exceed Noise Limits, Activists Say.**
*The Globe and Mail* (Toronto, Canada), 15/16 June 2011.
http://www.theglobeandmail.com/news/politics/ontario-unable-to-tell-if-wind-farms-exceed-noise-limits-activists-say/article2062789/

Leventhall G.
**Infrasound from Wind Turbines – Fact, Fiction, or Deception?**
*Canadian Acoustics* 2006;34(6):29-34,36.

Lipton E and Krauss C.
**A Gold Rush of Subsidies in Clean Energy Search.**
*New York Times* November 11, 2011.
http://www.nytimes.com/2011/11/12/business/energy-environment/a-cornucopia-of-help-for-renewable-energy.html?scp=1&sq=gold%20rush&st=cse

Ljung R; Sorqvist P; and Hygge S.
**Effects of road traffic noise and irrelevant speech on children's reading and mathematical performance.**
*Noise and Health* 2009; 11(45): 194-203.

**Lord Proposes Controversial 2km Residential Distance Ruling on Wind Farms.**
*Western Morning News*, 9 August 2010.
www.thisisdevon.co.uk/news/Lord-proposes-distance-ruling-wind-farms/article=2503820-detail/article.html

**Loud Road Noise Linked to Stroke in Older Adults.**
US National Library of Medicine, National Institutes of Health, MedlinePlus, January 26, 2011.

Lovelock J.
**The Revenge of Gaia: Why the Earth is Fighting Back.**
London: Penguin, 2006.

Mah C, Mah KE, Kezirian EJ, and Dement WC.
**The Effects of Sleep Extension on the Athletic Performance of Collegiate Basketball Players.**
*Sleep* 2011 Jul 1;34(7):943-950.

Maine Medical Association.
**Resolution Re: Wind Energy and Public Health.**
MMA (USA), 2009.
http://www.mainemed.com/annual/2009/2009_Proposed_Resolutions.pdf

Mair G.
**Italian Windfarm Diary, January 2007 to December 2007.**
http://docs.wind-watch.org/mair-diary.pdf

Makarewicz R.
**Is a Wind Turbine a Point Source?**
*JASA Journal of the Acoustical Society of America* Feb 2011;129(2): 579-581.

Mann T.
**Blumenthal Urges Tough Standards for Siting of Wind Power Projects.**
*The Day* (New London, Connecticut, USA), January 4 2011.
http://www.theday.com/article/20110104/NWS12/301049915/1069/rss

Marx RE.
**Uncovering the Cause Of 'Phossy Jaw' circa 1858 to 1906: Oral and Maxillofacial Surgery Closed Case Files - Case Closed.**
*Journal of Oral and Maxillofacial Surgery* 2008; 66(11): 2356-2363.

MAS Environmental.
**Assessing Noise from Proposed Wind Turbine Developments.**
MAS Environmental, Cambridge, UK, May 2009.

MAS Environmental.
**Noise Monitoring Graph measured within first floor bedroom – window open – Davis's House - Wind Farm Amplitude Modulation showing Significant Low Frequency Content, 5 July 2007**, *in*
Assessing Noise from Proposed Wind Turbine Developments.
MAS Environmental, Cambridge, UK, May 2009.

MAS Environmental.
**Noise Monitoring Graph within first floor bedroom - Davis's House - Wind Farm Noise, 5 July 2007**, *in*:
Assessing Noise from Proposed Wind Turbine Developments.
MAS Environmental, Cambridge, UK, May 2009.

**MAS Environmental (Cambridge, UK).**
**Proof of Evidence submitted by MAS to the North Dover Wind Park Inquiry (UK)**, pp 43-49, December 2008.

Matheson M; Clark C; Rocio M; van Kempen E; Haines M; Barrio I; Hygge S; Stansfeld S.
**The effects of road traffic and aircraft noise exposure on children's episodic memory: the RANCH Project** (Applied aspects of auditory distraction) (Report).
*Noise and Health* 2010; 12(49): 244-254.

McCann MS of McCann Appraisal, LLC (Real Estate Appraisal & Consulting), Chicago, Illinois (USA).
**Testimony to Adams County Board, Illinois, USA, 8 June 2010.**
http://www.windaction.org/documents/27736

McCann MS of McCann Appraisal, LLC (Real Estate Appraisal & Consulting), Chicago, Illinois (USA).
**There is a Measurable and Significant Loss of (Property) Values within 2 to 3 Miles** (letter).
*Ottawa Citizen* (Canada), 25 January 2011.
http://www.croh.info/index.php?option=com_content&view=article&id=1109:mccann-appraisal-llc&catid=10:news

