

# Wind turbine facilities in Prince Edward County : current thinking on renewable energy – 29 September 2009.

*Abstract: The public in most energy-consuming Western countries, and Canada in particular, is subjected daily to a mediatic and political plethora of details surrounding 'global warming', 'greenhouse gas emissions' and 'alternative energy sources'. Conservation appears to have taken a back seat to costly technological innovation. At the local level in Prince Edward County, great interest is being shown in potential development of wind turbine facilities as 'alternative' electrical energy sources. Lobbying by various industries, groups and individuals knows no bounds. Scientific inquiry is being stifled if it questions various assumptions. This has lead to misinformation and disinformation being presented as factual.*

I make no apologies for having spent an academic and professional career, now spanning half a century, in applying pure mathematics to the more pragmatic subject of fluid dynamics in fields that varied from aeronautical to oceanographic. During a period of post-doctoral research that involved the capture of ocean tidal energy, I grew an awareness of environmental concerns that I retain to this day; again I make no apologies for my philosophical approach. However, I am a scientist; I believe in logic; and I am – perhaps extremely – concerned by today's public attitude towards scientific method, thinking and theory, and the opinions and potentially untenable conclusions that are extrapolated by industry lobbyists, politicians and the media.

As Bertrand Russell once wrote: "*The fact that an opinion has been widely held is no evidence that it is not utterly absurd.*"

## 1. Background

Prince Edward County has a unique position in Ontario as far as electrical generation by wind driven industrial turbines is concerned. Available statistics for the North shoreline of Lake Ontario demonstrate more favourable numbers in wind strength and frequency than many other locations. Vacant land that is not wholly suitable for traditional agricultural purposes is potentially available for sale or lease. The relative proximity to the 500Kv grid along the 401 corridor minimizes line loss and capital expenditure.

Prince Edward County also has a unique position in other aspects; tourism and retirement homes, culture and recreation, lack (with few exceptions) of industrial infrastructure leading to a sense of rural quiet and green beauty, a shoreline that is unique in the Great Lakes region, a potentially sensitive environment for certain fauna and avian migration paths, and a non-negligible density of rural residential properties that challenges the siting of major industrial implantations. If offshore wind turbine facilities are envisaged, the County's proximity to the U.S. border and the density of submerged archaeological sites must also be considered.

Over the last several years, two projected developments – one in Hillier, the other at Point Petre – have languished, in great part due to community opposition. New projects are being proposed. "Green" versus "nimby" rhetoric is increasing with a mix of fact and fiction, alleged truth and blatant falsity that perplexes the vast majority of County residents and has led, *inter alia*, to a number of discussions, delegations and letters to editors – all well meaning but often demonstrating an inherent lack of understanding.

It is incumbent upon our community to look to leadership to avoid disruptive divisiveness and to safeguard our assets for future generations. This paper looks into some of the details.

## 2. Overview

### a. World

It was in 1973 that 'climate change' really hit the world headlines. The previous year, a working conference of top European and American researchers was convened by geologists George Kukla of the Czechoslovakian Academy of Sciences and of the Lamont-Doherty Geological Observatory, and Robert Matthews of Brown University to discuss "The Present Interglacial, How and When Will it End?"<sup>1</sup>. They summarized their results in a *Science* report in October 1972 and then wrote to US President Nixon in December 1972 with the main conclusion of the study and a call for action at the national level:

*"... a global deterioration of climate, by order of magnitude larger than any hitherto experienced by civilized mankind, is a very real possibility and indeed may be due very soon."*

By 1974, *Time*<sup>2</sup> was reporting in its science section that "a growing number of scientists", reviewing "the bizarre and unpredictable weather pattern of the last several years" were positing "a global climatic upheaval". In 1975, *Newsweek*<sup>3</sup> quoted a report by the US National Academy of Sciences that "a major climatic change would force economic and social adjustments on a worldwide scale".

These dramatic announcements, barely thirty years ago were announcing cooling and the possibility of a new Ice Age – not warming. It was not until 1991 that Professor Aaron Wildavsky of the University of California, Berkeley, described global warming as "the mother of all environmental scares"<sup>4</sup>.

Over the historical span of mankind, thus ignoring the four major glaciations of the Pleistocene period, it should be noted that we have been, and are, living in an interglacial warming for the last 18,000 years, starting with a melting of ice caps and a 300 feet raising of sea levels that separated Asia from Alaska some 8,000 years ago and Great Britain from Europe around 6,000 years ago. This period has been characterized by a series of more minor, but very real, variations. Earth was at its hottest in the Holocene Maximum, some 7000 to 3000 BCE, dropping sharply during the Pre-Roman Cold of 700-400 BCE, then the Roman Warming of 200 BCE to the sixth century AD (which led to vineyards in northern Europe and possibly equals the warmest period that the world has ever known<sup>5</sup>). The Dark Ages were cold, but led to the Medieval Warming of roughly 900-1300 AD which led into the Little Ice Age reaching its maximum cold in the second half of the sixteenth century and continuing until the early nineteenth century when warming started again. A new reversal in the early twentieth century led to the 1923 headline<sup>6</sup> "Scientist says Arctic ice will wipe out Canada", but warming started again in the inter-war years. 1940 started the Little Cooling which lasted – as mentioned above – into the 1970s.

