Commentary on Algonquin Power Co. Proposal for Amherst Island Wind Facility (AIWF) and the Potential Human Health Impact.

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Introduction

The first public meeting to describe the proposal for a 75 MW wind energy generating system on Amherst Island, dated December 2011, put forward a single document to address the potential adverse health impacts, a paper by Knopper and Ollson (2011) "Health effects and wind turbines: A review of the literature." Other references have been added to the company website but no further document has been prepared in advance of the second public meetings to be held on March 5th and 6th, 2013. Drs. Knopper and Ollson have been retained as consultants by Algonquin Power Co.

The purpose of this commentary is to evaluate the Knopper and Ollson (2011) paper on its own merits, including strengths and weaknesses, errors of commission and omission (Part 1) as well the existing state of knowledge as of January 2013 18 months after Knopper and Ollson's (2011) publication (Part B). A considerable amount of new information continues to evolve (Part B and Appendix C) which appears to have been passed over by Algonquin Power Co.

Part I

1. Publication of Knopper and Ollson (2011) strengths and weaknesses of authors

Both authors have academic doctorates from recognized mainstream universities in Canada. Knopper's thesis was entitled: Use of Non-destructive Biomarkers to Measure Effects of Pesticide Exposure in Meadow Voles (Microtus Pennsylvanicus) Living in Golf Course Ecosystems of the Ottawa/Gatineau Region, University of Ottawa, 2004. Dr. Knopper's thesis focused on molecular biological techniques to measure changes in the messenger RNA of voles following exposure to pesticides.

Dr. Ollson's thesis was entitled "Arsenic Risk Assessments: The Importance of Bioavailability" and was published in 2003 under the auspices of Royal Military College. The core of Dr. Ollson's work related to soil sampling techniques to determine concentrations of arsenic from natural and other sources as a basis for risk assessment to humans.

In addition to their theses both would have been required to do course work and would be expected to be well trained in research methodologies, critical appraisal and statistics at minimum. The responsible departments were Biology for Dr. Knopper and Environmental Sciences for Dr. Ollson's graduate work.

In short both have a credible basis of scholarship from which to review scientific literature.

Weaknesses

Neither author has any formal education nor training that qualify them to be licensed health care practitioners or clinician scientists. Interpreting a person or patient's history, conducting an examination of a human subject, ordering or interpreting diagnostic blood tests or imaging, developing a differential diagnosis, rendering a working or final diagnosis or recommending treatment are all activities that lie beyond their scope of expertise. As will be discussed these constraints appear to be set aside by the authors. In their remarks and conclusions they venture into the sphere of health care practitioners (e.g. diagnosis, pathogenesis and treatment recommendations) areas in which neither of them has expertise. Both authors are qualified in risk assessment of noxious agents pertaining to human health.

Background Assumptions

Strengths and Weaknesses

2a. Knopper and Ollson (2011) correctly portray government policy directions in favour of wind energy stating that "wind power has become an integrated part of provincial energy strategies across Canada; …" (p. 2/79), and go on to emphasize that in Ontario the "Ontario Power Authority has placed a great deal of emphasis "on procuring 'renewable and cleaner sources of electricity'". (p. 2/79) (Ontario Power Authority, 2008, p. 14). The quote and interpretation are accurate.

However this paper is produced by authors who have a legitimate claim to scholarship as noted above. One would expect that a role that they may have considered is critical appraisal of the operating assumption of governments. For example they might have referred the reader to objective sources in the scientific literature that substantiate the priority given to wind energy by governments in Canada and internationally. The claims of benefit, especially the reduction of greenhouse gases, have been put forward by the industry and their consultants and supported by governments but seldom confirmed by third party research. A few months after (December 2011) the Knopper and Ollson (2011) publication the Office of the Auditor General of Ontario (2011) raised this precise point "… no thorough and professional cost/benefit analysis had been conducted to identify potentially cleaner, more economically productive, and cost-effective alternatives to renewable energy, such as energy imports and increased conservation." (p. 97). As trained academic scholars the authors have a responsibility to question underlying assumptions. Furthermore in the Action Group Darmstadt Manifesto (1998), over 100 scientists from Germany signed a document questioning the rationale for the wind industry. Knopper and Ollson (2011) did not identify this source, as it was outside the scope of their review (2003 -2011). If

there is a paucity of third party evidence for benefit from wind energy the risk/benefit analysis changes. This is especially the case in view of the emerging literature confirming serious adverse health effects. (see Part II)

2b. Knopper and Ollson (2011) state "In terms of noise, high sound pressure levels (loudness) of audible noise and infrasound have been associated with learning, sleep and cognitive disruptions as well as stress and anxiety" (p. 2/79). The assertion is correct with appropriate supportive references.

2c. Knopper and Ollson (2011) then go on to state "This minimum setback distance was developed through noise modeling under worst-case conditions to give a conservative estimate of the required distance to attain a sound level of 40 dB(A) *(Ontario Ministry of the Environment: Development of Noise Setbacks for Wind Farms Requirements for Compliance with MOE Noise Limits 2009. [9]),* the noise level that corresponds to the WHO (Europe) night-noise guideline, a health-based limit value "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" *(World Health Organization Europe Night Noise Guidelines for Europe. 2009, ISBN 978 92 890 4173 7*) (p. 2/79). This claim is misleading (see Appendix A p3-4). As pointed out in the WHO document identified did not address noise from wind turbines which is a uniquely disturbing community based noise (Pedersen and Persson Waye 2004). Furthermore the regulations in Ontario permit noise levels up to 51 dBA. (Appendix A p.3) ander specified conditions. The omission of this higher upper limit on noise by Knopper and Ollson (2011) has significance in a logarithmic scale such as dBA. For example 50 dBA represents double the sound energy of 40 dBA2c. The authors also failed to reference the Ontario government commissioned report of Howe, Gastmeier, Chapnik Limited (2010), a late draft version of

December 2010 stated that "… a nontrivial percentage of persons being highly annoyed" (p. 2), is an anticipated outcome under Ontario's regulations. Dr. Ollson acknowledged he was aware of the report in testimony at the Environmental Review Tribunal, Ontario, Chatham Kent hearing of March 2011. (The draft version was not altered in the final report of December 2011.)

2d. Knopper and Ollson (2011) were unable to reference the Møller and Pedersen (2011) publication which concluded: "It is thus beyond any doubt that the low-frequency part of the spectrum plays an important role in the noise at the neighbors" (p. 3742). Knopper and Ollson submitted their paper on May 2, 2011 prior to the publication of the Møller and Pedersen paper. On the other hand the Møller and Pedersen (2011) publication is of such importance that every effort should have been made by Algonquin Power Co. in their current submission especially as low frequency noise was the focus of the Howe, Gastmeier, Chapnik (2010) report and of the testimony of the Environmental Review Tribunal, Ontario (2011) Chatham Kent. Given that Knopper and Ollson (2011) opine the most claims about adverse health effects are "anecdotal in nature" (p. 6/83). Algonquin Power Co. may have considered acknowledging the emergence of important new evidence in their submission since 17 months have passed since the Knopper and Ollson on-line publication. (The new evidence will be discussed in more detail in Part II of this commentary.)