McMorran C.
**Exasperated Planners Shut Wind Farm Down.**
*The Northern Times*, 9 June 2011
http://www.northern-times.co.uk/News/Exasperated-planners-shut-wind-farm-down-6934757.htm

Meneveau C and Meyers J.
**Optimization of Turbine Spacing in the Fully Developed Wind Turbine Array Boundary Layer.**
*Bulletin of the American Physical Society* Nov 2010;55(16):QD.00005

Meyers J and Meneveau C.
**Optimal turbine spacing in fully developed wind farm boundary layers.**
*Wind Energy* 14 Apr 2011 DOI: 10.1002/we.469

Møller H and Pedersen CS.
**Low-Frequency Noise from Large Wind Turbines.**
*JASA Journal of the Acoustical Society of America* June 2011;129(6): 3727-3744.

Monbiot G.
**The Unpalatable Truth is that the Anti-Nuclear Lobby has Misled Us All.**
*The Guardian*, 5 April 2011.
http://www.guardian.co.uk/commentisfree/2011/apr/05/anti-nuclear-lobby-misled-world

Moorhouse A; Hayes M; von Hünerbein; Piper B; and Adams M.
**Research into Aerodynamic Modulation of Wind Turbine Noise: Final Report.**
Report by University of Salford for Defra, BERR, DCLG, and the Dti (UK), URN 07/1235, Contract # NANR233, Dti, July 2007.
http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file40570.pdf

Moroney L and Constable J.
**The Den Brook Amplitude Modulation Noise Condition: Information Note.**
Renewable Energy Foundation (REF), London, UK, 31 October 2011.
http://www.ref.org.uk/publications/242-the-den-brook-amplitude-modulation-noise-condition

Mortensen BOG.
**'Danish Rules on Noise and Related Issues', p 215,**
*in* Legal Systems and Wind Energy: a Comparative Perspective,
Anker HT, Olsen BE, and Ronne A, eds.
*Energy and Environmental Law and Policy Series*, v2.
Alphen aan den Rijn: Kluwer Law International, 2009.

John Muir Trust.
**Analysis of UK Wind Power Generation, November 2008 - December 2010.**
John Muir Trust, March 2011.
http://www.jmt.org/wind-analysis-report.asp

Muller-Gass A and Campbell K.
**The Processing of Infrequently-Presented Low-Intensity Stimuli during Natural Sleep: An Event-Related Potential Study.**
*Noise & Health* 2010;12(47):120-128

**My Property Nighmare: Wind Farm.**
*Daily Telegraph*, 25 January 2005.
http://www.telegraph.co.uk/property/mypropertynightmare/3338689/My-property-nightmare-wind-farm.html

Myers ML and McGlothlin JD.
**Matchmakers' 'phossy jaw' eradicated.**
*American Industrial Hygiene Association Journal* Apr 1996; 57(4): 330-332.

National Renewable Energy Laboratory (NREL).
**Wind Energy Aerodynamics/Aeroacoustics.**
NREL, US Department of Energy, December 2010.
http://www.nrel.gov/wind/pdfs/48830.pdf

Nicol J and Seglins D.
**Ontario Wind Power Bringing Down Property Values.**
CBC News (Canada), 1 October 2011.
http://www.cbc.ca/news/canada/windsor/story/2011/09/30/ontario-wind-power-property-values.html

Nissenbaum MA.
***Affidavit: David McKinnon (Plaintiff) and Red Lily Wind Power Ltd Partnership, Red Lily Energy Corp, Rural Municipality of Martin, and Rural Municipality of Moosomin (Defendants),***
Queen's Bench, Judicial Centre of Saskatoon, Saskatchewan, Canada 2010.
http://docs.wind-watch.org/Nissenbaum-Saskatoon-Red-Lily.pdf

Nissenbaum MA.
**Mars Hill Wind Turbine Project Health Effects: Pilot Study.**
Rutland, Vermont, USA, Rutland Regional Medical Center, 6 May 2010.

Nissenbaum MA.
**Mars Hill wind turbine Project Health Effects: Preliminary Findings.**
Maine Medical Association, March 2009.
http://docs.wind-watch.org/nissenbaum-mars-hill.pdf

Nissenbaum M.
**Wind Turbines, Health, Ridgelines, and Valleys.**
Energize Vermont, Montpelier, Vermont, USA, May 7 2010.
http://vimeo.com/11577982

Nissenbaum M, Aramini J, and Hanning C.
**Adverse Health Effects of Industrial Wind Turbines: A Preliminary Report.**
10th International Congress on Noise as a Public Health Problem (ICBEN), London, UK, 24 – 28 July 2011.

