

**A Summary of new evidence:  
Adverse health effects and industrial wind turbines  
August 2011**

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## **To whom it may concern**

In previous communications, evidence has been provided regarding the risk of adverse health effects and industrial wind turbines (IWTs). Up to now, the siting of IWTs in Ontario is based on predictive computer modelling. While there is ample evidence regarding adverse health effects, the conduct of human health studies to determine regulations for setbacks and noise levels that protect health is still lacking.

The purpose of this document is to inform authorities and decision makers of new evidence, including articles published in peer reviewed scientific journals which advance knowledge on the topic of adverse health effects of IWTs.

Based on the evidence compiled in this document, no further IWT projects should be approved in proximity to humans until human health studies are conducted to determine setbacks and noise levels that will ensure the health and welfare of all exposed individuals.

Furthermore where there are reports of adverse health and/or noise complaints IWTs should be decommissioned until the human health studies have been conducted to determine regulations for setbacks and noise levels that protect health.

This summary may be used and submitted by other individuals.

No financial compensation has been requested nor received for this summary.

## **Denial of adverse health effects**

For years now, the Canadian Wind Energy Association (CanWEA) has denied that wind turbines can cause adverse health effects. However, based on previously known and recent information, this denial is incorrect.

A 2008 CanWEA media release informs the world “Scientists conclude that there is no evidence that wind turbines have an adverse impact on human health.”<sup>1</sup> None of references included in this CanWEA media release state “there is no evidence that wind turbines have an adverse impact on human health.”

An April 2009 CanWEA fact sheet states “Findings clearly show that there is no peer-reviewed scientific evidence indicating that wind turbines have an adverse impact on human health.”<sup>2</sup> The fact sheet contains eight references, none of which state “there is no peer-reviewed scientific evidence indicating that wind turbines have an adverse impact on human health.”

A 2009 CanWEA convened literature review concludes “Sound from wind turbines does not pose a risk of hearing loss or any other adverse health effect in humans.”<sup>3</sup> However, the contents of the literature review contradict this conclusion by acknowledging IWT noise

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may cause annoyance, stress and sleep disturbance and as a result people may experience adverse physiological and psychological symptoms. The literature review acknowledges possible symptoms include distraction, dizziness, eye strain, fatigue, feeling vibration, headache, insomnia, muscle spasm, nausea, nose bleeds, palpitations, pressure in the ears or head, skin burns, stress, and tension.

The above CanWEA sponsored statements which deny risk of adverse health effects are scientifically incorrect.

Assertions that IWTs do not pose a risk to human health only serve to confuse authorities and the public on the issue wind turbines and health effects.

For example, Ontario Minister of Health Matthews reportedly stated “There is no evidence, whatsoever, that there is an issue related to turbines,”<sup>4</sup> This statement is scientifically incorrect.

### **July 2011 Environmental Review Tribunal (ERT) Decision, Ontario**

As noted above, the CanWEA sponsored Colby et al. (2009) literature review stated “Sound from wind turbines does not pose a risk of hearing loss or any other adverse health effect in humans.”<sup>5</sup> Three of the co-authors of this statement, Drs. Colby, Leventhall, and McCunney testified on behalf of the Respondents (Ministry of Environment, Suncor Energy Services Inc.) during an Ontarian Environmental Review Tribunal (ERT).

Evidence provided at the ERT demonstrated the above statement authored by the CanWEA sponsored panel experts is incorrect.

The July 2011 ERT decision for an IWT project in Ontario<sup>6</sup> confirmed IWTs can harm humans:

“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.*” (p. 207) (*Emphasis added*)

Evidence and testimony provided to the ERT by witnesses called by the Appellants served to advance understanding of IWT induced health impacts. It is now acknowledged that IWTs do pose a risk of adverse health effect in humans if they are improperly sited.

All ten of the witnesses called upon by the Appellants were qualified as expert witnesses. The expert witnesses called upon by the Appellants have been involved in original

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research on the health effects of IWTs and/or have had related articles accepted in peer reviewed scientific journals.

During the ERT expert witnesses for both the Respondents and the Appellants provided evidence and/or testimony which acknowledged IWTs sound is perceived to be more annoying than transportation noise or industrial noise at comparable sound pressure levels.

Peer reviewed articles and other references acknowledge annoyance to be an adverse health effect. (Pedersen & Persson Waye, 2007<sup>7</sup>; Michaud et al. 2005<sup>8</sup>; Health Canada, 2005<sup>9</sup>; Suter, 1991<sup>10</sup>)

During the ERT expert witnesses for both the Respondents<sup>11, 12, 13, 14</sup> and the Appellants provided evidence and/or testimony which acknowledge annoyance to be a health effect.

Research confirms for chronically strong annoyance a causal chain exists between the three steps health–strong annoyance–increased morbidity<sup>15</sup> and must be classified as a serious health risk.<sup>16</sup>

During the ERT expert witnesses for both the Respondents and the Appellants provided evidence and/or testimony which acknowledged IWTs “will” cause annoyance, which can result in stress related health impacts including sleep disturbance, headache, tinnitus, ear pressure, dizziness, vertigo, nausea, visual blurring, tachycardia, irritability, problems with concentration and memory, and panic episodes associated with sensations of internal pulsation or quivering when awake or asleep, and depression.