2e. Finally Knopper and Ollson (2011) end the section on "Background" by identifying their intention to use a "weight-of-evidence" (p. 2/79) (WoE) approach. Knopper and Ollson (2011) gave no reference for this approach. However strict criteria for the deployment of the WoE approach do exist as outlined in Balls, Amcoff, Bremmer, Casati, Coecke, Clothier, Combes, Corvi, Curren, Eskes, Fentem, Gribaldo, Halder, Hartung, Hoffmann, Schechtman, Scott,

Spielmann, Stokes, Tice, Wagner, & Zuang (2006). For example the following excerpts were found:

> Conclusion #6.
>
> WoE validation assessments must be conducted with true independence and transparency, and must be designed and managed according to the highest standards. It is essential that those involved have sufficient expertise and experience, that the test methods or testing strategies are ready for evaluation, and that there is agreement on the nature, quantity and quality of the evidence to be considered and its collection, how the resultant data should be weighed, and how the conclusions of the evaluation should be determined and reported. (Balls et al., 2006, p. 12)
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> Conclusion #9.
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> The types of evidence to be collected, how it is to be obtained and selected, the extent to which it comprises all the available material, how its quality is to be checked, and whether it is relevant and reliable, are crucial issues. It must also be clearly established that the evidence is truly representative of the performance of the procedure or strategy, and that its collection is without bias. (Balls et al., 2006, p. 12)

Unfortunately these and the other conclusions and recommendations appearing in the Balls et al. (2006) paper seem not to have been followed. For example the authors have long been employed and/or retained by the wind industry and other wind industry proponents to provide expert advice which is acknowledged but nonetheless they lay claim to scientific objectivity. Yet the strict criteria outlined in Conclusion #9 have not been respected especially given the omission of references and the (mis) interpretation of others (see Appendix B).

Knopper and Ollson (2011) also claim that they "considered all available evidence." (p. 3/80) and yet the foregoing point about omissions and interpretations of references remains as a legitimate criticism.

Methods

3a. It is a strength that Knopper and Ollson (2011) used recognized search tools to retrieve the literature but thereafter a weaning process was done:

> Although hundreds of articles were found during the search, very few were related to the association between potential health effects and wind turbines. For example, numerous articles have been published about infrasound, but very few have been published about infrasound and wind turbines. Indeed, only fifteen articles, published between 2003 and 2011, were found relevant. (Knopper and Ollson, 2011, p. 3/80)

The authors cite their references 12-26 as representing the selected articles but the list is not complete using their criteria. For example van den Berg's (2005) paper is omitted. Was there a further weaning by the authors related to redundancy or some other criteria not mentioned? In short clarity surrounding selection criteria are incomplete and/or inadvertent omissions have arisen. Similarly the Howe, Gastmeier, Chapnik Limited (2010) report (as mentioned previously), the American Wind Energy and Canadian Wind Energy report (2009) and the published proceedings of the Fourth International meeting on Wind Turbine Noise (2011) were also omitted. All of these works have a direct bearing on Wind Turbine noise and human health impacts of high annoyance, sleep disturbance and stress and certainly merit inclusion as significant publications which the authors were or should have been aware of.

3b. In the final paragraph under "Methods" Knopper and Ollson (2011) opine: "What is clear is that some people living near wind turbines experience annoyance due to wind turbines, and visual impact tends to be a stronger predictor of noise annoyance than wind turbine noise itself" (p. 3/80). This statement is a conclusion not a description of methods and as such appears to anticipate the outcome of their literature review. Such reasoning fails the test of scholarship the authors claim for their paper. Apart from mis-placement, the statement is inherently inaccurate. According to Pedersen and Persson Waye (2004) wind turbine noise and its genesis of annoyance and sleep disturbance occurs at lower dBA levels than other community noise with the exception of railway shunting yards. dBA is a measure of loudness only and this does not and should not be expected to account for the entirety of human reaction to wind turbine noise owing to a number of qualities of the noise including intermittency, cresting, tonality and infrasound and low frequency noise content. The authors acknowledge some (not all since they exclude ILFN) of these characteristics but nonetheless simply seek correlation between human response and pure measures of loudness. Another recurring error is the claim of the importance of visual impact a priori and the assumption that cross-sectional studies can adequately establish a sequence or direction of causation. Only longitudinal or at minimum before and after studies can provide proof of the direction of causation. Without this study design the question of whether people come to dislike the sight of wind turbines **after** they or their neighbours became ill or did their dislike of the sight of wind turbines exist **before** the advent of turbines in their neighbourhood? According to Krogh, Gillis, Kouwen, and Aramini (2011) many individuals who welcomed the notion wind turbines prior to having to live within 2.0 kilometres of them changed their attitude for a number of reasons**.** (In subsequent publications Shepherd, McBride, Welch, Dirks, and Hill (2011) and Nissenbaum, Aramini, and Hanning (2012) also found early

enthusiasm for wind turbines changed following exposure to operating wind farms. (see Part II iii) Family members, including children became ill, neighbourhoods divided and often their plight was ignored by responsible authorities (Krogh, Gillis, Kouwen, & Aramini, 2011). These impacts would all contribute to wind turbines taking on a different and threatening meaning which could account for people not liking the disruption of their view-shed as a consequence of and not in anticipation of wind turbine facilities.

Five Key Points – 1

Generally the summary of the Pedersen and Persson Waye (2004, 2007, and 2008) papers under the first point are accurate and well presented. There are however some omissions which lend a different perspective to Pedersen and Persson Waye (2004) research findings. For example Pedersen and Persson Waye (2004) stated: "the proportions of respondents annoyed by wind turbine noise are higher than for other community noise sources at the same A-weighted SPL and ***that the proportion annoyed increases more rapidly.***" (p. 3467). (emphasis added). The emphasized wording further clarifies how noise from wind turbines is different from other community based noise.

Another statement Pedersen and Persson Waye (2004) made provides some insight into the difficulty of predicting visual influence owing to the existence of conflicting evidence. "A general prediction of the visual influence on noise annoyance, however, can not yet be made with any certainty as both attenuating Kastka and Hangartner, 1986 and amplifying effects e.g., Watts *et al.*, 1999 have been detected." (p. 3468)

Perhaps the most important comments by Pedersen and Persson Waye (2008) was:

> "There is thus support both from experimental and field studies ***that intrusive sound characteristics not fully described by the equivalent A weighted sound pressure level contribute to annoyance with wind turbine noise."*** (p.4) (emphasis added)

and

> In line with the attention restoration theory outlined by Kaplan (1995), it can however be anticipated that people with a need for recovery, for example when coming home from a stressful day at work, would react strongly and with annoyance if their home environment was made unsuitable for restoration by the intrusion of an annoying sound or a visually intrusive object. This should be investigated in further studies. (Pedersen & Persson Waye, 2008, p.4)

The need for further studies is a key point and one that Pedersen and Persson Waye (2004, 2008) recurrently make. The issue of absence of evidence not being proof of an absence of adverse effects will be expanded in subsequent discussion.

These comments suggest that seeking simple linear relations between sleep disruption and sound pressure level A-weighted, i.e. dBA, is not likely to succeed when the explanation is more complex. Among the complexities is that sleep disturbance cannot be measured solely by self-reports of wakening since people are not aware of arousals which can impact restoration. Arousals (which fall short of wakening) occurring during sleep can only be measured in human subjects by electronic monitoring in a sleep laboratory. The need for these studies has been clearly identified by Hanning, anaesthesiologist and sleep specialist, at the Environmental Review Tribunal, Ontario (2011). Dr. Ollson was present for these hearings and therefore is aware of this information which has not been cited here. As will be noted in Part II Hanning

(2012) and Nissenbaum, Aramini, and Hanning (2012) produced peer reviewed publications on the same subject but this was following publication of the Knopper and Ollson (2011) paper.

