## IN THE WINDMILLS OF HIS MIND: WHEN GOOD LEGISLATION GOES BAD

Under Premier Dalton McGuinty the Liberal Government of the Province of Ontario made a decision to (a.) rid itself of coal-fired electrical generators and (b.) Turn the province into a leader in green energy development and thus create thousands of jobs in the bargain. To achieve this worthy goal the government introduced The Green Energy Act. The act was passed into law and received Royal Assent on May 14, 2009 [347]. It was intended to:

1. Promote growth of clean and renewable sources of energy such as wind, solar, hydro, biomass and biogas in Ontario.

2. Create the potential for savings and better managed household energy expenditures through a series of conservation measures.

3. Create 50,000 jobs for Ontarians in its first three years.

Within a year forests of towering wind turbines were springing up across the rural landscape of Ontario. Almost immediately, complaints began to emerge about health effects associated with the resultant exposure to Low Frequency Noise (LFN). (Noise is defined as unwanted sound.) Protestations followed from government spokespersons and some medical authorities claiming that there were no proven adverse effects associated with exposure to sound from the turbines. Nonetheless, some people were abandoning their homes of many years because of the continual assault of the LFN. Protests multiplied across the province. The controversy heated up even further when plans were announced to establish offshore wind farms in Lake Huron and Lake Erie.





A number of physicians around the world have recorded an array of similar symptoms associated with exposure to noise arising from wind turbines. The physicians include Amanda Harry of England, Robyn Phipps in New Zealand, Robert McMurtry (formerly Dean of Medicine of the University of Western Ontario in London, Canada) in Canada and Nina Pierpont of New York. Dr. Pierpont refers to the symptoms as the "wind turbine syndrome" and is convinced that it is primarily due to the effects of LFN (20-200 Hz) on the inner ear, which is the site of equilibrium and balance control. Inner ear disturbances are commonly associated with vertigo. Another possible complicating factor is the strobe, or flicker effect that occurs when the sun is behind the blades. It is well known that this can trigger a seizure in some photosensitive epileptics [348]. The World Health Organization notes that measurable effects on sleep begin around 30 dB and continuous noise should not exceed this level indoors [349].

The array of symptoms referred to above include:

- Sleep disturbance
- Headache
- Tinnitus (ringing or buzzing in the ears)
- Pressure in the ears

- Pressure in the ears
- Dizziness, vertigo
- Nausea
- Blurring of vision
- Tachycardia (accelerated heart rate)
- Irritability
- Problems with concentration and memory
- Episodes of panic associated with sensations of internal pulsation or quivering that can occur both when awake and asleep.

Medical experts came out on both sides of the debate. Representatives of the Canadian Association of Physicians for the Environment (CAPE), including its Chairperson Dr. John Howard, issued a press release stating that there was no scientific evidence that wind turbines had adverse health effects provided the setbacks from habitations were adequate (more on this point later) and discredited data collected by others as anecdotal and therefore unreliable. Their opponents had collected over 100 reports of adverse effects like those listed above by September 2009 (the year in which the Ontario Green Energy Act was passed) with more coming in daily [350].

**Some Science**

CAPE was correct in stating that there is no 'scientific' evidence of harmful effects of wind generators but this is only because no scientific studies have been done here. Dr. McMurtry has not been able to convince the province to fund such a study. This is not to say that there is no evidence of harmful effects of LFN, however. Berglund *et al.* [351] in 1996 and Waye [352] in 2004 published exhaustive reviews of the health effects of LFN. The authors' describe the characteristics of LFN (20-200 cycles per second or Hz). Owing to the low velocity speed, low frequencies may propagate for long distances, with little attenuation of noise. Low frequencies will also pass with little attenuation through walls and windows. At long distance from the source, or indoors, the noise spectrum will be selectively attenuated, resulting in a spectrum dominated by





low frequencies. Indoors, room resonances in the low frequency range will increase the sound pressure levels and also lead to variations in sound pressure level inside the room. LFN will tend to mask higher frequencies rather than the other way around. LFN can also produce resonance in the human body and cause great subjective reactions. Sound below 20 Hz is generally called infrasound and conventional wisdom believes that it is inaudible to the human ear. But evidence suggests that there are considerable inter-individual differences amongst people and infrasound may be perceived by some people. Loudness, measured as decibels (dB) and duration as well as frequency affect the audible threshold. The following health effects have been reported both in laboratory studies and in the field.

**Hearing and Balance:** Studies have consistently shown that temporary threshold shifts (in hearing) occur with exposure to LFN, higher pitched sounds causing longer recovery periods. The clinical significance of this is unclear, but the authors [352] suggest that there is the potential for permanent threshold shifts with long term, chronic exposures in the community setting. Animal studies in monkeys and guinea pigs have shown evidence of vestibular effects of LFN but behavioural effects were small.

**Respiratory Effects:** LFN has been shown to cause suspended or reduced respiration, gagging and coughing but only at high levels of 150-154 dB and these symptoms are therefore of significance mainly for extreme occupational exposures.