Oike YT.
**Japanese Conference on Big Wind: Presentations by Victims. (excerpts), 30 April 2010.**
http://www.epaw.org/documents/Japanese%20Conference%20against%20Big%20Wind.pdf

**Onshore Wind – a Clear Conflict of Interest?**
*North Devon Journal*, 13 August 2008.
http://www.geoffreycox.co.uk/content/article-north-devon-journal-onshore-wind-clear-conflict-interest

Ontario Environmental Review Tribunal (ERT).
***Erickson v Director, Ministry of the Environment*: Decision, 18 July 2011.**
Ontario, Canada.
http://www.ert.gov.on.ca/english/decisions/index.htm
(See also **Summary of Case and Decision,**
**First Appeal of Renewable Energy Approval Dismissed.**
Torys on Environmental, Health and Safety 19 July 2011;18(7)
http://www.torys.com/Publications/Documents/Publication%20PDFs/EHS2011-7.pdf ; and
Chamberlain A.
**First Appeal Decision on Renewable Energy Approval for a Wind Farm Rendered by Ontario Environmental Review Tribunal.**
*Energy Markets Bulletin* July 2011
http://www.martindale.com/members/Article_Atachment.aspx?od=1081999&id=1318358&filename=asr-1318360.First.pdf .)

Parry S and Douglas E.
**In China, the True Cost of Britain's Clean, Green Wind Power Experiment: Pollution on a Disastrous Scale.**
*Daily Mail*, 29 January 2011.
http://www.dailymail.co.uk/home/moslive/article-1350811/In-China-true-cost-Britains-clean-green-wind-power-experiment-Pollution-disastrous-scale.html

Passchier-Vermeer W and Passchier WF.
**Noise exposure and public health.**
*Environmental Health Perspectives* March 2000; 108[Suppl 1]: 123-131.

Pawlaczyk-Luszczynska, M; Dudarewicz A; Szymczak W; and Sliwinska-Kowalska M.
**Evaluation of annoyance from low frequency noise under laboratory conditions.**
*Noise and Health* 2010; 12(48): 166-

Pedersen E; van den Berg F; Bakker R; and Bouma J.
**Can Road Traffic Mask Sound from Wind Turbines? Response to Wind Turbine Sound at Different Levels of Road Traffic Sound.**
*Energy Policy* 2010;38:2520-2527.

Pedersen E; van den Berg F; Bakker R; and Bouma J.
**Response to Noise from Modern Wind Farms in The Netherlands.**
*JASA Journal of the Acoustical Society of America* August 2009;126(2): 634-643.

Pedersen E and Waye KP.
**Wind Turbine Noise, Annoyance and Self-Reported Health and Well-Being in Different Living Environments.**
*Occupational and Environmental Medicine* 2007; 64: 480-486.

Pierpont N.
**Wind Turbine Syndrome: a report on a natural experiment.**
Santa Fe, NM: K-Selected Books, 2009.
http://www.windturbinesyndrome.com/

Pierpont N.
**Wind Turbine Syndrome and the Brain.**
First International Symposium on the Global Wind Industry and Adverse Health Effects: Loss of Social Justice? Picton, Ontario, Canada, 30 October 2010.
http://windturbinesyndrome.com/img/WTSbrain-color.pdf
http://windturbinesyndrome.com/img/WTSbrain-BW.pdf

**Planning Bill (UK)**: *See under* UK Proposed Bills, Legislation, and Policy Statements.

The Planning Inspectorate (UK).
**Tunstall, Roos, Hull. Appeal Decision.**
Inspector A Pykett. PINS Appeal Ref APP/E2001/A/10/2130670, 7 January 2011.
http://docs.wind-watch.org/Tunstall-Roos-Decision.pdf

Prasher D.
**Is There Evidence that Environmental Noise is Immunotoxic? (**Report)
*Noise and Health* 2009; 11(44):151-155.

Punch J, James R, and Pabst D.
**Wind Turbine Noise: What Audiologists Should Know.**
*Audiology Today* July/August 2010.

Rasmussen G.
**Symptoms for Vibration Exposure at Frequencies of 1 -- 20 Hz, in Human Body Vibration Exposure and its Measurement.**
Bruel & Kjaer *Technical Review*, v. 1, 1982.