Five Key Points – 2

Knopper and Ollson (2011) begin with a reasoned literature review of Pedersen (2011), Pedersen and Persson Waye (2004, 2007, 2008) Pedersen, F. van den Berg, Bakker, and Bouma (2009, 2010), Pedersen, Hallberg, and Persson Waye (2007), and Pedersen and Larsman (2008) work over the past 10 years the line of reasoning departs from the factual and into the speculative. The key paragraph in this respect is:

> Pedersen notes that this finding is not necessarily evidence of a causal relationship between wind turbine noise and stress but ***may be explained*** by cognitive stress theory whereby "an individual appraises an environmental stressor, such as noise, as beneficial or not, and behaves accordingly" (emphasis added). In other words, it appears ***that it is the change in the environment that is associated with the self-reported health effects, not the presence of wind turbines themselves.*** (Knopper & Ollson, 2011, p. 4/81) (emphasis added)

The text quoted from Pedersen (2011) is expressed in speculative fashion "may be" and then Knopper and Ollson (2011) proceed to a higher level of certainty in the last quoted sentence. This claim by Knopper and Ollson (2011) appears at odds with previous statement Pedersen, van den Berg, Bakker, and Bouma (2009) made:

> Wind turbines are a new source of community noise to which relatively few people have yet been exposed. The number of exposed people is growing, as in many countries the number of wind turbines is rapidly increasing. The need for guidelines for maximum exposure to wind turbine noise is urgent: While not unnecessarily curbing the development of new wind farms,

> it is also important to avoid possible adverse health effects. (Pedersen, van den Berg, Bakker, & Bouma, 2009, p. 634)

Knopper and Ollson took the notion a step further and appear to be forming a diagnostic conclusion ***"… it is the change in the environment … not the presence of the turbines …"*** (p. 8/85) (emphasis added) that are responsible for the reported health effects. As noted at the outset this is very troubling on several levels. First, neither of the authors has training as a health care professional nor as a clinician scientist. Secondly, they have formulated a diagnostic opinion in the absence of any direct evaluation of those being adversely effected. Thirdly, their conclusion contradicts the subsequent (July 2011) finding of the Chatham Kent ERT which stated specifically:

> 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, Ontario, 2011, p. 207)

The submission of Algonquin Power Co fails to address this ERT decision.

Five Key Points – 3

Much emphasis on the importance of visual impact is repeated but with the same short-comings outlined earlier (direction of causation, difficulty in correlating loudness or dBA with complex human response). However a new point is made about the lower rate of complaints among those receiving economic benefits from wind turbine installation. If economic benefit did not reduce the frequency of complaints it would be surprising. All manner of occupations are accepted if a risk premium is paid from National Football League players to workers employed

on high level steel girders, from miners to remote placement health professionals. If a risk premium is paid, the risk is accepted. It is concerning however that hosts of wind turbines are not being screened longitudinally for adverse health effects such as hypertensive episodes or sleep disturbance. These conditions are often insidious and disturbed sleep, for example, is a major risk factor for coronary heart disease **(**Chandola, Ferrie, Perski, Akbaraly, and Marmot, 2010). In the absence of such screening it may be claimed that complaints are fewer but it cannot be claimed that there are no adverse health effects.

In addition Knopper and Ollson (2011) refer to exposed individuals being "influenced by variables not yet identified, some of which are nonphysical." (p. 5/82) It is not clear what is meant by "nonphysical". Throughout the article the authors appear to separate psychological from physical and if so it is dated thinking. In the WHO (2001) report "New Understanding, New Hope" the Director General made the following statement: "Understanding how genetic, biological, social and environmental factors come together to cause mental and brain illness. Understanding how inseparable mental and physical health really are, and how their influence on each other is complex and profound." (p. IX)

In other words the separation of mind and body or of physiology and psychology represents a misunderstanding that Knopper and Ollson (2011) fall prey to throughout the paper. This is highly relevant to the reported adverse health effects which include both sleep disorders and hypertensive episodes as well as stress and psychological distress. The effects of stress, psychological distress, sleep disruption and difficulty in initiating sleep are pathogenic in nature and in the long term may lead to irreversible damage through a process of allostatic overload as described by McEwen (1998). Physiological and psychological adverse effects are not separate effects but rather pathologically synergistic and part of the same pathophysiology.

Five Key Points – 4

This section is ably presented.

Key Points – 5

In this section Knopper and Ollson (2011) address the question of ILFN by quoting an industry funded study commissioned by NextEra and undertaken by O'Neal, Hellweg, and Lampeter (2011). Apart from the obvious concerns about conflict of interest in the genesis of the study one is left to wonder why the Howe, Gastmeier, Chapnik Limited (2010) report which was commissioned by the Government of Ontario was overlooked by the authors. (See Appendix A p6 reference 34). It is also noteworthy that no human subjects are evaluated in the O'Neal et al. (2011) study but rather reference standards and criteria generated by engineering practices versus anthropocentric or human health assessment.

Popular Literature

Knopper and Ollson (2011) are critical of the work of Nissenbaum (2010) because the research had not yet appeared in a peer reviewed journal. The criticisms are no longer valid since the publication of Nissenbaum, Aramini, and Hanning (2012) in a peer review journal. Knopper and Ollson (2011) go on to state that the work is flawed because Nissenbaum (2010) "appear to lack objectivity as authors are also known advocates who oppose wind turbine developments." (p. 7/84) No reference is given nor evidence advanced for this pronouncement. Nissenbaum, Aramini, and Hanning have appeared for plaintiffs regarding wind turbine developments just as Ollson has appeared for the wind industry. Both Nissenbaum and Hanning are fully qualified medical specialists while Aramini has a doctoral degree in statistics. The tribunal decision from the Environmental Review Tribunal, Ontario (2011) Chatham Kent portrayed a different and

more respectful view: “Not surprisingly, once the definitive statements on the legal test were peeled back, a healthy scientific debate was uncovered”. (p. 195) The comment unfortunately appears to reflect more on Knopper and Ollson than Nissenbaum, Aramini and Hanning. Their claims of objectivity appear compromised especially as they are closely linked to the wind industry and have gained employment in the past from the wind industry as acknowledged in the section “Competing Interests”. In contrast Nissenbaum et al. (2012) pursue their employment independent of any financial influence of special interests, government or industry groups.