During the ERT witnesses for both the Respondents and/or the Appellants provided evidence and/or testimony which indicate plausible causes of these health effects include: IWT amplitude modulation, audible low frequency sound, infrasound, tonality, lack of nighttime abatement, shadow flicker, visual impact, economic impacts or a combination thereof.

It is acknowledged Ontario regulations and/or noise guidelines will not protect all individuals from these health impacts. A 2010 final draft report prepared for the Ontario Ministry of Environment (MOE) states:

*“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.”<sup>17</sup> (Emphasis added)*

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MOE documents obtained through a Freedom of Information request confirm current Ontario IWT guidelines will cause adverse effects. One 2010 MOE internal memorandum states:

“It appears compliance with the minimum setbacks and the noise study approach currently being used to approve the siting of WTGs will result or likely result in adverse effects contrary to subsection 14(1) of the EPA”<sup>18</sup>

Another MOE reference documents Ontario families that have abandoned their homes due to sleep disturbance caused by exposure to wind farms.<sup>19</sup> Sleep disturbance is an adverse health effect. MOE correspondence also documents families that have moved out of their homes and have made financial settlements with the respective IWT developer.<sup>20</sup>

Based on original research in Ontario, and elsewhere, a peer reviewed article states:

“It is acknowledged that IWTs, if not sited properly, can adversely affect the health of exposed individuals. In addition to physiological and psychological symptoms there are individuals reporting adverse impacts, including reduced well-being, degraded living conditions, and adverse societal and economic impacts. These adverse impacts culminate in expressions of a loss of fairness and social justice.

The above impacts represent a serious degradation of health in accordance with commonly accepted definitions of health as defined by the WHO and the Ottawa Charter for Health Promotion.”<sup>21</sup>

### **August 2011 peer reviewed articles published in a scientific journal**

Subsequent to the July Ontario ERT decision nine peer reviewed articles have been published in a special August, 2011 edition of the scientific journal, *Bulletin of Science, Technology and Society (BSTS)*. These articles explore health and social impacts of IWT installations.<sup>22, 23, 24, 25, 26, 27, 28, 29, 30</sup>

The Special Edition is entitled *Windfarms, Communities and Ecosystems*. Included in the special edition, is a commentary by the editor, Willem H. Vanderburg.<sup>31</sup>

The SAGE website states:

*“The goal of the **Bulletin of Science, Technology and Society** is to provide a means of communication within as wide of a spectrum of the STS community as possible. This includes faculty and students from sciences, engineering, the humanities, and social science in the newly emerging groups on university and college campuses, and in the high school systems, all of which teach integrative STS subject matters. It also includes professionals in government, industry and universities, ranging from philosophers and historians of science to social scientists concerned with the effects*

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*of science and technology, scientists and engineers involved with the study and policy-making of their own craft, and the concerned general leader. A third category of readers represents "society": all journalists dealing with the impacts of science and technology in their respected fields, the public interest groups and the attentive public."*<sup>32</sup>

One article presents the result of WindVOiCe, an Ontario self reporting health survey that follows the principles of Health Canada for vigilance monitoring of pharmaceuticals and other products.<sup>33</sup>

Another article documents social justice impacts when people cannot obtain mitigation or resolution and in some cases, have abandoned their homes due to IWT exposure.<sup>34</sup>

An article authored by Dr. Bob Thorne documents his research on IWT noise and correlates this with reported IWT adverse health impacts. Based this field work Dr. Thorne concludes a sound level of LAeq 32 dB outside the residence is required to avoid serious harm to human health.<sup>35</sup>

Ontario MOE documents obtained from a Freedom of Information request support a 32 dBA sound limit for IWTs. Based on real world field investigations MOE field officers advised the Ministry about IWT adverse effects and stated "... the setback distances should be calculated using a sound level limit of 30 to 32 dBA at the receptor, instead of the 40 dBA sound level limit."<sup>36</sup>

Dr. Robert McMurtry, former Dean of Medicine, University of Western Ontario, and 2011 recipient of Member of Order of Canada, published a case definition to facilitate a clinical diagnosis regarding adverse health effects and IWTs.<sup>37</sup>

Other articles explore topics including how to properly interpret IWT epidemiological evidence,<sup>38</sup> the physics of IWT noise,<sup>39</sup> public health ethics,<sup>40</sup> potential IWT noise impacts on children,<sup>41</sup> and potential IWT infrasound sound impacts on the human ear.<sup>42</sup>

These articles are critical to anyone interested in the safe siting of IWTs. It is recommended that authorities and regulators obtain a copy of each of the nine articles.

Please use this link if you wish to access these articles <http://bst.sagepub.com>

Downloads of these articles can be obtained with an individual subscription for \$100. This will allow you to download these and other articles from the BSTS scientific journal.

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## **IWT low frequency noise and infrasound**

In the past some commentators have stated low frequency noise from IWTs is not an issue. Other references indicate most available evidence suggests that reported IWT health effects, such as sleeplessness and headache, are related to audible low frequency noise.<sup>43</sup>

A June 2011 Federal Australian Senate committee investigating IWT and adverse health effects report recommended:

“... 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 vibrations indoors at impacted dwellings.”<sup>44</sup>

A June 2011 peer reviewed article on IWT low frequency noise is available.<sup>45</sup>

The abstract states:

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 ([1] 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.”