Ray P.
**Charges against Wind Companies Upheld.**
*Altoona Mirror*, 27 March 2009.
http://www.altoonamirror.com/page/content.detail/id/517439.html

Lord Reay (Mackay HW).
**Wind Turbines (Minimum Distances from Residential Premises) Bill [HL] 2010-11.**
http://services.parliament.uk/bills/2010-11/windturbinesminimumdistancesfromresidentialpremiseshl.html

Reid D.
**Health Effects of Turbines? We Already Know.**
*The Beacon Herald* (Ontario, Canada), 9 January 2011.
http://www.stratfordbeaconherald.com/ArticleDisplay.aspx?e=2922808

Renewable Energy Foundation (REF).
**Response to DECC Consultation on the Revised Draft National Policy Statement EN-3 Renewable Energy Infrastructure and related documents.**
REF, 24 January 2011.
http://www.ref.org.uk/publications/218-ref-response-to-re-consultation-on-nps-en-3

Ribnick PG and Green LA.
**Adverse Impacts from Wind Turbines in Waubra, Australia and Surrounding Area.**
Green & Ribnick, Professional Resource Group (PRG), Wellfleet, Massachusetts, USA, 14 January 2011.
http://docs.wind-watch.org/Ribnick-Green-Adverse-Effects-Waubra.pdf

Ritch J.
**Interview, July 2011.**
http://rt.com/programs/interview/energy-fukushima-nuclear-expert/

Rolfe P.
**Turbines Declared Nasty Neighbour as Secret Buyout is Revealed.**
*Sunday Herald Sun*, 30 January 2011.
http://www.heraldsun.com.au/news/victoria/turbines-declared-a-nasty-neighbour/story-e6frf7kx-1225996775637

***Rylands v Fletcher*** (UK), 3 HL 330, (1868) LR 3 HL330, [1868] UKHL 1.
http://www.bailii.org/uk/cases/UKHL/1868/1.html

Saccorotti G, Piccinini D, Cauchie L, and Fiori I.
**Seismic Noise by Wind Farms: A Case Study from the VIRGO Gravitational Wave Observatory, Italy.**
*Bulletin of the Seismological Society of America* April 2011;101(2):568-578.

**Salford Report**: see Moorhouse A.

Salt, AN.
**Infrasound: Your Ears Hear It But They Don't Tell Your Brain.**
First International Symposium: The Global Wind Industry and Adverse Health Effects: Loss of Social Justice?
Society for Wind Vigilance, Ontario, Canada, 29-31 October 2010.
http://www.windvigilance.com/international-symposium/proceedings-first-international-symposium

Salt AN and Hullar TE.
**Responses of the Ear to Low Frequency Sounds, Infrasound and Wind Turbines.**
*Hearing Research* 2010 Sept 1;268(1-2):12-21.

Schreckenberg D; Griefash B; and Meis M.
**The associations between noise sensitivity, reported physical and mental health, perceived environmental quality, and noise annoyance.**
*Noise and Health* 2010; 12(46): 7-16.

**Scottish Parliament Written Answers.**
Question S3W-38080, 15 Dec 2010
**Whitefield K and Brown K**, 15 December 2010.
http://www.scottish.parliament.uk/Apps2/MAQASearch/QAndMSearch.aspx?datefrom=5/1/2007%2012:00:00%20AM&dateto=3/22/2011%2012:00:00%20AM&datechoice=6&referencenumber=S3W-38080&keyword=wind&mspid=1805&isinanything=false,false&isinmotion=false&isinfmq=false&isinoralquestion=false&isinwrittenquestion=false&issortbyrank=Relevance_Rank&resultsperpage=50
See also: http://www.scottish.parliament.uk/business/petitions/docs/PE1328.htm

Scourfield G.
**Report on a Sample of Properties Inspected near a Proposed Wind Farm at Esgairwen Fawr nr Lampeter (Wales, UK).**
RG Lewis & Company Estate Agents, Auctioneers and Property Valuers, T/A ReMAX Estate Agents, Carmarthen, Summary, 11 July 2005, p 6.

Seglins D and Nicol J.
**Ontario Wind Farm Health Risks Downplayed: Documents.**
*CBC News*, 22 September 2011.
http://www.cbc.ca/news/health/story/2011/09/21/wind-turbines.html

Seglins D and Nicol J.
**Wind Farm Health Risks Claimed in $1.5M Suit: Ontario Family Sues Suncor, Alleging Health Problems.**
*CBC News*, 21 September 2011.
http://www.cbc.ca/news/canada/toronto/story/2011/09/21/seglins-windfarms.html

Sellars P.
**Turbines Cast Shadow over Land Values.**
*Weekly Times* (Australia), 16 April 2003.

Shepherd D, McBride D, Welch, Dirks KN, and Hill EM.
**Evaluationg the Impact of Wind Turbine Noise on Health-Related Quality of Life.**
*Noise and Health* [serial online] 2011 [cited 2011 Oct 1];13:333-9. Available from:
http://www.noiseandhealth.org/text.asp?2011/13/54/333/85502

Shepherd D, Welch D, Dirks KN, and Mathews R.
**Exploring the Relationship between Noise Sensitivity, Annoyance and Health-Related Quality of Life in a Sample of Adults Exposed to Environmental Noise.**
*International Journal of Environmental Research and Public Health* 2010;7:3579-3594.