Finally Knopper and Ollson (2011) state: “Though sound pressure level in most of the peer reviewed studies was scaled to dB(A) (but refer to O’Neal et al. (2011) for actual measurements of low frequency noise and infrasound), infrasound is a component of the sound measurements and was inherently accounted for in the studies.”(p. 7/84) This is a claim that is not in accordance with the work of Leventhall, Pelmear, and Benton (2003) nor in agreement with the WHO Guidelines for Community Noise (1999) edited by Berglund, Lindvall, and Schwela position which is explicitly quoted by Leventhall et al (2003) as follows:

- "For noise with a large proportion of low frequency sounds a still lower guideline (than 30 dBA) is recommended"
- "When prominent low frequency components are present, noise measures based on A-weighting are inappropriate"
- "Since A-weighting underestimates the sound pressure level of noise with low frequency components, a better assessment of health effects would be to use C-weighting
- "It should be noted that a large proportion of low frequency components in a noise may increase considerably the adverse effects on health"

- "The evidence on low frequency noise is sufficiently strong to warrant immediate concern"

The matter of monitoring ILFN is a crucial one. When Denmark was contemplating more stringent guidelines regarding ILFN in 2011 the response from the industry was allegedly negative. According to Aalborg Universitet (2011) in an article citing "New Danish regulations for wind turbine noise" found that:

> In October 2011, a report from Aalborg University revealed serious errors in the Environmental Impact Assessment for a prestigious Danish test centre for large wind turbines[6]. The law establishing the centre had to be revised, and the handling of noise from wind turbines in the EPA attracted political attention in Parliament. The Minister of the Environment promised to introduce limits for low-frequency wind turbine noise.
>
> Political pressure was also put on the EPA to consult our group at Aalborg University when preparing the rules. This was not accomplished in a meaningful manner, however, and, despite many comments and suggestions made to the EPA, it had no impact at all on the result. (Aalborg Universitet, para 11, 12).

Annoyance

In this section of the Knopper and Ollson (2011) paper the following claim is made: "… the hypothesis that infrasound is a causative agent in health effects does not appear to be supported." (p. 8/85). This claim in contrary to the paper "Low-frequency noise from large wind turbines" by Henrik Møller and Christian Sejer Pedersen published in June 2011. (The Møller and Pedersen paper appeared the in June 2011 the month following the submission of the Knopper and Ollson (2011) paper.) The submission of Algonquin Power Co. does not consider

this new information which is unfortunate considering the conclusion reached by Møller and Pedersen (2011) was quite different from that of Knopper and Ollson (2011) , specifically: " It is thus beyond any doubt that the low-frequency part of the spectrum plays an important role in the noise at the neighbors." [of large wind turbines] (p. 3742)

Conclusions

Knopper and Ollson (2011) state categorically in the conclusions of their paper: "To date, no peer reviewed scientific journal articles demonstrate a causal link between people living in proximity to modern wind turbines, the noise (audible, low frequency noise, or infrasound) they emit and resulting physiological health effects." (p. 8/85) Assuming for the moment that this claim is true (see previous commentary where even proponents acknowledge annoyance occurs and that it is an adverse health effect) the conclusion is flawed. A more defensible conclusion would be that in the absence of definitive evidence for or against significant adverse health effects being experienced by people in the environs of wind turbines, more research is needed. While Knopper and Ollson (2011) do accurately reflect the position of the industry, governments and proponents who favour wind energy there is insufficient evidence to make the claim quoted above. Knopper and Ollson might also have reviewed the evidence of Dr. Warwick Anderson (Commonwealth of Australia, Official Committee Hansard, Senate. (2011) : "… we believe that a precautionary approach should be taken to this, because, as you would understand, the absence of evidence does not mean that there might not be evidence in the future …" (Commonwealth of Australia, Official Committee Hansard, Senate, 2011, "Social and economic impact of rural wind farms," p. 86) . This claim of absence of evidence by Knopper and Ollson (2011) appears to be put forward as proof that there are no significant adverse health effects. To the contrary the dearth of evidence should stimulate more research not denial. In addition more consideration

should be given to application of the precautionary principle as suggested in the Australian Senate hearings above.

Finally in the conclusions Knopper and Ollson (2011) claim: "… and the fact that it appears that a limited number of people have self-reported health effects that may be attributed to the indirect effects of visual and attitudinal cue." (p. 9/86) In view of the evidence to date and subsequent to the Knopper and Ollson (2011) paper, this claim cannot be defended. It seems Knopper and Ollson (2011) are victim blaming and expressing willingness to trade off damaged people for a presumption of a greater good. They express the willingness in the absence of any critical appraisal or quantification of how many people are being adversely affected, how serious the impact is over time and whether or not claims made by critics about the possible ineffectiveness of wind energy are valid as claimed by Action Group Darmstadt Manifesto (1998) and Office of the Auditor General of Ontario's Report of December 2011 among others.

Mr. Peter Hadden (a United Kingdom medical specialist presenting to a parliamentary committee in 2008) identified his doubts about the benefits of wind energy and the possible violation of human rights. Subsequently in Falmouth, MA, USA, C. Devlin (posted 2013, January 16) pointed out in November 2012 some governments and the wind industry are conducting "Experimentation on people without their consent". These concerns would be effectively addressed if the requisite research were to be done that would enable the creation of evidence-based guidelines for wind turbine setbacks. To date that research has not been done.

Conclusions of Commentary

1. While Knopper and Ollson (2011) are well qualified academically, they have committed errors of omission and commission identified throughout the text of this commentary as well as inaccuracies in the use of references (see Appendix B).

2. Bias has been suggested by Knopper and Ollson (2011) description of experts testifying on behalf of complainants of adverse health effects from the wind industry installations as "known advocates who oppose wind energy development" (p. 7/84) in spite of the fact (revealed in testimony at the Environmental Review Tribunal, Ontario (2011) Chatham Kent which Dr. Ollson attended) that physicians such as Hanning and Nissenbaum have a professional responsibility to be health advocates.

3. Knopper and Ollson (2011) have inappropriately attributed adverse health effects reported by complainants as a matter of "indirect effects of visual and attitudinal cue" (p. 9/86) in the absence of direct clinical evaluation or testing of complainants by health care professionals and clinical scientists.

4**.** The stance of the wind energy proponents is accurately represented by Knopper and Ollson (2011) that in the author's opinion: "To date, no peer reviewed scientific journal articles demonstrate a causal link between people living in proximity to modern wind turbines, the noise (audible, low frequency noise, or infrasound) they emit and resulting physiological health effects." (p. 8/85). However the absence of evidence is no reason to conclude no harm exists since there is a shortfall in the relevant research.

5. The possible violation of human rights noted by Hadden (2008) in a presentation to the UK parliamentary committee (and post publication by Devlin, 2012) has not been addressed by Knopper and Ollson (2011).

6. As scholars with academic credentials Knopper and Ollson have an ethical responsibility to update and address the short-comings of their paper and evolving evidence (See Part B).

7. The Knopper and Ollson (2011) paper falls short as an objective literature review and does not advance the understanding of global reports of adverse health effects in the environs of wind turbines.