Annoyance from audible low frequency noise is acknowledged to be more severe in general. Low frequency noise does not need to be considered loud for it to cause annoyance and irritation.<sup>46</sup> Low frequency noise causes immense suffering to those who are unfortunate to be sensitive to it<sup>47</sup> and chronic psychophysiological damage may result from long-term exposure to low-level low frequency noise.<sup>48</sup> Some symptoms associated with exposure to low frequency noise include annoyance, stress, sleep disturbance, headaches, difficulty concentrating, irritability, fatigue, dizziness or vertigo, tinnitus, anxiety, heart ailments and palpitation.<sup>49</sup>,<sup>50</sup>,<sup>51</sup>

Møller and Pedersen, (2011) indicate IWT low frequency noise is more of an issue for large turbines of 2.3 MW and up.<sup>52</sup> However low frequency noise from smaller turbines (ie 1.5MW) can also cause adverse health effects. Freedom of Information documents

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obtained from the MOE document low frequency noise issues from smaller IWTs (i.e., 1.5 MW) at Ontario wind farms. The MOE documents how IWT low frequency noise caused a home to be “uninhabitable” resulting in family members abandoning trying to sleep there.<sup>53</sup> For further discussion see Krogh (2011)<sup>54</sup> and Thorne (2011).<sup>55</sup>

Research on the potential impacts of IWT infrasound has been published in two peer reviewed scientific journals (Salt and Hullar, 2010<sup>56</sup>, Salt and Kaltenbach, 2011<sup>57</sup>). These articles conclude that it is scientifically possible that infrasound from IWTs could affect people living nearby and more research is needed.

### **Wind Turbines Noise, Fourth International Meeting**

During the Rome Conference Fourth International Meeting on Wind Turbine Noise Rome Italy 12-14 April 2011 there were a number of presentations documenting IWT noise issues.

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.”<sup>58</sup>

A number of conference papers addressed human health impacts of IWTs. For example one research team conducted a study which demonstrated those living in the immediate vicinity of IWTs scored worse than a matched control group in terms of physical and environmental health related quality of life (HRQOL).<sup>59</sup>

The Ontario ERT expert witnesses for both the Respondents and the Appellants provided evidence and/or testimony which acknowledged IWT amplitude modulation and/or audible low frequency noise are probable causes of IWT adverse health effects.

Research related to low frequency noise “...confirms the importance of fluctuations as a contributor to annoyance and the limitation of those assessment methods, which do not include fluctuations in the assessment.”<sup>60</sup>

In addition, the World Health Organization states:

“Noise measures based solely on LAeq values do not adequately characterize most noise environments and do not adequately assess the health impacts of noise on human well-being. It is also important to measure the maximum noise level and the number of noise events when deriving guideline values. If the noise includes a large proportion of low-frequency components, values even lower than the guideline values will be needed, because low-frequency components in noise may increase the adverse

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effects considerably. When prominent low-frequency components are present, measures based on A-weighting are inappropriate.”<sup>61</sup>

Consultants for the Ontario MOE, Aeroacoustics, submitted a paper at the Fourth International Meeting on Wind Turbine Noise which states:

“Sound emissions from operating wind farms frequently give rise to noise complaints. Most compliance-based noise audits measure hourly “A”-weighted Leq, thereby removing the low-frequency contents of the wind turbine sound. The metric is also insensitive to amplitude modulation and is unsatisfactory when sensitive receptor are annoyed by the low frequency sound and amplitude modulation.”<sup>62</sup>

Current Ontario guidelines are based on the A-Weighted Leq metric and hence must be considered unsatisfactory to protect individuals from the health impacts of IWT amplitude modulation and/or low frequency noise.

### **The need for research**

The authors of a Canadian Wind Energy Association sponsored report state they do not “advocate for funding further studies.”<sup>63</sup>

The April 2011 Wind Turbine Noise post-conference report states:

“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.”<sup>64</sup>

A June 2011 Australian Senate committee investigating IWT and adverse health effects report recommended:

“... 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.”<sup>65</sup>

The July 2011 Ontario ERT decision also acknowledged that more research is needed.<sup>66</sup>

“Just because the Appellants have not succeeded in their appeals, that is no excuse to close the book on further research. On the contrary, further research should help resolve some of the significant questions that the Appellants have raised.” (p. 207)

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International experts who have conducted original research and/or published peer reviewed articles in scientific journals confirm that research is required.<sup>67, 68, 69, 70, 71, 72, 73, 74, 75, 76</sup>

### **Inappropriate use of literature reviews**

Literature reviews can be useful tools for summarizing existing literature related to a particular topic. In order to be considered reliable a literature review must be complete, accurate, and objective.

In recent years a number of literature reviews have been produced which purport to explore the health effect of IWTs. Some literature reviews which have been relied upon to deny IWTs can adversely affect the health of humans. These literature reviews include Chatham-Kent Public Health Unit. (2008),<sup>77</sup> Colby et al, (2009),<sup>78</sup> Ontario Chief Medical Officer of Health, (2010),<sup>79</sup> and the National Health and Medical Research Council (Australia) (2010).<sup>80</sup> None of these literature reviews have been published in a peer reviewed scientific journal.

Reliance on these literature reviews is inappropriate as they contain errors of omission and/or commission and are neither convincing nor authoritative. Many of the conclusions are incomplete, inaccurate, lack objectivity and consequently only serve to confuse the issue of IWT health effects.