Shreve E.
**Turbines Get Louder at Night, Hearing Told.**
*Chatham Daily News*, 25 January 2011.
http://www.chathamdailynews.ca/ArticleDisplay.aspx?e=2959622

Society for Wind Vigilance.
**Wind Energy Industry Acknowledgement of Adverse Health Effects.**
**Part 1: Conclusion and Executive Summary of an Analysis of the American/Canadian Wind Energy Association sponsored "Wind Turbine Sound and Health Effects".**
Authored by: Horner B; James RR; Jeffery RD; McMurtry RY; Nissenbaum MA; and White DL.
Society for Wind Vigilance, Ontario, CA, January 2010.
http://www.windvigilance.com/news/analysis-of-a-canwea-panel-review

Society for Wind Vigilance.
**Wind Energy Industry Acknowledgement of Adverse Health Effects.**
**Part 2: Detailed Analysis of an Analysis of the American/Canadian Wind Energy Association sponsored "Wind Turbine Sound and Health Effects".**
Authored by: Horner B; James RR; Jeffery RD; McMurtry RY; Nissenbaum MA; and White DL.
Society for Wind Vigilance, Ontario, CA, January 2010.
http://5468964569013158095-a-1802744773732722657-s-sites.googlegroups.com/site/windvigilancecom/ACanWEA_part_1_final.pdf?attachauth=ANoY7cq_d_1Orlovb50qQZ-w66yPsIOyQMv1mZxcbsNUaDOruIFkM7kPSfLR3LmrEh4AHriuUPosRCEIiqNoH1TbROLukCNATZpqtaH331FxBLBxtBJWFv

pJPRA0pG6yhSv082szHpqlv1tDVYSyHuIs1PE4ggnRM2GyfISuDiA4PcJiR3XSYc8rW4KY5njRMVZyBAE4JRNqucXnvSzoAVJMBwBe9gm1Sg%3D%3D&attredirects=0 or
http://www.windvigilance.com/news/analysis-of-a-canwea-panel-review

Sorensen M, Hvidberg M, Andersen ZJ, Nordsborg RB, Lillelund KG, Jakobsen J, Tjonneland A, Overvad K, and Raaschou-Nielsen O.
**Road Traffic Noise and Stroke: a prospective cohort study.**
*European Heart Journal* 2011 Mar;32(6):737-744.

Spears J.
**Legal Challenge Could Stall Ontario Wind Projects.**
*The Star* (Ontario, Canada), 5 January 2011.
http://www.thestar.com/news/ontario/article/916620--legal-challenge-could-stall-ontario-wind-projects

Spears J.
**Top Court Rejects Wind Turbine Challenge.**
*The Star* (Ontario, Canada), 21 June 2011.
http://www.thestar.com/business/companies/article/1012641--top-court-rejects-wind-turbine-challenge

Stansfeld S and Crombie R.
**Cardiovascular Effects of Environmental Noise: Research in the United Kingdom.**
*Noise & Health* 2011 May-June 2011;13(52):229-233.

State Government of Victoria.
**Wind Energy Facilities, Amendment VC82.**
Department of Planning and Community Development, State Government of Victoria, Australia, 29 August 2011.
http://www.dpcd.vic.gov.au/planning/news-and-events/news/amendment-vc82-implements-new-policy-on-wind-energy-facilities-in-victoria

Stateline Victoria.
**Claims of Wind Farm Illness, 19 February 2010.**

Stephens DG; Shepherd KP; Hubbard HH; and Grosveld FW.
**Guide to the Evaluation of Human Exposure to Noise from Large Wind Turbines.**
NASA *Technical Memorandum* 83288, March 1982.
http://ia700507.us.archive.org/12/items/nasa_techdoc_19820016175/19820016175.pdf or
http://www.archive.org/details/nasa_techdoc_19820016175

Stewart A.
**Wind Farm No-Go Zones to be Established.**
*ABC News* (Australian Broadcasting Corporation), 29 August 2011.
http://www.abc.net.au/news/2011-08-29/wind-farm-no-go-zones-to-be-established/2859708

Stigwood M.
**The Effect of a Common Wind Shear Adjustment Methodology on the Assessment of Wind Farms when applying ETSU-R-97.**
MAS Environmental, Cambridge, UK, 27 September 2011.
http://www.masenv.co.uk/uploads/STUDYREPORTComparison%20of%20thearticleandETSUW111004FINAL_sec.pdf

Stigwood M.
**Public Inquiry into Proposed Construction of wind Farm at North Dover wind park by Ecotricity: Proof of Evidence of Mike Stigwood, MAS Environmental, for Langdon Action Group.**
(UK) PINS Ref: APP/X2220/A/08/2071880/NWF, 16 December 2008, pp 43-39.