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Part II

i. Errors of Omission in references by Knopper and Ollson (2011):

1. Erickson v. Director, Ministry of the Environment, Environmental Case Nos. 10-121 and 10-122. Transcript of Dr. G. Rachamin, Mar, 4, 2011 in which Dr. Rachamin "explicitly acknowledged the report looked *only* at direct links to human health." Dr. Ollson who attended the hearing was aware of this major omission. (Appendix A, p2)

2. Both the Noise Guidelines for Wind Farms (Interpretation for Applying MOE NPC and the approvals (Renewable Energy Approval Number 7988-8AVKM5 Issue Date: November 10 2010) of Ontario permit noise levels of up to 51 dBA. Knopper and Ollson fail to acknowledge this fact in their paper. (Appendix A, p3)

3. Knopper and Ollson failed to state that the 40 dBA noise limit identified in the WHO Night Noise Guidelines for Europe was not based on research related to wind turbines but rather road, rail and airplane noise. (Appendix A, p4)

4. Knopper and Ollson failed to reference a report (Colby, W. D., Dobie, R., Leventhall, G., Lipscomb, D. M., McCunney, R. J., Seilo, M. T., & S0ndergaard, B. (2009, December). Wind turbine sound and health effects: An expert panel review. Washington, DC: American Wind Energy Association and Canadian Wind Energy Association.) The report attributes reported wind turbine symptoms (sleep disturbance, headache, tinnitus, ear pressure, dizziness, vertigo, nausea, visual blurring, tachycardia, irritability, problems with concentration and memory, and panic attack episodes associated with sensations of internal pulsation or quivering when awake or asleep) to be the "well known stress effects of exposure to noise." (Appendix A, p5)

5. Knopper and Ollson (2011) failed to reference the published proceedings from the Fourth International Meeting on Wind Turbine Noise from April12-14, 2011. The Wind Turbine Noise (2011) post-conference report states:

> The main effect of daytime wind turbine noise is annoyance. The night time effect is sleep disturbance. These may lead to stress related illness in some people. Work is required in understanding why low levels of wind turbine noise may produce affects which are greater than might be expected from their levels.

6. Knopper and Ollson did not reference the 2007 report of United Kingdom physician Amanda Harry M.B. ChB, P.G. Dip. ENT http://www.wind-watch.org/documents/windturbines-noise-and-health/. Dr. Harry reports cases of 39 complainants using a standardized questionnaire to document symptoms and concluded that "people living near wind turbines are genuinely suffering".

7. Knopper and Ollson did not reference the study: Phipps, R., Amati, M., McCoard, S., & Fisher, R. Visual And Noise Effects Reported By Residents Living Close To Manawatu Wind Farms: Preliminary Survey Results, (2007) Retrieved from http://www.wind-watch.org/documents/visual-and-noise-effects-reportedby-residents-living-close-to-manawatu-wind-farms-preliminarysurvey-results/

8. Knopper and Ollson did not reference: Committee on Environmental Impacts of Wind Energy Projects, National Research Council (2007). *Environmental Impacts of Wind-Energy Projects*, p. 158-9. The committee stated in regards to wind turbines: "More needs to be understood regarding the effects of low-frequency noise on humans."

9. Knopper and Ollson did not reference Health Canada, Community Noise Annoyance, Its Your Health, (2005, September) which stated “annoyance is an adverse health effect”.

10. Knopper and Ollson might have considered referencing Niemann H, Bonnefoy X, Braubach M, Hecht K, Maschke C, Rodrigues C, Robbel N. Noise-induced annoyance and morbidity results from the pan-European LARES study. Noise Health 2006;8:63-79. The conclusion of the paper was: “The results of the LARES study in relation to severe annoyance by: neighbourhood noise demonstrate that neighbourhood noise must be classified as a ***serious health endangerment*** for adults.” (emphasis added). The paper was not about the more disturbing wind turbine noise (Pedersen, E., Bakker, R., Bouma, J., & van den Berg, F., “Response To Noise From Modern Wind Farms In The Netherlands”, Journal of the Acoustical Society of America, 126, 634-643, (2009) which stated: “The study confirms that wind turbine sound is easily perceived and, compared with sound from other community sources [except traffic noise (road noise, railway noise, aircraft noise, noise of parking cars)], relatively annoying.” The abstract summarizes the findings as follows:

> Adults who indicated chronically severe annoyance by neighbourhood noise were found to have an increased health risk for the cardiovascular system and the movement apparatus, as well as an increased risk of depression and migraine. Furthermore adults with chronically strong annoyance by traffic noise additionally showed an increased risk for respiratory health problems. With regards to older people both neighbourhood and traffic noise indicated in general a lower risk of noise annoyance induced illness than in adults. It can be assumed that the effect of noise-induced annoyance in older people is concealed by physical consequences of age (with a strong increase of illnesses). With children the effects of noise-induced annoyance from traffic, as well as neighbourhood noise, are evident in the respiratory system.

> The increased risk of illness in the respiratory system in children does not seem to be caused primarily by air pollutants, but rather, as the results for neighbourhood noise demonstrate, by emotional stress. (abstract p.1)

Why would Knopper and Ollson assume there is no relevance to such a study focused on health effects of community noise?

11. Knopper and Ollson might have referenced the Acoustic Ecology Institute (AEI) which is an exceptionally well run blog site which is steadfastly neutral and has been used as a resource by the wind industry. The AEI has commentaries on a number of subject areas apart from wind turbines but has maintained a monthly update on news and publications since December 2007 in addition to annual summaries of evolving news and scientific literature. (http://aeinews.org/archives/category/wind-turbines)

Part B

ii. Errors of Commission in references by Knopper and Ollson (2011):

1. Knopper and Ollson state that "… health effects from annoyance have been shown to be mitigated though behavioural and cognitive behavioural interventions …" (p. 8 para 2). This claim cannot be confirmed by review of the peer review literature nor their references. The 2 cited articles do not provide evidence that the Knopper and Ollson hypothesis is supportable. Reference 30 in their article (Coping Strategies for Low Frequency Noise Geoff Leventhall*, Stephen Benton and Donald Robertson, J Low Freq Noise VA 2008 27: 35-52) is a study with many weaknesses including selection criteria of the subjects in the study. There were initially 9 then 8 subjects for which the selection criteria are ill-defined. They are vaguely described as long-term complainants from low frequency noise who have not benefitted from standard

interventions. There were no control subjects and furthermore the people evaluated were not exposed to wind turbine noise.

The second reference (Int Rev Psychiatry. 2006 Feb;18(1):67-73. Behavioural mechanisms and cognitive-behavioural interventions of somatoform disorders. Tazaki M, Landlaw K.) There is no peer review scientific evidence that the complainants are suffering from somatoform disorders i.e. a disorder in which the history, physical examination and diagnostic laboratory and imaging tests are normal. On the contrary the existing and evolving evidence suggests a causal relationship through indirect pathogenic pathways between wind turbine noise and the reported adverse health effects. Knopper and Ollson have no training that would enable them to generate nor have they produced sufficient evidence to substantiate their hypothesis of somatoform disorder nor the hypothesis of complaints explained by "… the indirect effects of visual and attitudinal cue." (p.9 para2 Knopper and Ollson)

2. In quoting "Health aspects associated with wind turbine noise—Results from three field studies Eja Pedersen Noise Control Eng. J. 59 (1), Jan-Feb 2011" Knopper and Ollson appear to have been misleading as they stated: "What is more, health effects from annoyance have been shown to be mitigated though behavioural and cognitive behavioural interventions [30,41], lending support to Pedersen's [25] ***conclusion*** that health effects can be explained by cognitive stress theory." (emphasis added). The following quote appeared in the "Discussion" section of Pedersen's paper. The wording that Pedersen used was: "This should, however, not be taken as evidence of a causal relationship between wind turbine noise and stress, mediated by annoyance. The finding ***could be explained*** in the light of Lazarus and Folkman's cognitive stress theory, …" (emphasis added) p.52

Pedersen also made an important further statement: “This study has several limitations. All health symptoms were self-reported by the respondents. Health examinations carried out by professionals would have been a better way to assess the prevalence of possible health effects and is desired in future studies.” p.52.