For example, these literature reviews limit their discussion to direct effects using qualifiers such as “direct physiopathological effects” or “direct causal links”. Failure to carefully evaluate the indirect causal pathways and the psychological harm of IWT exposure represent errors of omission. Annoyance, sleep disturbance, cognitive and emotional response, and stress are health effects that occur through the indirect pathway.<sup>81</sup> The health outcomes associated with the indirect pathway are significant:

“Physiological experiments on humans have shown that noise of a moderate level acts via an indirect pathway and has health outcomes similar to those caused by high noise exposures on the direct pathway. The indirect pathway starts with noise-induced disturbances of activities such as communication or sleep.”<sup>82</sup>

The Ontario Environmental Review Tribunal expressed concern that the Director for the MOE relied on references which did not address the indirect pathway.<sup>83</sup>

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As a consequence of their weaknesses some literature reviews have been criticized for their poor quality.

In March 2011, the Chief Executive Officer of National Health and Medical Research Council stated regarding their July 2010 literature review:

“We regard this as a work in progress. We certainly do not believe that this question has been settled. That is why we are keeping it under constant review. That is why we said in our review that we believe authorities must take a precautionary approach to this.”<sup>84</sup>

Chatham-Kent Public Health Unit (2008),<sup>85</sup> Colby et al, December 2009,<sup>86</sup> Ontario Chief Medical Officer of Health (2010),<sup>87</sup> share many of the same weaknesses as National Health and Medical Research Council (2010).<sup>88</sup> These literature reviews cannot be relied for Renewable Energy Applications and/or Renewable Energy Approvals to support the contention there is no evidence that IWTs can cause adverse health effects. For detailed analysis of some of these literature reviews visit [www.windvigilance.com](http://www.windvigilance.com)

## **Conclusion**

### **Based on the best available evidence the following conclusions can be made**

1. The Canadian Wind Energy Association sponsored statements that IWTs do not pose a risk of adverse health effects in humans are scientifically incorrect.
2. Experts who have conducted original research and/or published peer reviewed articles in scientific journals confirm IWTs can harm human health if they not sited properly.
3. Acknowledged adverse health effects include: annoyance, stress, sleep disturbance, headache, tinnitus, ear pressure, dizziness, vertigo, nausea, visual blurring, tachycardia, irritability, problems with concentration and memory, and panic episodes associated with sensations of internal pulsation or quivering when awake or asleep. Other adverse impacts include reduced well-being, degraded living conditions, and adverse societal and economic impacts. These adverse impacts culminate in expressions of a loss of fairness and social justice.
4. The above impacts in conclusion 3 represent a serious degradation of health in accordance with commonly accepted definitions of health as defined by the WHO and the Ottawa Charter for Health Promotion.
5. It is expected that at typical setbacks and with the noise study approach currently being used in Ontario to approve the siting of IWTs, a non trivial percentage of exposed individuals will experience serious degradation of health.

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6. Harm to human health can be avoided with science based regulations based on research conducted on human response to IWT exposure.
7. Experts who have conducted original research and/or published peer reviewed articles in scientific journals confirm that research is required to establish scientifically based IWT regulations to protect human health.
8. Until scientifically based research has been conducted IWTs should not sited in proximity to human habitation.

Respectfully submitted,

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<sup>1</sup> Canadian Wind Energy Association. (2008, October 6). Scientists conclude that there is no evidence that wind turbines have an adverse impact on human health. Retrieved from [http://www.canwea.ca/media/release/release\\_e.php?newsId=37](http://www.canwea.ca/media/release/release_e.php?newsId=37)

<sup>2</sup> Canadian Wind Energy Association. (2009, April). Addressing concerns with wind turbines and human health. Retrieved from <http://www.canwea.ca/pdf/CanWEA%20-%20Addressing%20concerns%20with%20wind%20turbines%20and%20human%20health.pdf>

<sup>3</sup> Colby, W. D., Dobie, R., Leventhall, G., Lipscomb, D. M., McCunney, R. J., Seilo, M. T., & Søndergaard, B. (2009). Wind turbine sound and health effects: An expert panel review 2009. Prepared for American Wind Energy Association and Canadian Wind Energy Association. Retrieved from [http://www.canwea.ca/pdf/talkwind/Wind\\_Turbine\\_Sound\\_and\\_Health\\_Effects.pdf](http://www.canwea.ca/pdf/talkwind/Wind_Turbine_Sound_and_Health_Effects.pdf)

<sup>4</sup> Heath, C. (2010, December). Health minister visits Clinton FHT. Clinton News Record. Retrieved from <http://www.clintonnewsrecord.com/ArticleDisplay.aspx?e=2891265>

<sup>5</sup> Colby, W. D., Dobie, R., Leventhall, G., Lipscomb, D. M., McCunney, R. J., Seilo, M. T., & Søndergaard, B. (2009). Wind turbine sound and health effects: An expert panel review 2009. Prepared for American Wind Energy Association and Canadian Wind Energy Association. Retrieved from [http://www.canwea.ca/pdf/talkwind/Wind\\_Turbine\\_Sound\\_and\\_Health\\_Effects.pdf](http://www.canwea.ca/pdf/talkwind/Wind_Turbine_Sound_and_Health_Effects.pdf)

<sup>6</sup> 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, <http://www.ert.gov.on.ca/english/decisions/index.htm>

<sup>7</sup> Pedersen, E., & Persson Wayne, K. (2007). Wind turbine noise, annoyance and self-reported health and well being in different living environments. Occupational and Environmental Medicine, 64, 480-486. doi:10.1136/oem.2006.031039