Stigwood M.
**Summary to: The Effect of a Common Wind Shear Adjustment Methodology on the Assessment of Wind Farms when applying ETSU-R-97.**
MAS Environmental, Cambridge, UK, 27 September 2011.
http://www.masenv.co.uk/uploads/Summary%20ETSU%20IoA%20article.pdf

Stigwood M.
**Windfarm Nuisance Investigation & Assessment Seminar.**
MAS Environmental, University Centre, Cambridge, UK, 20 November 2008

Styles P, Stimpson I, Toon S, England R, and Wright M.
**Microseismic and Infrasound Monitoring of Low Frequency Noise and Vibrations from Windfarms: Recommendations on the Siting of Windfarms in the Vicinity of Eskdalemuir, Scotland.**
Report prepared for the UK Ministry of Defence (MoD), 18 July, 2005.
http://geophysics.esci.keele.ac.uk/resources/docs/Final_Report.pdf

Swinbanks MA.
**The Audibility of Low Frequency Wind Turbine Noise: Conclusion.**
The Fourth International Wind Turbine Noise Conference, Rome, April 12-14, 2011.

Swinbanks MA.
**Submission to the Michigan Public Service Commission (MPSC, USA)** re: Case No U-15899.
MAS Environmental, Cambridge, UK, 9 December 2009.
http://efile.mpsc.state.mi.us/efile/docs/15899/0051.pdf

Swinbanks MA.
**Wind Turbines: Low-Frequency Noise & Infrasound Revisited.**
Environmental Protection UK One-day Workshop, Birmingham, 9 September 2010.
http://www.friendsofmainesmountains.org/uploads/Exhibit%2041,%20Wind%20Turbines-%20Low-Frequency%20Noise%20%20Infrasound%20Revisited%20Malcolm_Swinbanks.pdf

Takahashi Y; Kanada K; Yonekawa Y; and Harada N.
**A Study on the Relationship between Subjective Unpleasantness and Body Surface Vibrations Induced by High-Level Low-Frequency Pure Tones.**
*Industrial Health* 2005; 43:580-587.
http://www.jniosh.go.jp/en/indu_hel/pdf/43-3-24.pdf

Takahashi Y; Yonekawa Y; and Kanada K.
**A New Approach to Assess Low Frequency Noise in the Working Environment.**
*Industrial Health* 2001; 39:281-286.
http://www.jniosh.go.jp/en/indu_hel/pdf/IH39_40.pdf

Takahashi Y; Yonekawa Y; Kanada K; and Maeda S.
**A Pilot Study on the Human body Vibration Induced by Low Frequency Noise.**
*Industrial Health* 1999; 37:28-35.
http://www.journalarchive.jst.go.jp/jnlpdf.php?cdjournal=indhealth1963&cdvol=37&noissue=1&startpage=28&lang=en&from=jnlabstract

***Tegni Cymru Cyf Respondent - And - The Welsh Ministers & ANR Appellant.***
S.24, Case No: C1/2010/1426/QBENF, Lord Justice Carnwath, Lord Justice Elias and Lord Justice Pitchford between: Tegni Cymru Cyf Respondent - And - The Welsh Ministers & ANR Appellant, 24 November 2010.

Thorne B.
**Noise Impact Assessment Report: Waubra Wind Farm. Report No 1537.**
Noise Measurement Services Pty Ltd. (NMS Pty Ltd), South Brisbane, Australia, July 2010.

Thorne B.
**The Problems with "Noise Numbers" for Wind Farm Noise Assessment.**
*Bulletin of Science, Technology & Society* 2011;31(4):262-290.
http://bst.sagepub.com/content/31/4/262

Todd W.
**Living with Turbines – a Personal Account, 16 February 2009.**
http://www.windaction.org/documents/15113

Todd W.
**Testimony to Maine Legislature, 30 April 2007.**
http://www.maine.gov/dep/ftp/bep/ch375citizen_petition/pre-hearing/AR-70%20Wendy%20Todd%20testimony.pdf or
http://www.wind-watch.org/documents/testimony-of-wendy-todd-to-the-maine-legislature-april-30-2007/

**Transcript: Senate Confirmation Hearings Nominating Eric Holder as Attorney General.**
*New York Times*, 16 January 2009.
http://www.nytimes.com/2009/01/16/us/politics/16text-holder.html

Tromans S.
**Assessing the Noise Impacts of Onshore Wind Turbines.**
ThirtyNine Essex Street *Environmental and Planning Law Newsletter*, November 2010, pp 3-4.
http://www.39essex.com/docs/news/eandpnov10.pdf

**Turbine Noise a Wind Developer Finds Objectionable.**
Industrial Wind Action Group, 15 June 2010.
http://www.windaction.org/faqs/27803