The concept of the 'greenhouse effect' was first posited early in the nineteenth century by Joseph Fourier, and developed by a number of most respectable researchers. By the time early automobiles appeared it was accepted that a certain number of 'greenhouse gases' (GHGs) stabilized the average world surface temperature at around 15°C rather than an unlivable minus 19°C without them. Of these GHGs, water vapour is the most important contributor, accounting for 95% of the greenhouse effect, carbon dioxide (CO<sub>2</sub>) is second in importance at 3.6% followed by nitrous oxide, methane and other gases all at less than one percent, many at trace level.

To put CO<sub>2</sub> into context, it must be understood that it is a naturally occurring gas without which all known life on earth would cease to exist – the animal kingdom uses oxygen as a fuel and emits CO<sub>2</sub> as a by-

1 Robert W. Reeves, Daphne Gemmill, Robert E. Livezey, and James Laver, U.S. National Oceanic and Atmospheric Administration, National Weather Service

2 Time, 24 June 1974

3 Newsweek, 28 April 1975

4 Lindzen, Richard, "Global Warming: The Origin and Nature of the Alleged Scientific Consensus", Cato Institute, Vol 15, 1992 <<http://www.cato.org/pubs/regulation/regv15n2/reg15n2g.html>>

5 Lamb, Hubert, "Climate, History and the Modern World", 1977, 2<sup>nd</sup> edition 1995

6 Chicago Tribune, 9 August 1923, quoting Professor Gregory of Yale University predicting that North America would disappear under ice as far south as the Great Lakes and that huge parts of Europe and Asia would be 'wiped out.'

product, the plant kingdom uses CO<sub>2</sub> as fuel and emits oxygen as a by-product. Approximately 200 billion tonnes of CO<sub>2</sub> are released into the earth's atmosphere annually, of which half is from oceanic biological sources, and nearly half from other natural sources (volcanoes, plant decay, etc). Anthropogenic<sup>7</sup> CO<sub>2</sub> emissions account for some six billion tonnes (3% of the total) and are increasing due in part to population growth and in part through growing energy consumption to improve (particularly for less developed nations) quality of life as we have come to expect it. Mathematically however, given anthropological CO<sub>2</sub> at 3% of total CO<sub>2</sub> which itself has a potential of 9%<sup>8</sup> of the greenhouse effect, man-made carbon dioxide only accounts for less than 1% of the total greenhouse potential.<sup>9</sup>

The role of the Intergovernmental Panel on Climate Change (IPCC) - a body tasked to evaluate the risk of climate change caused by human activity - must be considered. The panel was established in 1988 under the aegis of the United Nations. The IPCC has published a number of reports, arguably the most important of which was the Fourth Assessment Report (AR4) in early 2007; the next is due in 2014. The IPCC does not carry out scientific research itself, but relies on commissioned and published papers. While much of the content of AR4 meets high standards, it must be remembered that this content is now three or more years old, and that scientific criticism based on more recent, peer-reviewed research is mounting.

The most worrisome aspect of the IPCC's AR4 is, however, the fact that it has polarized the public together with the media, politicians and industry, to the point where reasonable scientific debate (and the granting of research funding) becomes problematic. Those involved in debate at all levels are arbitrarily labeled as "deniers" or "believers in the gospel truth"; climate change has become a quasi-religion

### **b. Canada**

Geographically the second largest nation in the world, we have some excuses for a high per capita energy consumption – greater travel distances and a relatively cold environment. Despite localized pockets of heavy industry, we are relatively "green" with extended areas of prairie, forest and tundra and with above average fresh water resources. Canada's rank in the world of per capita electricity consumption is fourth, behind Iceland, Norway and Finland.<sup>10</sup>

In 2007,<sup>11</sup> hydro generation accounted for 59% of electric power and is the largest source. Nuclear energy provided about 14% of total Canadian electricity production (in Ontario, nuclear power accounted for more than 53% of total electricity generation.) Electricity generated using fossil fuels accounted for 26%. Although electricity generation from wind, solar and tidal sources is rising, total generation from these sources represented less than 0.5% of total generation.

Canadian demand for electricity saw an overall increase of 3.2% to 592,161 GW.h in 2007. Residential use increased 7.6% to 158,576 GW.h from 147,330 GW.h in 2007. For each of the 8,896,800 census families in Canada, this shows an average annual consumption of 17.8 MW.h; in more practical terms, each family uses two kilowatts of power every hour of the day and night, year round.