**Annoyance, Loudness and Noisiness:** The most frequently reported effect of LFN is annoyance rather than loudness. The responses of individuals may be quite varied and depend on a number of factors including culture, activity at the time of exposure, the person's attitude to the source of the noise, their individual sensitivity to noise and their ability, or lack thereof, to control the source. Two, fairly recent studies [353, 354], in Sweden in 2007 and in The Netherlands in 2009, examined this annoyance factor in a thorough, scientific manner. In both studies over 700 individuals were surveyed by standard questionnaire and sound pressure measurements were taken outside their dwellings. The metres employed are generally equipped with filters usually identified as A, B or C type that help to isolate the frequency range of the sound being measured and to approximate the response of the human ear. Measurements of LFN use dB(A). The authors found a dose-response relationship between the level of noise and the degree of annoyance experienced. At 30-35 dB(A) 44% of respondents reported being annoyed by the noise, the highest percentage recorded. At 40-45 dB(A) 32% found the noise annoying, 10% found it very annoying. In general people found the noise from wind turbines more annoying than equivalent sound pressures from traffic. The authors speculate that this may be the result of the swishing noise from the turbine blades as a number of respondents commented on this. There were other, psychological factors that influenced attitudes toward the turbine noise. Those who were benefiting financially from the turbines were more tolerant of their noise. Those who found them visually intrusive and ugly were less so. A rural location tended to increase the frequency of those who found the noise annoying and complex, hilly ground also increased the annoyance factor. Annoyance was associated with lower sleep quality and negative emotions. It should be noted that sleep deprivation can result in all of the other symptoms. (Sleep deprivation was a standard "enhanced interrogation" technique at Guantanamo Bay prison after all.)

These authors commented on the paucity of reliable studies and felt that such factors as geography and other area-related factors should be considered when locating wind farms [353, 354].

**Cardiovascular Effects:** Laboratory studies have shown changes in heart rate and blood pressure, especially in individuals sensitive to LFN.

**Performance and Cognition:** Noise has been shown to adversely affect these, especially learning in children but studies of LFN specifically are scarce and inconclusive.

**Sleep:** Both continuous and intermittent noise have been shown to disturb sleep. Waye [352] reviewed numerous papers and concluded that controlled clinical studies were scarce and that adequate data on sound frequencies and strengths were often lacking. Nevertheless, he concluded that, despite the need for





additional, well designed studies, such studies as existed supported the findings of field studies that LFN at comparatively low pressures disturbs sleep.

Other effects discussed by Berglund *et al.* [351] are more relevant to occupational exposures than to continuous, low volume LFN exposures.

The importance of individual differences in sensitivity to noise cannot be overemphasized. Stansfeld reviewed studies of noise sensitivity and its relationship to psychiatric disorders [355]. In two groups of women; one highly noise sensitive and the other with low noise sensitivity, the low sensitivity group habituated quickly to the physiological responses to noise but not the noise sensitive group. The latter group attended more to noise, discriminated more between noises, found noises more threatening and out of their control and adapted to noises more slowly. Their defence/startle responses were also greater than in the low sensitive group. There appeared to be an association between depression and high noise sensitivity which tended to abate when the recovery from depression but which remained elevated. Another group, Bell *et al.* [356] investigated patients with chemical sensitivity, noise sensitivity and both conditions. They assessed questionnaire responses of 897 young, adult college students who reported high *versus* low frequency of illness related to exposure to several environmental chemical odours and high *versus* low sensitivity to environmental noise. Subjects who reported increased rates of illness from chemical odours, with or without noise sensitivity, scored higher on a measure of limbic system symptomatology. (The limbic system consists of a number of primitive brain centres located beneath the cortex and related to emotions such as fear, anger, pleasure and pain as well as memory.) Subjects who were sensitive to both odours and noise had characteristics similar to those of patients with Multiple Chemical Sensitivity (MCS, see Chapter **5B, Multiple Chemical Sensitivity**).

It must be pointed out that these studies do not relate specifically to LFN but they illustrate the importance of individual variation in sensitivity and that there are neurophysiological consequences to exposure to noise.

To summarize what can be said with some degree of certainty about LFN:

- LFN can propagate over very long distances with little attenuation.
- LFN can penetrate walls and windows with little attenuation.
- Room resonance occurs and non LFN may be filtered out.
- LFN tends to mask higher frequency sounds.
- Resonance can be produced in the human body.
- A number of physiological changes have been identified but most are of uncertain clinical significance.
- Annoyance is a common complaint associated with LFN.
- It is well accepted that LFN can cause sleep disturbances, from which the other reported ailments could well flow.

The characteristics of LFN clearly indicate the importance of setbacks, which some medical authorities feel should be at least 2 km (11/4 mi). The current 550 metre setback may well be inadequate. It is important to note that these articles appeared years before the Green Energy Act was passed so they can hardly be viewed as having bias toward any particular point of view. Thus there is considerable validity to the request of Dr. McMurtry and others for a proper study of the noise levels to which people are exposed. Measurements of these levels should be conducted at various distances from the source, most especially