**Turbines advice 'blowing in the wind'.**
*The Journal* (Newcastle-Upon-Tyne), 18 Aug 2008.
http://www.journallive.co.uk/north-east-news/todays-news/2008/08/18/turbines-advice-blowing-in-the-wind-61634-21552502/

Turkel T.
**Turbines Turn into Headache for Vinalhaven; Noise Complaints Energize Opponents of Wind Power and Complicate Maine's Renewable Energy Efforts.**
*Portland Press Herald*, 24 January 2010.
http://www.pressherald.com/archive/turbines-turn-into-headache-for-vinalhaven_2010-01-24.html?searchterm=headache+for+vinalhaven

UK Civil Service.
**Code of Conduct.**
http://www.civilservice.gov.uk/about/values/cscode/index.aspx

**UK Equality and Human Rights Commission (EHRC).**
http://www.equalityhumanrights.com/

**UK Noise Association (UKNA).**
22 January 2011.
http://menmedia.co.uk/manchestereveningnews/news/s/1406023_windfarm_worries_woman_believes_turbines_at_scout_moor_are_making_her_ill
www.ukna.org.uk

**UK Proposed Bills, Legislation, and Policy Statements:**

- **Environmental Protection Act 1990**
http://www.legislation.gov.uk/ukpga/1990/43/section/79

- **Human Rights Act 1998**
http://www.legislation.gov.uk/ukpga/1998/42/contents

- **Planning Bill 2008**
http://services.parliament.uk/bills/2007-08/planning.html

- **The Planning Act 2008, Section 158 Nuisance**
http://www.legislation.gov.uk/ukpga/2008/29/contents

- **The Planning Act 2008, Section 152 Compensation**
http://www.legislation.gov.uk/ukpga/2008/29/contents

- **National Policy Statement draft NPS (EN-1) section 4.14: Common law nuisance and statutory nuisance (2010)**
http://www.official-documents.gov.uk/document/other/9780108509346/9780108509346.pdf

- **National Policy Statement draft NPS (EN-3)**
http://www.official-documents.gov.uk/document/other/9780108508516/9780108508516.pdf

- **Planning Policy Statement 22 (PPS22): Renewable Energy, 10 August 2004.**
http://www.communities.gov.uk/publications/planningandbuilding/pps22

- *See also* **Heaton-Harris**; and Lord **Reay** for links to their proposed bills on distances for wind turbines from homes.

United Nations (UN).
**Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment.**
United Nations, June 1987.
http://treaties.un.org/doc/Publication/UNTS/Volume%201465/volume-1465-I-24841-English.pdf

United Nations (UN).
**Universal Declaration of Human Rights.**
United Nations, December 1984.
http://www.un.org/en/documents/udhr

Valuation Tribunal Service.
**Council Tax Valuation List Appeal for The Farmhouse at Greys Farm, North Drove Bank, Spalding, Lincolnshire PE11 3JX.**
Appeal Number 2525475651/032C/20, 17 July 2008
www.valuation-tribunals.gov.uk

van den Berg GP.
**The Beat is Getting Stronger: the Effect of Atmospheric Stability on Low Frequency Modulated Sound of Wind Turbines.**
*Journal of Low Frequency Noise, Vibration and Active Control* 2005; 24(1): 1-24.
http://docs.wind-watch.org/vandenberg-beatgettingstronger.pdf

van den Berg GP.
**Do Wind Turbines Produce Significant Low Frequency Sound Levels?**
11th International Meeting on Low Frequency Noise and Vibration and its Control, Maastricht, The Netherlands, 30 August - 1 September 2004.
http://docs.wind-watch.org/vandenBerg-lowfreqnoise.pdf

Van Gerven PWM; Vos H; van Boxtel MPJ; Janssen SA; and Miedema HME.
**Annoyance from Environmental Noise across the Lifespan.**
*JASA Journal of the Acoustical Society of America* July 2009; 126(1): 187-194.

Watts, AC.
**Wind Turbines may represent a Health Hazard to Our Residents** (letter).
*Blayney Chronicle* (NSW, Australia), 21 March 2011.

**Waubra Resident on 24-hour Check.**
*The Courier* (Australia), 31 December 2010.
http://www.thecourier.com.au/news/local/news/general/waubra-resident-on-24hour-check/2037606.aspx

**Waubra Resident Tells Court of Wind Farm 'Hell'.**
*The Courier* (Australia), 18 January 2011.
http://www.thecourier.com.au/news/local/news/general/waubra-resident-tells-court-of-wind-farm-hell/2049825.aspx

Waye K.
**Effects of Low Frequency Noise on Sleep.**
*Noise and Health* April/June 2004; 6(23):87-91.