### **c. Prince Edward County**

The County relies on importing its electrical energy from Ontario public utilities.<sup>12</sup> Despite a lack of published statistics at regional level, there is no reason to believe that the County uses more electrical energy than the national average, and probably a little less given its rural character and low penetration by heavy

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7 man-made

8 T. Kiehl and Kevin E. Trenberth, National Center for Atmospheric Research, Boulder, Colorado; "Clear sky". 9% - 26% but deducting albedo and aerosol effects. See also: Lindzen, R.S. and Y.-S. Choi, 2009: On the determination of climate feedbacks from ERBE data, accepted Geophys. Res. Ltrs.

9 It must be noted that other anthropogenic emissions (nitrous compounds, CFCs, etc) also play a role in the greenhouse effect, probably doubling that of CO<sub>2</sub>. It is however generally accepted that these will prove less difficult to control through technology and regulation.

10 [http://en.wikipedia.org/wiki/List\\_of\\_countries\\_by\\_electricity\\_consumption](http://en.wikipedia.org/wiki/List_of_countries_by_electricity_consumption). Other statistics suggest Canada might lead Finland into third place.

11 Latest year available: Statistics Canada catalogue no. 57-003-X "Report on Energy Supply and Demand in Canada," [http://dsp-psd.pwgsc.gc.ca/collection\\_2009/statcan/57-003-X/57-003-x2007000-eng.pdf](http://dsp-psd.pwgsc.gc.ca/collection_2009/statcan/57-003-X/57-003-x2007000-eng.pdf)

12 The usage of solar panels, stand-by generators, etc. is statistically insignificant.

industry. The County probably therefore consumes no more than 350 GW.h per year, of which 125 GW.h is for residential use.

In early 2009, the Ontario Power Authority awarded 20-year contracts for six new, large-scale wind power projects, one in the County.<sup>13</sup> The OPA claimed that they

“will help create about 2,200 new jobs in Ontario, will create 492 megawatts of new renewable generation and enough electricity for more than 120,000 homes and will result in about \$3 million in annual lease payments to hundreds of landowners hosting wind turbines and about \$1 million in annual municipal tax revenues. The six projects are expected to be in service by the end of 2012.”

The County project, named Bryan, is a nominal 64.5 MW wind farm being developed by SkyPower Corporation on 5,220 hectares of private land. The numbers, at the ratio of 492 to 64.5, suggest that the County project will proportionally create 290 new jobs (the developers, SkyPower Corp state: “Bryan Wind Project is expected to create approximately 100 construction jobs and 8 highly skilled, full-time operations and maintenance jobs”)

The numbers also suggest that the turbines will produce about \$131,000 municipal tax revenues – this is an increase of just over \$25 per hectare of “private” land. However, this may not be possible through rezoning; additionally adjoining properties may lose value. MPAC appear to be ambivalent about how they may proceed. In all eventualities, it is certain that the PEC municipality will set the “property tax rate” (previously the mil rate) at a level sufficient to cover projected budgetary expenditure – this will inevitably lead to all County tax payers making up for losses experienced in and around industrial wind turbine facilities.

In fact, the 550 meter setback proposed<sup>14</sup> by Regulation under Bill 150 (Green Energy Act, 2009) defines an area of 95 hectares or 235 acres. Placing a turbine less than 550 meters from a property boundary leads inevitably to a neighbour’s loss of the right to build residentially. Taking a more cautious approach of potential increase in health hazards and loss of property value at 1500 meters (half the California setback<sup>15</sup> and a widely accepted number that we have proposed in appendix 1) the 43 turbines potentially affect 30,400 hectares – nearly one third of the total area of Prince Edward County<sup>16</sup>.

Concerning the phrase “enough electricity” for a certain number of homes, the Ontario government’s arms-length Independent Electricity System Operator (IESO) has stated that “for capacity planning purposes, wind generation has a dependable capacity contribution of 10 per cent of the listed installed capacity of the project”<sup>17</sup>. On this basis, the Bryan project would supply 3,174 homes (17.8MWh for each census family; see above), and not the 18,060 homes suggested by SkyPower in stating that “1 MW of wind energy is sufficient to service approximately 280 homes”<sup>18</sup> or even “will provide sufficient energy to service approximately 16,000 homes.”<sup>19</sup>

### 3. Various points of relevance

Costs: we would refer to our previous paper “Policy Comments” available at <[http://www.aandc.org/research/wind\\_pec\\_present.html](http://www.aandc.org/research/wind_pec_present.html)>; this paper was presented to PEC Council in 2002, but

13 Three projects are located in Chatham-Kent and one each in Essex, Prince Edward County and Thunder Bay.

[http://www.powerauthority.on.ca/Storage/97/9300\\_OPA\\_Annual\\_Report2008FINALfor\\_postingMay5\\_09\\_rev.pdf](http://www.powerauthority.on.ca/Storage/97/9300_OPA_Annual_Report2008FINALfor_postingMay5_09_rev.pdf)

14 [http://ogov.newswire.ca/ontario/GONE/2009/06/09/c4695.html?lmatch=&lang=\\_e.html](http://ogov.newswire.ca/ontario/GONE/2009/06/09/c4695.html?lmatch=&lang=_e.html). “Wind turbines would not be permitted less than 550 metres from the nearest dwelling”.