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- 
- <sup>8</sup> Michaud DS, Keith SE, McMurchy D. (2005). Noise annoyance in Canada. *Noise Health* 2005;7:39-47
- <sup>9</sup> Health Canada. (2005). Community noise annoyance. Retrieved from <http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/life-vie/community-urbain-eng.php#he>
- <sup>10</sup> Suter, A. H. (1991). Noise and its effects. Administrative Conference of the United States. Retrieved from <http://www.nonoise.org/library/suter/suter.htm>
- <sup>11</sup> Reference submitted by Dr. Mundt, Health Canada. (2005). Community noise annoyance. Retrieved from <http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/life-vie/community-urbain-eng.php#he>
- <sup>12</sup> Reference submitted by Dr. Leventhall, General Purpose Standing Committee No. 5 Rural wind farms Ordered to be printed 16 December 2009 according to Standing Order 231
- <sup>13</sup> Transcript of Dr. C. Ollson, Mar, 22, 2011, p. 118, l. 4 to l. 21, <http://www.ert.gov.on.ca/english/decisions/index.htm>
- <sup>14</sup> Supplementary Witness Statement of William David Colby, MSc, MD, FRCP(C), p. 3, para. 1
- <sup>15</sup> Niemann, H., & Maschke, C. (2004). WHO LARES final report: Noise effects and morbidity. Retrieved from [http://www.euro.who.int/\\_data/assets/pdf\\_file/0015/105144/WHO\\_Lares.pdf](http://www.euro.who.int/_data/assets/pdf_file/0015/105144/WHO_Lares.pdf)
- <sup>16</sup> Maschke, C., Niemann, A. Health effects of annoyance induced by neighbour noise. *Noise Control Eng. J.* 55 (3), 2007 May-June
- <sup>17</sup> Howe Gastmeier Chapnik Limited. (2010, December). Low frequency noise and infrasound associated with wind turbine generator systems: A literature review (Rfp No. Oss-078696) Final Draft. Mississauga, Ontario, Canada: Ministry of the Environment.
- <sup>18</sup> Ontario Ministry of Environment Memorandum, April 9, 2010
- <sup>19</sup> Reference FOI, MOE Internal Correspondence, May 1, 2009
- <sup>20</sup> Reference FOI, MOE Internal Correspondence Officer, June 29, 2009
- <sup>21</sup> Krogh, CME, (2011), Industrial Wind Turbine Development and Loss of Social Justice? *Bulletin of Science Technology & Society* 2011 31: 321, DOI: 10.1177/0270467611412550, <http://bst.sagepub.com/content/31/4/321>
- <sup>22</sup> Krogh, CME, (2011), Industrial Wind Turbine Development and Loss of Social Justice? *Bulletin of Science Technology & Society* 2011 31: 321, DOI: 10.1177/0270467611412550, <http://bst.sagepub.com/content/31/4/321>
- <sup>23</sup> Krogh, CME, Gillis, L, Kouwen, N, and Aramini, J, (2011), 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, DOI: 10.1177/0270467611412551, <http://bst.sagepub.com/content/31/4/334>
- <sup>24</sup> McMurtry, RY, Toward a Case Definition of Adverse Health Effects in the Environs of Industrial Wind Turbines: Facilitating a Clinical Diagnosis, *Bulletin of Science Technology & Society* 2011 31: 316, DOI: 10.1177/0270467611415075, <http://bst.sagepub.com/content/31/4/316>
- <sup>25</sup> Salt, AN, and Kaltenbach, JA, (2011) Infrasound From Wind Turbines Could Affect Humans, *Bulletin of Science Technology & Society* 2011 31: 296, DOI: 10.1177/0270467611412555, <http://bst.sagepub.com/content/31/4/296>
- <sup>26</sup> Shain, M, (2011), Public Health Ethics, Legitimacy, and the Challenges of Industrial Wind Turbines: The Case of Ontario, Canada, *Bulletin of Science Technology & Society*, 2011 31: 256, DOI: 10.1177/0270467611412552, <http://bst.sagepub.com/content/31/4/346>
- <sup>27</sup> Bronzaft, AL, (2011) The Noise From Wind Turbines: Potential Adverse Impacts on Children's Well-Being, *Bulletin of Science Technology & Society* 2011 31: 256, DOI: 10.1177/0270467611412548, <http://bst.sagepub.com/content/31/4/291>
- <sup>28</sup> Harrison, JP, (2011), Wind Turbine Noise, *Bulletin of Science Technology & Society* 2011 31: 256, DOI: 10.1177/0270467611412549, <http://bst.sagepub.com/content/31/4/256>
- <sup>29</sup> Phillips, CV, (2011), Properly Interpreting the Epidemiologic Evidence About the Health Effects of Industrial Wind Turbines on Nearby Residents, *Bulletin of Science Technology & Society* 2011 31: 303, DOI: 10.1177/0270467611412554, <http://bst.sagepub.com/content/31/4/303>
- <sup>30</sup> Thorne, B, (2011), The Problems With "Noise Numbers" for Wind Farm Noise Assessment, *Bulletin of Science Technology & Society* 2011 31: 262, DOI: 10.1177/0270467611412557, <http://bst.sagepub.com/content/31/4/262>

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Any errors or omissions contained within this document are unintentional.