Webb C.
**My Property Nightmare: Wind Farm.**
*Sunday Telegraph*, 26 January 2005.
http://www.telegraph.co.uk/property/mypropertynightmare/3338689/My-property-nightmare-wind-farm.html#disqus_thread

Webster B.
**Climate Change Could 'Lead to Rise in Coal Power Plants'.**
*The Times* (UK), 15 July 2011.

Webster B.
**Helicopter Noise Court Challenge for Wind Farms.**
*The Times* (UK), 4 July 2011.
http://www.thetimes.co.uk/tto/environment/article3082809.ece

Wetterer R.
**Statement presented to the State of New Hampshire Site Evaluation Committee**, re: Docket No. 2010-01, New Hampshire, USA, 31 August 2010.
http://www.nhsec.nh.gov/2010-01/documents/100831wetterer_2.pdf

White L.
**Wind Farms Can Cause Significant Health Problems.**
*Weekly Times Now*, 24 December 2009.
http://www.weeklytimesnow.com.au/article/2009/12/24/144511_national-news.html

Wind Concerns Ontario.
**A Self-Reporting Survey: Adverse Health Effects with Industrial Wind Turbines and the Need for Vigilance: Abstract and Participant Comments.**
Wind Concerns Ontario Community-based Health Survey, July 2009.
Presented on April 22 2009, by Dr Robert McMurtry to the Ontario Government's Standing Committee re: Bill 150, the Green Energy Act.
http://windconcernsontario.wordpress.com/health/health-survey-information/

**Wind Energy Staff Act As Advisors.**
*Western Morning News*, 13 August 2008.
http://www.chilla-against-turbines.co.uk/index2.php?option=com_content&do_pdf=1&id=104

**Wind Expert Quits Thinktank; Resignation Hits Wind Findings.**
*Noise Bulletin* Aug-Sept 2007;Issue 15, pp 1, 4-5.

**Wind Farms Banned as MoD Listening Post Demands Hush to Detect Nuclear Blasts.**
*The Scotsman,* 10 February 2010.

**Windfarms, Communities and Ecosystems**. Part I (Special Issue).
*Bulletin of Science, Technology and Society* 2011; 31(4).

WNEM TV5 Investigates.
**Possible Conflict of Interest; Lawsuit against Wind Energy COs: This Man's Family Can't Sleep,**
WNEM TV5 (Michigan, USA), 29 May 2010.

**Woman Tells a Tale of Turbine Torment: Retired Pharmacist Speaks to Killaloe, Hagarty and Richards about the Effects Industrial Wind Turbines had on her Health.**
*Barry's Bay This Week*, 11 February 2009.
http://www.barrysbaythisweek.com/ArticleDisplay.aspx?e=1430532

Lord Woolf.
**The Pursuit of Justice.**
Campbell-Holt C, ed.
Oxford University Press, March 2008.

World Health Organization Regional Office for Europe and the Joint Research Centre of the European Commission.
**Burden of Disease from Environmental Noise: Quantification of Health Life Years Lost in Europe.** (WHO BDEN)
WHO and and the Joint Research Centre of the European Commission, 2011.
http://www.euro.who.int/__data/assets/pdf_file/0008/136466/e94888.pdf

World Health Organization.
**Community Noise.**
WHO, 1995.
http://www.nonoise.org/library/whonoise/whonoise.htm or
http://www.who.int/docstore/peh/noise/Noiseold.html

World Health Organization.
**Guidelines for Community Noise.**
Berglund B, Lindvall T, and Schwela DH, eds.
WHO, 2000 (1999).
http://whqlibdoc.who.int/hq/1999/a68672.pdf

World Health Organization.
**Night Noise Guidelines for Europe.**
WHO, 2009.
http://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf
(WHO NNG)

World Health Organization: Regional Office for Europe.
**Evaluation and Use of Epidemiological Evidence for Environmental Risk Assessment: Guideline Document.**
WHO, 2000.
http://www.euro.who.int/__data/assets/pdf_file/0006/74733/E68940.pdf

World Health Organization.
**WHO/Europe: Health Effects of Noise 2011.**
http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/noise/facts-and-figures/health-effects-of-noise

World Health Organization.
**WHO/Europe: Noise: Facts and Figures, 2011.**
http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/noise/facts-and-figures

Zaharna M & Guilleminault.
**Sleep, noise and health: review.**
*Noise & Health* 2010; 12(47): 64-69.

Zeller, T Jr.
**For Those Near, the Miserable Hum of Clean Energy.**
*New York Times*, 5 October 2010.
http://www.windturbinesyndrome.com/news/2010/for-those-near-the-miserable-hum-of-clean-energy-ny-times/