This is a crucial point as Pedersen has pointed to one of the key weaknesses in her research and that of the literature broadly. There has been “no health examinations carried out by professionals”, no diagnostic testing nor longitudinal observations undertaken by clinician scientists of people within the environs of wind turbines. These evaluations should be carried out not only on complainants but a random sample of others including hosts. Insidious chronic diseases such as sleep disorders and hypertension could cause undetected permanent and serious harm with long term exposure. This short coming is being addressed by Health Canada in their new study design announced on February 10 2013. While the study will be cross-sectional, not longitudinal, it is a promising start as human subjects will be evaluated as stated below:

> Health Canada is collaborating with Statistics Canada on an epidemiological study to evaluate measurable health endpoints in people living in 8-12 communities at distances up to 10km from wind turbine installations. Measured endpoints include an automated blood pressure/heart rate assessment, hair cortisol concentrations and sleep actimetry. The seven days of sleep measurement data will be analyzed in relation to synchronized wind turbine operational data, providing the strength of a repeated measures design that incorporates objectively determined health outcome measures.
>
> *Health Canada Releases Revised Research Design for the Wind Turbine Noise and Health Study February 10, 2013 12:00 PM http://www.hc-sc.gc.ca/ewh-emt/consult/_2013/wind_turbine-eoliennes/research_recherche-eng.php*

3. Appendix B is a detailed audit performed by Mr. Brett Horner which addresses the use of some references by Knopper and Ollson. In total 6 references are audited as the authors alleged that to be quoting "governmental health agencies" (p.7 para. 6). As Horner concluded the deployment of these references by Knopper and Ollson cannot be substantiated.

4. Other errors of commission are identified in Part A section 2b regarding Night Guidelines for Noise in Europe and 2c regarding the failure to reference the Howe, Chapnick, Gastmeier Report.

iii. Updated literature not considered by Algonquin Power Company proposal (See also Appendix C)

Study (a)

Low-frequency noise from large wind turbines. Henrik Møller and Christian Sejer Pedersen Section of Acoustics, Aalborg University, Fredrik Bajers Vej 7-B5, DK-9220 Aalborg Ø, Denmark:

> 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 the neighbors. The noise emission from 48 wind turbines with nominal electric power up to 3.6 MW is analyzed and discussed. The relative amount of low-frequency noise is higher for large turbines (2.3-3.6 MW) than for small turbines (< 2 MW), and the difference is statistically significant. The difference can also be expressed as a downward shift of the spectrum of approximately one-third of an octave. A further shift of similar size is suggested for future turbines in the 10-MW range. Due to the air absorption, the higher low-frequency content becomes even more pronounced, when sound pressure levels in relevant neighbor distances are considered. Even

when A-weighted levels are considered, a substantial part of the noise is at low frequencies, and for several of the investigated large turbines, the one-third-octave band with the highest level is at or below 250 Hz. It is thus beyond any doubt that the low-frequency part of the spectrum plays an important role in the noise at the neighbors.

2011 Acoustical Society of America. Pages: 3727-3744

Comment:

This study was published in June 2011 too late for Knopper and Ollson to be able to comment in their electronic publication of July 2011. The importance of the paper is that it addresses the long-standing dispute between wind energy proponents and health professional experts. This author (RYM) has presented to Prince Edward Municipal Council November 2008 (see Appendix D) and at the Government of Ontario Standing Committee on General Government in April 2009. (see Appendix E) making the point that Infra and Low Frequency Noise (ILFN) should be monitored. To date it appears that the Ministry of Environment (MOE) has no capacity to measure ILFN despite the findings of the Howe, Gastmeier, Chapnik report for MOE that a "non-trivial percentage" of exposed people will be "highly annoyed". (see Part I, reference Howe B (2012).

Study (b)

Shepherd D, McBride D, Welch D, Dirks KN, Hill EM. Evaluating the impact of wind turbine noise on health-related quality of life. Noise Health 2011;13:333-9 Abstract:

We report a cross-sectional study comparing the health-related quality of life (HRQOL) of individuals residing in the proximity of a wind farm to those residing in a demographically matched area sufficiently displaced from wind turbines. The study employed a nonequivalent comparison group post-test-only design. Self-administered questionnaires, which included the brief version of the World Health Organization quality of life scale, were delivered to residents in two adjacent areas in semirural New Zealand. Participants were also asked to identify annoying noises, indicate their degree of noise sensitivity, and rate amenity. Statistically significant differences were noted in some HRQOL 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. Our data suggest that wind farm noise can negatively impact facets of HRQOL.

Comment:

This study demonstrates a statistically significant difference between two demographically matched groups based on distance of their residences from wind turbine installations. This study confirms the work of others but is more robust in design as there is a control group and validated questionnaires are deployed. However in common with previous studies this publication is cross-sectional and there are no anthropocentric diagnostic health studies.

Study (c) (Editorial)

Hanning C, Evans A. Wind Turbine Noise Seems to affect health adversely and an independent review of the evidence is needed BMJ 2012;344:e1527 doi: 10.1136/bmj.e1527 (Editorial 8 March 2012)

> The evidence for adequate sleep as a prerequisite for human health, particularly child health, is overwhelming. Governments have recently paid much attention to the effects of environmental noise on sleep duration and quality, and to how to reduce such noise.[1] However, governments have also imposed noise from industrial wind turbines on large swathes of peaceful countryside.
>
> The impact of road, rail, and aircraft noise on sleep and daytime functioning (sleepiness and cognitive function) is well established.1 Shortly after wind turbines began to be erected close to housing, complaints emerged of adverse effects on health. Sleep disturbance was the main complaint.[2] Such reports have been dismissed as being subjective and anecdotal, but experts contend that the quantity, consistency, and ubiquity of the complaints constitute epidemiological evidence of a strong link between wind turbine noise, ill health, and disruption of sleep.[3]
>
> The noise emitted by a typical onshore 2.5 MW wind turbine has two main components. A dynamo mounted on an 80 m tower is driven through a gear train by blades as long as 45 m, and this generates both gear train noise and aerodynamic noise as the blades pass through the air, causing vortices to be shed from the edges. Wind constantly changes its velocity and direction, which means that the inflowing airstream is rarely stable. In addition, wind velocity increases with height (wind shear), especially at night, and there may be inflow

turbulence from nearby structures—in particular, other turbines. This results in an impulsive noise, which is variously described as “swishing” and “thumping,” and which is much more annoying than other sources of environmental noise and is poorly masked by ambient noise.[4,5] Permitted external noise levels and setback distances vary between countries. UK guidance, ETSU-R-97, published in 1997 and not reviewed since, permits a night time noise level of 42 dBA, or 5 dBA above ambient noise level, whichever is the greater. This means that turbines must be set back by a minimum distance of 350-500 m, depending on the terrain and the turbines, from human habitation. The aerodynamic noise generated by wind turbines has a large low frequency and infrasound component that is attenuated less with distance than higher frequency noise. Current noise measurement techniques and metrics tend to obscure the contribution of impulsive low frequency noise and infrasound.[6] A laboratory study has shown that low frequency noise is considerably more annoying than higher frequency noise and is harmful to health—it can cause nausea, headaches, disturbed sleep, and cognitive and psychological impairment.[7] A cochlear mechanism has been proposed that outlines how infrasound, previously disregarded because it is below the auditory threshold, could affect humans and contribute to adverse effects.[8] Sixteen per cent of surveyed respondents who lived where calculated outdoor turbine noise exposures exceeded 35 dB LAeq (LAeq, the constant sound level that, in a given time period, would convey the same sound energy as the actual time varying sound level, weighted to approximate the response of the human ear) reported disturbed sleep.[4] A questionnaire survey concluded that turbine noise was more annoying at night, and that interrupted sleep and difficulty in returning to sleep increased with calculated noise level.[9] Even at the lowest noise levels, 20% of respondents reported disturbed sleep at least one night a month. In a meta-analysis of three European datasets

(n=1764),[10] sleep disturbance clearly increased with higher calculated noise levels in two of the three studies.