15 [http://www.rcip.org/documents/general\\_plan/gen\\_plan/03\\_d\\_16.pdf](http://www.rcip.org/documents/general_plan/gen_plan/03_d_16.pdf), para LU 15.9

16 PEC has an area of 1,050 square kilometers or 105,000 hectares. The “Bryan” project appears to widely space the proposed installation sites.

17 Reported in Hansard at <http://hansardindex.ontla.on.ca/hansardeissue/38-2/l057a.htm>. See also The Ontario Reliability Outlook (ORO) published by the Independent Electricity System Operator (IESO) as [ont\\_reliability\\_report-2007-2-2.pdf](http://ont_reliability_report-2007-2-2.pdf)

18 <http://www.skypower.com/SKYPOWER2008/BYRAN/faq.html#A2>

19 <http://www.skypower.com/SKYPOWER2008/BYRAN/faq.html#A5>

remains valid.

## ***Health***

We would refer to “Deputation to the Standing Committee on General Government Regarding Bill C-150”.<sup>20</sup> Dr McMurtry has accurately covered the current status of potential health hazards.

Additionally, a communication from two paediatricians to the author is relevant regarding potential cardiac deformation with specific reference to children:

*We have gathered a number of references, all current within the last 10 years, from acoustical studies of wind turbines, studies from medical journals and journals of environmental health documenting negative impacts of noise that are characteristic of noise emissions from wind turbines and even a few small studies around wind farms in Europe. We also have some basic clinical research studies documenting endocrinological effects of offending noise in children and adults which represent the early pathophysiology leading to the documented increased incidence of ischemic heart disease and other cardiovascular complications and potentially even more far reaching implications in children.*

*Sincerely,*

*A\*\*\*\*\* Jr. M.D.*

*J\*\*\*\*\*, M.D.*

We have respected a requested degree of anonymity pending peer review of their findings.

## ***Medium to long term***

Developers and Hydro One: grid connection is one of the “best kept secrets” in costing wind energy. Hydro One is obliged to accept developers’ output at artificial price levels, supply the grid infrastructure (which will be billed to users) and have not yet publicly announced the associated costs while simultaneously requesting, *inter alia*, to “meet the requirements of the *Green Energy and Green Economy Act, 2009*”, an increase of nearly 25% over two years<sup>21</sup>. Studies in other countries show that Hydro One’s involvement will be at least equal to the developers’ costs.

Official Plan of PEC: this has been fairly constant over at least the last 35 years and clearly indicates preservation of the countryside with a tendency towards encouraging development within the townships. It can be argued that quasi-industrialization of a major portion of agricultural and light-density residential lands appears nowhere.

## ***Draft Bylaw***

On 21 October 2008, we proposed a draft by-law to the Municipality for consideration (attached as appendix 1). In the covering letter we stated:

In the interests of tax payers as far as their health, finances and quality of life are concerned, as well as financial liability that could potentially threaten the Municipality, I would ask you to look through the attached draft document.

Relevant points are:

- this does **not** prevent the installation of wind powered electrical generating facilities in the County

20 <<http://www.wind-watch.org/documents/>>

21 [http://www.hydroonenetworks.com/en/regulatory/2010-11\\_distribution\\_rate\\_application/Dx\\_Rate\\_Filing/A-03-01\\_Summary\\_of\\_Application.pdf](http://www.hydroonenetworks.com/en/regulatory/2010-11_distribution_rate_application/Dx_Rate_Filing/A-03-01_Summary_of_Application.pdf). “approximately 9.7% in 2010 and approximately 13.3% in 2011 on the distribution portion of the average customer total bill” cumulates to 24.3%

- it reflects many concerns expressed both locally and worldwide by local residents and concerned professionals
- it guarantees that certain statements made by developers (road works, sound levels, flicker effect, radio and TV reception, health issues, decommissioning, etc) are backed up by financial bond
- it openly encourages developers to pre-negotiate potential mitigation requirements with affected neighbours and obliges such agreements to be recorded; this principle is designed to cover property values
- the remedy to non-compliance would be shutting down the turbine[s] in question and it would to a limited extent increase the cost of development. However, this should be accepted by developers as an integral part of doing business in an ethical and transparent manner

#### 4. Conclusion: Anarchy or . . .

In May 2007 Forbes magazine editor-in-chief Steve Forbes wrote "the issue of global warming has indeed reached religious proportions. Even though the science determining whether carbon dioxide is fundamentally changing weather patterns is at best mixed, our political and cultural elite say it is so. They turn on anyone who dares question this orthodoxy with a ferocity that would do the perpetrators of the Salem witch trials proud".