- 
- <sup>31</sup> Vanderburg, WH, (2011), Assessing Our Ability to Design and Plan Green Energy Technologies, *Bulletin of Science Technology & Society* 2011 31: 262, DOI: 10.1177/0270467611412558, <http://bst.sagepub.com/content/31/4/251>
- <sup>32</sup> BSTS web site (cited August, 2011), <http://bst.sagepub.com>
- <sup>33</sup> Krogh, CME, Gillis, L, Kouwen, N, and Aramini, J, (2011), 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, DOI: 10.1177/0270467611412551, <http://bst.sagepub.com/content/31/4/334>
- <sup>34</sup> Krogh, CME, (2011), Industrial Wind Turbine Development and Loss of Social Justice? *Bulletin of Science Technology & Society* 2011 31: 321, DOI: 10.1177/0270467611412550, <http://bst.sagepub.com/content/31/4/321>
- <sup>35</sup> Thorne, B, (2011), The Problems With "Noise Numbers" for Wind Farm Noise Assessment, *Bulletin of Science Technology & Society* 2011 31: 262, DOI: 10.1177/0270467611412557, <http://bst.sagepub.com/content/31/4/262>
- <sup>36</sup> Reference FOI, Senior Environmental Officer, April 10, 2010
- <sup>37</sup> McMurtry, RY, Toward a Case Definition of Adverse Health Effects in the Environs of Industrial Wind Turbines: Facilitating a Clinical Diagnosis, *Bulletin of Science Technology & Society* 2011 31: 316, DOI: 10.1177/0270467611415075, <http://bst.sagepub.com/content/31/4/316>
- <sup>38</sup> Phillips, CV, (2011), Properly Interpreting the Epidemiologic Evidence About the Health Effects of Industrial Wind Turbines on Nearby Residents, *Bulletin of Science Technology & Society* 2011 31: 303, DOI: 10.1177/0270467611412554, <http://bst.sagepub.com/content/31/4/303>
- <sup>39</sup> Harrison, JP, (2011), Wind Turbine Noise, *Bulletin of Science Technology & Society* 2011 31: 256, DOI: 10.1177/0270467611412549, <http://bst.sagepub.com/content/31/4/256>
- <sup>40</sup> Shain, M, (2011), Public Health Ethics, Legitimacy, and the Challenges of Industrial Wind Turbines: The Case of Ontario, Canada, *Bulletin of Science Technology & Society*, 2011 31: 256, DOI: 10.1177/0270467611412552, <http://bst.sagepub.com/content/31/4/346>
- <sup>41</sup> Bronzaft, AL, (2011) The Noise From Wind Turbines: Potential Adverse Impacts on Children's Well-Being, *Bulletin of Science Technology & Society* 2011 31: 256, DOI: 10.1177/0270467611412548, <http://bst.sagepub.com/content/31/4/291>
- <sup>42</sup> Salt, AN, and Kaltenbach, JA, (2011) Infrasound From Wind Turbines Could Affect Humans, *Bulletin of Science Technology & Society* 2011 31: 296, DOI: 10.1177/0270467611412555, <http://bst.sagepub.com/content/31/4/296>
- <sup>43</sup> Minnesota Department of Health. (2009). Public health impacts of wind turbines. Retrieved from <http://www.health.state.mn.us/divs/eh/hazardous/topics/windturbines.pdf>
- <sup>44</sup> Community Affairs References Committee. (2011). The social and economic impact of rural wind farms. Retrieved from [http://www.aph.gov.au/senate/committee/clac\\_ctte/impact\\_rural\\_wind\\_farms/index.htm](http://www.aph.gov.au/senate/committee/clac_ctte/impact_rural_wind_farms/index.htm)
- <sup>45</sup> Møller, H and Pedersen CS, Low-frequency noise from large wind turbines, Section of Acoustics, Aalborg University, Fredrik Bajers Vej 7-B5, DK-9220 Aalborg Ø, Denmark. *J. Acoust. Soc. Am.* 129 (6), June 2011
- <sup>46</sup> DeGagne, D. C., & Lapka, S. D. (2008). Incorporating low frequency noise legislation for the energy industry in Alberta, Canada. *Journal of Low Frequency Noise, Vibration and Active Control*, 27, 105-120.
- <sup>47</sup> Leventhall, H. G., assisted by P. Pelmear & S. Benton. (2003). A review of published research on low frequency noise and its effects. Retrieved from <http://westminsterresearch.wmin.ac.uk/4141/>
- <sup>48</sup> Leventhall, H. G. (2004). Low frequency noise and annoyance. *Noise & Health*, 6, 59-72.
- <sup>49</sup> DeGagne, D. C., & Lapka, S. D. (2008). Incorporating low frequency noise legislation for the energy industry in Alberta, Canada. *Journal of Low Frequency Noise, Vibration and Active Control*, 27, 105-120.
- <sup>50</sup> Schust M. (2004) Effects of low frequency noise up to 100 Hz. *Noise Health* 2004;6:73-85
- <sup>51</sup> Leventhall, H. G., assisted by P. Pelmear & S. Benton. (2003). A review of published research on low frequency noise and its effects. Retrieved from <http://westminsterresearch.wmin.ac.uk/4141/>
- <sup>52</sup> Møller, H and Pedersen CS, Low-frequency noise from large wind turbines, Section of Acoustics, Aalborg University, Fredrik Bajers Vej 7-B5, DK-9220 Aalborg Ø, Denmark. *J. Acoust. Soc. Am.* 129 (6), June 2011
- <sup>53</sup> Reference FOI, MOE Internal Correspondence, May 1, 2009

A Summary of new evidence:

Adverse health effects and industrial wind turbines

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- 
- <sup>54</sup> Krogh, CME, (2011), Industrial Wind Turbine Development and Loss of Social Justice? Bulletin of Science Technology & Society 2011 31: 321, DOI: 10.1177/0270467611412550, <http://bst.sagepub.com/content/31/4/321>
- <sup>55</sup> Thorne, B, (2011), The Problems With "Noise Numbers" for Wind Farm Noise Assessment, Bulletin of Science Technology & Society 2011 31: 262, DOI: 10.1177/0270467611412557, <http://bst.sagepub.com/content/31/4/262>
- <sup>56</sup> Salt, A. N., & Hullar, T. E. (2010). Responses of the ear to low frequency sounds, infrasound and wind turbines. Hearing Research, 268, 12-21. doi:10.1016/j.heares.2010.06.007
- <sup>57</sup> Salt, A. N., & Kaltenbach, J.A., Infrasound From Wind Turbines Could Affect Humans, Bulletin of Science Technology & Society 2011 31: 296, DOI: 10.1177/0270467611412555 <http://bst.sagepub.com/content/31/4/296>
- <sup>58</sup> Wind Turbine Noise. (2011). Post conference report. Retrieved from [http://www.confweb.org/wtn2011/index.php?option=com\\_content&view=article&id=70:report&catid=35:information](http://www.confweb.org/wtn2011/index.php?option=com_content&view=article&id=70:report&catid=35:information)
- <sup>59</sup> Shepherd, D., McBride, D., Welch, D., Dirks, K., Hill, E., 2011. Wind turbine noise and health-related quality of life nearby residents: a cross-sectional study in New Zealand. Fourth International Meeting on Wind Turbine Noise. Rome Italy 12-14 April 2011
- <sup>60</sup> Leventhall, H. G., assisted by P. Pelmeur & S. Benton. (2003). A review of published research on low frequency noise and its effects. Retrieved from <http://westminsterresearch.wmin.ac.uk/4141/>
- <sup>61</sup> World Health Organization. (1999). Guidelines for community noise. Geneva; OMS,1999, 94 p. Ilus, Authors: Berglund, B., Lindvall, T., Schwela, D. H. ,
- <sup>62</sup> Richarz, W., Richarz, H., and Gambino, T., (2011), Correlating very low frequency sound pulse to audible wind turbine sound, Aercoustice Engineering Limited, Ontario, Canada, Rome Conference Fourth International Meeting on Wind Turbine Noise Rome Italy 12-14 April 2011
- <sup>63</sup> Colby, W. D., Dobie, R., Leventhall, G., Lipscomb, D. M., McCunney, R. J., Seilo, M. T., & Søndergaard, B. (2009). Wind turbine sound and health effects: An expert panel review 2009. Prepared for American Wind Energy Association and Canadian Wind Energy Association. Retrieved from [http://www.canwea.ca/pdf/talkwind/Wind\\_Turbine\\_Sound\\_and\\_Health\\_Effects.pdf](http://www.canwea.ca/pdf/talkwind/Wind_Turbine_Sound_and_Health_Effects.pdf)
- <sup>64</sup> Wind Turbine Noise. (2011). Post conference report. Retrieved from [http://www.confweb.org/wtn2011/index.php?option=com\\_content&view=article&id=70:report&catid=35:information](http://www.confweb.org/wtn2011/index.php?option=com_content&view=article&id=70:report&catid=35:information)
- <sup>65</sup> Community Affairs References Committee. (2011). The social and economic impact of rural wind farms. Retrieved from [http://www.apf.gov.au/senate/committee/clac\\_ctte/impact\\_rural\\_wind\\_farms/index.htm](http://www.apf.gov.au/senate/committee/clac_ctte/impact_rural_wind_farms/index.htm)
- <sup>66</sup> 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, <http://www.ert.gov.on.ca/english/decisions/index.htm>
- <sup>67</sup> Krogh, CME, (2011), Industrial Wind Turbine Development and Loss of Social Justice? Bulletin of Science Technology & Society 2011 31: 321, DOI: 10.1177/0270467611412550, <http://bst.sagepub.com/content/31/4/321>
- <sup>68</sup> Krogh, CME, Gillis, L, Kouwen, N, and Aramini, J, (2011), 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, DOI: 10.1177/0270467611412551, <http://bst.sagepub.com/content/31/4/334>
- <sup>69</sup> McMurtry, RY, Toward a Case Definition of Adverse Health Effects in the Environs of Industrial Wind Turbines: Facilitating a Clinical Diagnosis, Bulletin of Science Technology & Society 2011 31: 316, DOI: 10.1177/0270467611415075, <http://bst.sagepub.com/content/31/4/316>
- <sup>70</sup> Salt, AN, and Kaltenbach, JA, (2011) Infrasound From Wind Turbines Could Affect Humans, Bulletin of Science Technology & Society 2011 31: 296, DOI: 10.1177/0270467611412555, <http://bst.sagepub.com/content/31/4/296>
- <sup>71</sup> Bronzaft, AL, (2011) The Noise From Wind Turbines: Potential Adverse Impacts on Children's Well-Being, Bulletin of Science Technology & Society 2011 31: 256, DOI: 10.1177/0270467611412548, <http://bst.sagepub.com/content/31/4/291>