In a survey of people residing in the vicinity of two US wind farms, those living within 375-1400 m reported worse sleep and more daytime sleepiness, in addition to having lower summary scores on the mental component of the short form 36 health survey than those who lived 3-6.6 km from a turbine. Modelled dose-response curves of both sleep and health scores against distance from nearest turbine were significantly related after controlling for sex, age, and household clustering, with a sharp increase in effects between 1 km and 2 km.[11] A New Zealand survey showed lower health related quality of life, especially sleep disturbance, in people who lived less than 2 km from turbines.[12]

A large body of evidence now exists to suggest that wind turbines disturb sleep and impair health at distances and external noise levels that are permitted in most jurisdictions, including the United Kingdom. Sleep disturbance may be a particular problem in children,1 and it may have important implications for public health. When seeking to generate renewable energy through wind, governments must ensure that the public will not suffer harm from additional ambient noise. Robust independent research into the health effects of existing wind farms is long overdue, as is an independent review of existing evidence and guidance on acceptable noise levels.

Competing interests: Both authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; CDH has given expert evidence on the effects of wind turbine noise on sleep and

health at wind farm planning inquiries in the UK and Canada but has derived no personal benefit; he is a member of the board of the Society for Wind Vigilance; AE has written letters of objection on health grounds to wind farm planning applications in Ireland.

Provenance and peer review: Not commissioned; externally peer reviewed.

1. WHO. Burden of disease from environmental noise. 2011. www.euro.who.int/__data/assets/pdf_file/0008/136466/e94888.pdf.

2. Krogh C, Gillis L, Kouwen N, Aramini J. WindVOiCe, a self-reporting survey: adverse health effects, industrial wind turbines, and the need for vigilance monitoring. Bull Sci Tech Soc 2011;31:334-9.

3. Phillips C. Properly interpreting the epidemiologic evidence about the health effects of industrial wind turbines on nearby residents. Bull Sci Tech Soc 2011;31:303-8.

4. Pedersen E, Persson Waye K. Perception and annoyance due to wind turbine noise—a dose-response relationship. J Acoust Soc Am 2004;116:3460-70.

5. Pedersen E, van den Berg F, Bakker R, 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;38:2520-7.

6. Bray W, James R. Dynamic measurements of wind turbine acoustic signals, employing sound quality engineering methods considering the time and frequency sensitivities of human perception. Proceedings of Noise-Con 2011, Portland, Oregon, 25-27 July 2011.Curran Associates, 2011.

7. Møller M, Pedersen C. Low frequency noise from large wind turbines. J Acoust Soc Am 2010;129:3727-44.

8. Salt A, Kaltenbach J. Infrasound from wind turbines could affect humans. Bull Sci Tech Soc 2011;31:296-303.

9. van den Berg G, Pedersen E, Bouma J, Bakker R. Project WINDFARMperception. Visual and acoustic impact of wind turbine farms on residents. FP6-2005-Science-and-Society-20. Specific support action project no 044628, 2008. www.rug.nl/wewi/deWetenschapswinkels/natuurkunde/publicaties/WFp-final-1.pdf.

10. Pedersen E. Effects of wind turbine noise on humans. Proceedings of the Third International Meeting on Wind Turbine Noise, Aalborg Denmark 17-19 June 2009. www.confweb.org/wtn2009/.

11. Nissenbaum M, Aramini J, Hanning C. Adverse health effects of industrial wind turbines:a preliminary report. Proceedings of 10th International Congress on Noise as a Public Health Problem (ICBEN), 2011, London, UK. Curran Associates, 2011.

12. Shepherd D, McBride D, Welch D, Dirks K, Hill E. Evaluating the impact of wind turbine noise on health related quality of life. Noise Health 2011;13:333-9.

Comment:

The importance of this editorial is that is published in a top-rank journal (BMJ) and effectively synthesizes the evidence from the perspective of experts who are health care professionals. The Nissenbaum et al 12 paper in Noise and Health had not yet been published (see below).

Study (d)

Effects of industrial wind turbine noise on sleep and health. Michael A. Nissenbaum, Jeffery J. Aramini, Christopher D. Hanning Noise & Health, September-October 2012, Volume 14:60, 237-43

Abstract:

Industrial wind turbines (IWTs) are a new source of noise in previously quiet rural environments. Environmental noise is a public health concern, of which sleep disruption is a major factor. To compare sleep and general health outcomes between participants living close to IWTs and those living further away from them, participants living between 375 and 1400 m (n = 38) and 3.3 and 6.6 km (n = 41) from IWTs were enrolled in a stratified cross-sectional study involving two rural sites. Validated questionnaires were used to collect information on sleep quality (Pittsburgh Sleep Quality Index — PSQI), daytime sleepiness (Epworth Sleepiness Score — ESS), and general health (SF36v2), together with psychiatric disorders, attitude, and demographics. Descriptive and multivariate analyses were performed to investigate the effect of the main exposure variable of interest (distance to the nearest IWT) on various health outcome measures. Participants living within 1.4 km of an IWT had worse sleep, were sleepier during the day, and had worse SF36 Mental Component Scores compared to those living further than 1.4 km away. Significant dose-response relationships between PSQI, ESS, SF36 Mental Component Score, and log-distance to the nearest IWT were identified after controlling for gender, age, and household clustering. The adverse event reports of sleep disturbance and ill health by those living close to IWTs are supported.

Comment:

This study is a stratified cross-sectional design with a control group comparing groups that are near (375-1400 m) and far (3.3-6.6 km). Once again validated questionnaires are used (3). While the numbers are relatively small, 38 and 41 for the near and far groups respectively, a statistically significant difference between the 2 groups was found regarding sleep disturbance and self-reported ill health.

Study (e)

Statement from Society of Occupational and Environmental Medicine (DASAM)

Retrieved from https://www.wind-watch.org/documents/statement-on-the-revision-of-the-executive-order-on-noise-from-wind-turbines/

> DASAM [the Danish Society for Occupational and Environmental Medicine] has with interest read the proposal for a new executive order on noise from wind turbines. DASAM welcomes that low frequency noise from wind turbines are now being subjected to the same limits as low frequency noise from other industries during the night.
>
> DASAM believes however, that the executive order not sufficiently protects against health risks due to noise and therefore recommends:
>
> - The noise limits should be lowered from 39dB (A) to 35 dB (A).
> - Health based assessment on the effects of introducing up to 1000 wind turbines in Denmark should be performed.

Based on current knowledge about the relationship between noise from wind turbines and effects on humans, and the raised critic on the quality of the proposed noise measurements, for example from researchers from Aalborg University, we are concerned whether the proposed noise limit values for wind turbines will sufficiently protect the Danish citizens against annoyance of living close to wind turbines.