Passing laws such as the Green Energy Act that remove the democratic rights from citizens and shift the burden of proof from the proponents to its opponents is regressive.

The proposed arrival of industrial turbines in Prince Edward County is not a prudent investment for taxpayers, nor is it either an economically or environmentally viable option. Contrary to claims made by proponents of wind power, it will not be an engine of economic revitalization and job creation for the area – in fact the reverse is much more likely. Construction of wind facilities, despite potentially enormous provincial and federal subsidies, will inevitable lead to a higher cost of living, a lower quality of life and a most probable reversal of positive trends already apparent in our local economy.

Respectfully submitted

## **Appendix 1: Draft proposal – Rev 2 (23 September 2008)**

# **Wind-powered electrical generating facility By-law for Prince Edward County**

**Purpose:** to provide a regulatory structure for the construction and operation of Wind Energy Facilities in Prince Edward County, subject to reasonable restrictions designed to preserve public health and safety and establish a financial, liability and remedial framework.

**Definitions:** As used in this By-law, the following terms have the meanings indicated:

- **Affected Property:** Property impacted by Wind Turbine.
- **Applicant:** The person or entity filing an application under this By-law.
- **Wind Turbine:** A wind energy conversion system which converts wind energy into electricity through the use of a wind driven turbine generator when the total height exceeds 150 feet or the nameplate capacity exceeds 100 kilowatts. Such wind turbine includes the turbine, blade, tower, base and pad transformer, if any.
- **Committee:** The Planning Committee of the Municipality or any successor committee established by the Municipal Council for the oversight and supervision of Prince Edward County Official Plan, Planning.
- **County, Municipality:** Prince Edward County.
- **Developer:** The person or entity requesting a Wind Energy Facility Site Permit or Wind Turbine Permit and/or responsible for the design and/or construction of a Wind Energy Facility
- **Hub Height:** The distance measured from ground level to the center of the turbine hub.
- **Anemometer tower:** A meteorological tower used for the measurement of wind speed.
- **Owner/Operator:** The person or entity responsible for the day-to-day operation and maintenance of a wind turbine or Wind Energy Facility. This definition includes, as required, the developer if an owner/operator is not distinctly identified.
- **Total Height:** The distance measured from ground level to the blade of a wind turbine extended at its highest point.
- **Shadow Flicker:** The moving shadows or light gradient areas which are cast by rotating turbine blades.
- **Wind Energy Facility:** An electricity generating facility consisting of one or more Wind Turbines under common ownership or operating control, and includes substations, anemometer towers, cables/wires and other buildings accessory to such facility, whose main purpose is to supply electricity to off-site customer(s).
- **Wind Energy Facility Site Permit or Wind Turbine Permit:** A construction and operating permit granted in accordance with the provisions of this By-law.

### **General Requirements for Wind Energy Facilities:**

1. Wind Turbines shall be painted a non-reflective, non-obtrusive color which shall be pre-approved through the permit issuing process.
2. At Wind Energy Facility sites, the design of the buildings and related structures shall, to the extent reasonably possible, use materials, colors, textures, screening and landscaping that will blend the Wind Energy Facility to the natural setting and environment at pre-construction time.
3. Wind Energy Facilities shall not be artificially lighted, except to the extent required by the Department of Transport (Aviation) or other applicable authority.
4. Wind Turbines shall not be used for displaying any advertising except for reasonable identification of the manufacturer or operator of the Wind Energy Facility. Any such identification shall not appear on the