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- <sup>72</sup> Harrison, JP, (2011), Wind Turbine Noise, Bulletin of Science Technology & Society 2011 31: 256, DOI: 10.1177/0270467611412549, <http://bst.sagepub.com/content/31/4/256>
- <sup>73</sup> Phillips, CV, (2011), Properly Interpreting the Epidemiologic Evidence About the Health Effects of Industrial Wind Turbines on Nearby Residents, Bulletin of Science Technology & Society 2011 31: 303, DOI: 10.1177/0270467611412554, <http://bst.sagepub.com/content/31/4/303>
- <sup>74</sup> Thorne, B, (2011), The Problems With "Noise Numbers" for Wind Farm Noise Assessment, Bulletin of Science Technology & Society 2011 31: 262, DOI: 10.1177/0270467611412557, <http://bst.sagepub.com/content/31/4/262>
- <sup>75</sup> Salt, A. N., & Hullar, T. E. (2010). Responses of the ear to low frequency sounds, infrasound and wind turbines. Hearing Research, 268, 12-21. doi:10.1016/j.heares.2010.06.007
- <sup>76</sup> Low-frequency noise from large wind turbines, Henrik Møllera and Christian Sejer Pedersen Section of Acoustics, Aalborg University, Fredrik Bajers Vej 7-B5, DK-9220 Aalborg Ø, Denmark. J. Acoust. Soc. Am. 129 (6), June 2011
- <sup>77</sup> Chatham-Kent Public Health Unit. (2008), The health impact of wind turbines: A review of the current white, grey, and published literature. Chatham, Ontario, Canada: Chatham-Kent Municipal Council. Retrieved from <http://www.wind-works.org/LargeTurbines/Health%20and%20Wind%20by%20C-K%20Health%20Unit.pdf>
- <sup>78</sup> Colby, W. D., Dobie, R., Leventhall, G., Lipscomb, D. M., McCunney, R. J., Seilo, M. T., & Søndergaard, B. (2009). Wind turbine sound and health effects: An expert panel review 2009. Prepared for American Wind Energy Association and Canadian Wind Energy Association. Retrieved from [http://www.canwea.ca/pdf/talkwind/Wind\\_Turbine\\_Sound\\_and\\_Health\\_Effects.pdf](http://www.canwea.ca/pdf/talkwind/Wind_Turbine_Sound_and_Health_Effects.pdf)
- <sup>79</sup> Chief Medical Officer of Health. (2010, May). Report: The potential health impact of wind turbines. Retrieved from [http://www.health.gov.on.ca/en/public/publications/ministry\\_reports/wind\\_turbine/wind\\_turbine.pdf](http://www.health.gov.on.ca/en/public/publications/ministry_reports/wind_turbine/wind_turbine.pdf)
- <sup>80</sup> National Health and Medical Research Council. (2010a). Wind turbines and health a rapid review of the evidence. Retrieved from <http://www.nhmrc.gov.au/publications/synopses/new0048.htm>
- <sup>81</sup> World Health Organization. (2009). Night noise guidelines for Europe. Retrieved from [http://www.euro.who.int/\\_data/assets/pdf\\_file/0017/43316/E92845.pdf](http://www.euro.who.int/_data/assets/pdf_file/0017/43316/E92845.pdf)
- <sup>82</sup> World Health Organization. (2009). Night noise guidelines for Europe. Retrieved from [http://www.euro.who.int/\\_data/assets/pdf\\_file/0017/43316/E92845.pdf](http://www.euro.who.int/_data/assets/pdf_file/0017/43316/E92845.pdf)
- <sup>83</sup> 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, <http://www.ert.gov.on.ca/english/decisions/index.htm>
- <sup>84</sup> Community Affairs References Committee. (2011). The social and economic impact of rural wind farms. Retrieved from [http://www.aph.gov.au/senate/committee/clac\\_ctte/impact\\_rural\\_wind\\_farms/index.htm](http://www.aph.gov.au/senate/committee/clac_ctte/impact_rural_wind_farms/index.htm)
- <sup>85</sup> Chatham-Kent Public Health Unit. (2008), The health impact of wind turbines: A review of the current white, grey, and published literature. Chatham, Ontario, Canada: Chatham-Kent Municipal Council. Retrieved from <http://www.wind-works.org/LargeTurbines/Health%20and%20Wind%20by%20C-K%20Health%20Unit.pdf>
- <sup>86</sup> Colby, W. D., Dobie, R., Leventhall, G., Lipscomb, D. M., McCunney, R. J., Seilo, M. T., & Søndergaard, B. (2009). Wind turbine sound and health effects: An expert panel review 2009. Prepared for American Wind Energy Association and Canadian Wind Energy Association. Retrieved from [http://www.canwea.ca/pdf/talkwind/Wind\\_Turbine\\_Sound\\_and\\_Health\\_Effects.pdf](http://www.canwea.ca/pdf/talkwind/Wind_Turbine_Sound_and_Health_Effects.pdf)
- <sup>87</sup> Chief Medical Officer of Health. (2010, May). Report: The potential health impact of wind turbines. Retrieved from [http://www.health.gov.on.ca/en/public/publications/ministry\\_reports/wind\\_turbine/wind\\_turbine.pdf](http://www.health.gov.on.ca/en/public/publications/ministry_reports/wind_turbine/wind_turbine.pdf)
- <sup>88</sup> National Health and Medical Research Council. (2010a). Wind turbines and health a rapid review of the evidence. Retrieved from <http://www.nhmrc.gov.au/publications/synopses/new0048.htm>

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