A number of original papers and several reviews show that between 10% and 40% of citizens living close to wind turbines feel annoyed or extremely annoyed by the noise, and it is shown that the number of annoyed people rises sharply when the noise exceeds 35 dB [1-7]. Generally, it has not been possible to distinguish between nuisances from noise and low frequency noise respectively. Some of the studies also suggest that living near a wind turbine affect sleep quality and the most recent review concluded that "Wind turbine noise is causing noise annoyance and possible also sleep disturbance, which means that one cannot completely rule out effects on the cardiovascular system after prolonged exposure to wind turbine noise, despite moderate levels of exposure" [2].

Some case studies describe vibroacoustic disease and wind turbine syndrome in persons living close to wind turbines, but these findings have not been confirmed by more systematic studies.

The current noise limits that are unchanged in the new revised proposal is 44 dB(A) at 8 m/s (open land) and 39 dB(A) at 8 m/s (noise sensitive land use). Actually, the noise load can be considerably higher, due to 1) no enhanced noise limits in the night, even though it is well documented, that the noise reduction can be lowered 3-15 dB at night [8,9] and 2) that the noise level can increase at higher wind speeds.

As something new, an indoor noise limit value of 20 dB for low-frequency noise is proposed, but it is accepted, that the noise limit value will be exceeded in 33% of households living close to wind turbines. Basically DASAM finds this approach unacceptable. The Environmental Protection Agency's calculation of the insulation capability of houses against low frequency noise – including the acceptance of the large number of exceedings – and the controversial use of measurement variability in the control measurements for noise has been strongly criticized by international experts in noise and acoustic [10]. In the proposed executive order the noise insulation numbers are increased compared to earlier, resulting in calculated indoor levels of low frequency noise below 20 dB, despite the fact that the real levels are well above 20 dB. We refer to [10] and to the statement on the executive order from Aalborg University for further details.

We estimate that with the current noise limit values for wind turbines, an unacceptable proportion of citizens in the vicinity of wind turbines will be annoyed or strongly annoyed by the noise. In the suggested noise limit values it has not been taken into consideration that susceptible subjects due to e.g. pre-existing disease can be more sensitive to noise compared to the general population .

No studies so far have investigated the magnitude of the problem in Denmark, but based on studies from mainly Sweden and Holland DASAM recommends that the noise limit value is decreased from the current 39 dB (A) so in the future no more than 35 dB is allowed at residences at a wind speed of 8 m/s. It is also recommended to use 35 dB as the noise limit value in noise sensitive land use – today it is covered by the 44 dB noise limit value. By doing this the Danish noise limit values will become comparable to the Swedish [11] and the

New Zeelandic [Zealand] [12] noise limit values. Based on present knowledge, this means that less than 10% of citizens living close to wind turbines will be annoyed by the noise.

DASAM finds it relevant that a health-based assessment is made of the effects of introducing as planned up to 1000 wind turbines in Denmark. DASAM can propose a person capable of performing the task, including suggestions on how effects of wind turbines may be monitored and estimated in the future.

Sincerely

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Comment:

This statement highlights the point that health care professionals internationally are growing increasingly concerned by the exposure of the public to sound energy the level of which has been determined by engineering analysis without anthropocentric or human centred evaluation by health care professionals. DASAM is expressing concern relating to adverse health effects and the failure of current regulations to protect the public. DASAM is based in Denmark, the country recognized as being at the forefront globally of alternative energy deployment generally and the wind industry in particular. Ontario's regulations are less stringent than those of Denmark and as noted earlier to the Ontario Government does not monitor wind turbines for infrasound and low frequency noise.

Study (f)

Health Canada Revised Research Design

Health Impacts and Exposure to Sound From Wind Turbines: Updated Research Design and Sound Exposure Assessment

http://www.hc-sc.gc.ca/ewh-semt/consult/_2013/wind_turbine-eoliennes/research_recherche-eng.php (accessed February 13, 2013)

Summary

The last decade has seen a sharp increase in wind turbine generated electricity in Canada. As of November 2012, Canada's installed capacity was 5.9 Gigawatts, providing 2.3 percent of Canada's current electricity demands. The wind energy industry has set a vision that by 2025 wind energy will supply 20% of Canada's electricity demands. Some public concern has been expressed about the potential health impacts of wind turbine sound (WTSFootnote i). The health effects reported by individuals living in communities in close proximity to wind turbine installations are poorly understood due to limited scientific research in this area. This is coupled with the many challenges faced in measuring and modeling WTS, including low frequencies, which represent knowledge gaps in this area. The continued success and viability of wind turbine energy in Canada, and around the world, will rely upon a thorough understanding of the potential health impacts and community concerns.

Health Canada is collaborating with Statistics Canada on an epidemiological study to evaluate measurable health endpoints in people living in 8-12 communities at distances up to

10km from wind turbine installations. Measured endpoints include an automated blood pressure/heart rate assessment, hair cortisol concentrations and sleep actimetry. The seven days of sleep measurement data will be analyzed in relation to synchronized wind turbine operational data, providing the strength of a repeated measures design that incorporates objectively determined health outcome measures.

In addition, self-reported data will be collected during an anticipated 30-35 minute face-to-face computer-assisted interview at participants' homes. The questionnaire instrument includes, but is not limited to, modules that probe endpoints such as noise annoyance, health effects, quality of life, sleep quality, perceived stress, lifestyle behaviours (e.g., cigarette smoking, alcohol consumption), prevalent chronic disease and property value impacts. Following completion of the questionnaire, subjects will be invited to participate in the physical health measures collection portion of the study.

Both self-reported and measured endpoints will be analyzed in relation to modeled WTS levels as a function of frequency (i.e. permitting A-, C- and G-weighting assessments). Modeled WTS will be validated and adjusted (if necessary) based on measurements taken indoors and outdoors in a sub-sample of dwellings. The targeted sample will consist of 2000 dwellings at setback distances ranging from less than 500 metres to distances of up to 10 kilometers randomly selected from communities in the vicinity of 8 to 12 wind turbine installations. As sleep disturbance is a frequent health complaint associated with WTS in observational and case studies, one of the primary research objectives in the study is to quantify the magnitude of sleep disturbance due to WTS. Statistics Canada's experience in sampling from similar communities is that 20% of the 2000 dwellings that are initially targeted will be unoccupied. With a response rate of approximately 70-75% (among which

around 20% will be within the closest distances) there should be sufficient statistical power to detect a 7% difference in the prevalence of sleep disturbances with 80% power and a 5% false positive rate (Type I error). Of course there is uncertainty in the power assessment because Health Canada's study is the first study to implement measured endpoints to study the impact that exposure to WTS may have on human health. Ultimately the results, while not definitive on their own, will contribute to the body of international peer-reviewed scientific evidence examining the health impact of WTS, and may also lead the way for supporting future studies examining this complex issue.

Comment:

This design should result in the most comprehensive evaluation of people exposed to wind turbine noise to date. It is still cross-sectional versus longitudinal but this design does include face-to-face interviews, detailed history taking and physiological monitoring of people directly i.e. it is anthropocentric or human centred design. The study design should enable the development of dose-response curves which are a core element of the goal of evidence-based guidelines for set-backs of wind turbines from residences, hospitals, schools and places of work. The development of evidence-based guidelines is a must for safe deployment of wind turbines. The absence of such guidelines is one of the greatest sources of negative reaction that the advent of wind turbines in Ontario have received in rural Ontario.