- blades or other moving parts or exceed one square meter per Wind Turbine.
5. Electrical controls and control wiring and power-lines shall be wireless or not above ground except where wind farm collector wiring is brought together for connection to the transmission or distribution network, adjacent to that network.
  6. Public roads to be used during the construction phase shall be documented by the Owner/Operator, and reviewed and approved by the Prince Edward County Public Works Department prior to construction. At the Committee's request a qualified independent third party, agreed to by the applicable entity(s), and paid for by the applicant, shall be hired to pre-inspect the roadways to be used during construction and an appropriate bond amount set. The public travel route will be re-inspected 30 days after project completion; any and all repairs will be completed within 90 days of end of construction project and paid by the developer. The bond can be used by Prince Edward County for any degradation or damage caused by heavy machinery associated with the construction and demolition phases of a Wind Energy Facility.
  7. An appropriate continuous renewal bond amount shall be set for each Wind Turbine for decommissioning should the Owner/Operator fail to comply with the By-law requirements or the Wind Turbine does not operate for a period of twelve (12) consecutive months.
  8. A statement shall be signed by the landowner acknowledging that the landowner is financially responsible if the owner/operator fails to reclaim the site as required and that any removal and reclamation costs incurred by the County will become a lien on the property and may be collected from the landowner in the same manner as property taxes.
  9. Proof of continuous liability insurance in the minimum amount of five million dollars per occurrence shall be submitted to Prince Edward County indicating coverage for potential damages or injury to landowners, occupants, or other third parties.
  10. There shall be a schedule set prior to the construction phase of the project with a starting and ending date when the construction project will be completed.
  11. Evidence of compliance with any/all Federal and Provincial requirements shall be submitted by the Applicant to Prince Edward County.
  12. A map shall be provided showing a proposed grid of any future Wind Energy Facilities being envisaged by the applicant to be located in Prince Edward County and surrounding counties.
  13. A document for each Wind Turbine including an accompanying diagram or maps showing the shadow flicker projection for a calendar year, in relation to affected property, roads and residences shall be submitted with the permit application.
  14. Access to a Wind Energy Facility and construction area shall be constructed and maintained following a detailed Erosion Control Plan in a manner designed to control erosion and provide maneuverability for service and emergency response vehicles.
  15. If a Wind Turbine foundation is proposed in a bedrock area, a baseline of all wells and public potable water infrastructure in a one kilometer radius shall be established and permanent remedies shall be the responsibility of the developer if contamination occurs.
  16. If an area where Wind Turbines are planned is identified as having a significant population of avian endangered species a monopole tubular type tower shall be used instead of lattice type structure.
  17. Setbacks: The following setbacks and separation requirements shall apply to Wind Turbines:
    - i. Public Roads: Each Wind Turbine shall be set back from the nearest public road and its right of way a distance no less than two (2) times its Total Height.
    - ii. Wind Turbine spacing: Each Wind Turbine shall have a separation distance from other Wind Turbines equal to one and two-tenths (1.2) times the total height of the tallest Wind Turbine.
    - iii. Communication and electrical lines: Each Wind Turbine shall be set back from the nearest above-ground public electric power line or telephone line a distance no less than two (2) times its Total Height.
    - iv. Inhabited structures: Each Wind Turbine shall be set back from the nearest structure used as a residence, school, hospital, church, place of employment or public library, a distance no less than fifteen hundred (1500) meters, unless mitigation has taken place and agreed by owner/operator and affected property owners involved and recorded in the Prince Edward County Land Registry which describes the benefited and burdened properties and which advises all subsequent owners of the burdened property.

- v. Property lines: Each Wind Turbine shall be set back from the nearest property line a distance no less than one thousand (1000) meters, unless mitigation has taken place and agreed by owner/operator and affected property owners involved, and recorded in the Prince Edward County Land Registry which describes the benefited and burdened properties and which advises all subsequent owners of the burdened property.
  - vi. From any wetland, water body, environmental significant or scenic area, each Wind Turbine total height shall have a minimum setback of two (2) times its total height or five hundred (500) meters which ever is greater.
  - vii. From any historical, cultural and archaeological resource area, each Wind Turbine shall have a minimum setback of two (2) times its Total Height or five hundred (500) meters which ever is greater.
  - viii. Any new proposed residences, schools, hospitals, churches, public libraries, or place of employment, shall apply for a conditional use permit if they are to be located in the required set back area stated in section 17 (iv.) Inhabited structures.
  - ix. Unless owned by the applicant, no parcel of real estate shall be subject to shadow flicker from a Wind Turbine unless mitigation has taken place and agreed by the owner/operator and affected property owners involved and recorded in the Prince Edward County Land Registry which describes the benefited and burdened properties and which advises all subsequent owners of the burdened property that shadow flicker may exist at times on or at the burdened property.
  - x. There shall be a three (3) kilometer Setback from any recognized [federal/provincial] Park Wildlife Refuge located in Prince Edward County.
18. Noise: Audible Sound (Audible Noise) emitted during the operation of any Wind Energy Facility or individual Wind Turbine is limited to the standards set forth in this provision. [Testing procedures are provided in Appendix A of this By-law.]
- i. Audible Noise due to Wind Energy Facility or Wind Turbine operations shall not exceed the lesser of five (5) decibels (dBA) increase over the existing background noise level (L90) or exceed forty (40) decibels (dBA) for any period of time, when measured at any structure used as a residence, school, hospital, church, place of employment, or public library existing on the date of approval of any Wind Energy Facility Permit or Wind Turbine Permit. All measurements shall be taken using procedures meeting American National Standard Institute Standards including: ANSI S12.18-1994 (R 2004) American National Standard Procedures for Outdoor Measurement of Sound Pressure Level, and (ANSI) S12.9-Parts 1-5:
    - Part 1: American National Standard Quantities and Procedures for Description and Measurement of Environmental Sound
    - Part 2: Measurement of Long-Term, Wide-Area Sound
    - Part 3: Short-Term Measurements with an Observer Present
    - Part 4: Noise Assessment and Prediction of Long-Term Community Response
    - Part 5: Sound Level Descriptors for Determination of Compatible Land UseMeasurements must be taken with qualified acoustical testing instruments meeting ANSI Type 1 standards, and Class 1 filters. The windscreens recommended by the instrument's manufacturer must be used and measurements conducted only when wind speeds are fifteen (15) kilometers per hour (kph) or less. The microphone must be located at a height of one and two-tenths (1.2) to one and one-half (1.5) meters from the ground.
  - ii. In the event Audible Noise due to Wind Energy Facility or Wind Turbine operations contains a steady Pure Tone, including, but not limited to, a whine, screech, or hum, the standards for audible noise set forth in subparagraph (a) of this subsection shall be reduced by five (5) dBA. A Pure Tone is defined to exist when the one-third (1/3) octave band sound pressure level in the band, including the tone, exceeds the arithmetic average of the sound pressure levels on the two (2) contiguous one-third (1/3) octave bands by five (5) dBA for center frequencies of five hundred (500) Hz and above, and eight (8) dBA for center frequencies between one hundred sixty (160) Hz and four hundred (400) Hz, or by fifteen (15) dBA for center frequencies less than or equal to one hundred twenty-five (125) Hz.

- iii. In the event the Audible Noise due to Wind Energy Facility or Wind Turbine operations contains Repetitive Impulsive Sounds, the permitted sound pressure level for Audible Noise in 18(a) shall be reduced by five (5) dBA.
- iv. In the event the Audible Noise due to Wind Energy Facility or Wind Turbine operations contains both a Pure Tone and Repetitive Impulsive Sounds, the permitted sound pressure level for Audible Noise in 19(a) shall be reduced by seven (7) dBA.
- v. No low frequency sound or infrasound due to Wind Energy Facilities or Wind Turbine Operations shall be created which causes the sound pressure level at any existing residence, school, hospital, church, place of employment, or public library within a fifteen hundred (1500) meter radius from any Wind Turbine to exceed the following limits:

Band No.	1/3 Octave Band Center Frequency (HZ)	Limits for 1/3 Octave Bands	Limits for 1/1 Octave Bands
1	1.25 and below	65	
2	1.6	65	
3	2	65	70
4	2.5	65	
5	3.15	65	
6	4 65	70	
7	5	65	
8	6.3	65	
9	8	65	70
10	10	65	
11	12.5	61	
12	16	61	65
13	20	61	
14	25	60	
15	31.5	58	63
16	40	58	
17	50	58	
18	63	55	61
19	80	53	
20	100	52	
21	125	50	55

- vi. A Wind Energy Facility or Wind Turbine operation that emits sound or causes structural or human body vibration with strong low-frequency content where the time-average C-weighted sound level exceeds the A-weighted sound level by at least 20 dB when measured inside a structure and adversely affects the subjective habitability or use of any existing residence, school, hospital, church, place of employment, or public library or other sensitive noise receptor shall be deemed unsafe and shall be shut down immediately. Exceeding any of the limits in Table 18.e.1 shall also be evidence that the Wind Energy Facility or Wind Turbine operation is unsafe and shall be shut down immediately.
- vii. Prior to approval, developers of a Wind Turbine operation or Wind Energy Facility shall submit a pre-construction Background Noise Survey with measurements for each residence, school, hospital, church, place of employment, or public library within fifteen hundred (1500) meters of

- the proposed development. The Background Noise Survey shall be conducted in accordance with the procedures provided in Appendix A of this By-law, showing background sound levels (L90) and 1/1 or 1/3 octave band sound pressure levels (L90) during the quietest periods of the day and night over a reasonable period of time (not less than 10 minutes of sampling). The pre-construction Background Noise Survey shall be conducted at the Applicant's expense by an independent noise consultant contractor acceptable to the Prince Edward County Planning Department.
- viii. Prior to approval, developers of a Wind Energy Facility or Wind Turbine operation shall provide additional information regarding the make and model of the turbines, Sound Power Levels (LW) for each octave band from the Blade Passage Frequency up through 10,000 Hz, and a Sound Impact Study with results reported on a contour map projection showing the predicted sound pressure levels in each of those octave bands for all areas up to fifteen hundred (1500) meters from any Wind Turbine or Wind Energy Facility for the wind speed and direction that would result in the worst case Wind Energy Facility sound emissions. This Sound Impact Study may be made by a computer modeling, but shall include a description of the assumptions made in the model's construction and algorithms. If the model does not consider the effects of wind direction, geography of the terrain, and the effects of reinforcement from coherent sounds or tones from the turbines, these shall be identified and other means shall be used to adjust the model's output to account for these factors. The Sound Impact Study results shall be displayed as a contour map of the predicted levels, but shall also include a data table showing the predicted levels at any existing residence, school, hospital, church, public library, or place of employment within the model's boundaries. The predicted values shall include dBA values and shall also include the non-weighted octave band levels in the data tables. The Sound Impact Study shall be conducted at the Applicant's expense by an independent noise consultant contractor acceptable to the Prince Edward County Planning Department.
- ix. Operators of a Wind Energy Facility or Wind Turbine operation shall submit a post-construction Sound and Vibration Measurement Study conducted for each Wind Turbine or Wind Energy Facility according to the procedures provided in Appendix A of this By-law within twelve (12) months of the date that the project is fully operational to demonstrate compliance with the noise limitations in Section 18(a). The study shall be conducted at the wind energy facility owner/operator's expense by a noise consultant contractor acceptable to the Prince Edward County Planning Department.
- x. The Committee may impose a noise setback that exceeds the other setbacks set out in this By-law or require waivers from affected property owners and persons in legal possession acceptable to the Committee if it deems that greater setbacks are necessary to protect the public health and safety, or if the proposed wind energy facility is anticipated to exceed the levels set forth in Section 18(a) at any existing residence, school, hospital, church, place of employment, or public library.
- xi. Any noise level falling between two (2) whole decibels shall be deemed the higher of the two.
- xii. If the noise levels resulting from the Wind Turbine or Wind Energy Facility exceed the criteria listed above, a waiver to said levels may be granted by the Committee provided that express written consent from all affected property owners and persons in legal possession has been obtained stating that they are aware of the noise limitations imposed by this By-law, and that consent is granted to allow noise levels to exceed the maximum limits otherwise allowed. If the applicant wishes the waiver to apply to succeeding Owner/Operators of the property, either a permanent noise impact easement or easement for the life of the wind turbine shall be recorded in the Prince Edward County Land Registry which describes the benefited and burdened properties and which advises all subsequent owners of the burdened property that noise levels in excess of those permitted by this By-law may exist at the burdened property.
- xiii. A Noise Study may be conducted at the expense of a Wind Energy Facility or a Wind Turbine Owner/Operator by an independent noise consultant contractor acceptable to the Prince Edward County Planning Department if two (2) or more complaints are received and documented at a particular site. The study shall be conducted according to the procedures provided in Appendix A

of this By-law for any sites where the complaints were documented. The Operator shall reimburse the County for the Noise Study expense within ten (10) days of billing. Failing to reimburse may be a basis for revoking a permit.

19. Minimum Ground Clearance: The blade tip of a Wind Turbine shall, at its lowest point, have ground clearance of no less than twenty five (25) meters.
20. Signal Interference and Microwave Frequency Interference: The owner/operator shall minimize any interference with electromagnetic communications, such as radio, telephone or television signals caused by any Wind Energy Facility or Turbine.
  - i. A one thousand (1,000) feet microwave communication corridor between turbines must be maintained if the turbine facility is located between transmission towers.
  - ii. Communication tower – Wind turbine setback shall be at least fifteen hundred (1500) meter to prevent signal interference.
  - iii. Emergency communication towers will be located on a Geographical Information System (GIS) map so turbine facilities can be properly planned to avoid conflict with Prince Edward County Emergency Services.

### **Miscellaneous Safety Requirements** for Wind Turbines:

- a) All wiring between Wind Turbines and the Wind Energy Facility substation shall be underground.
- b) All neutral grounding connectors from Wind Turbines shall be insulated from the earth and shall be sized to accommodate at least twice the peak load of the highest phase conductor, to absolutely prevent transient ground currents, in order to comply with standards as follows:
  - Grounding of both the electrical transmission lines and the supply lines to the internal electrical systems of the turbines themselves, shall be so arranged that under normal circumstances, there will be no objectionable flow of current over the grounding conductor.
  - It is not permissible to use the earth as a part of a supply circuit.
  - Under no circumstances shall any Wind Turbine be connected directly to the grid; connection must be made through a substation or transformer properly grounded and filtered to keep harmonic distortion within recommended limits.
  - Bare, concentric neutrals are specifically prohibited in buried lines between turbines and in underground transmission lines to substations.
- c) Wind Turbine towers shall not be climbable up to five (5) meters above ground level.
- d) All access doors to Wind Turbine towers and electrical equipment shall be lockable and locked when unattended.
- e) Appropriate warning signage shall be placed on Wind Turbine towers, electrical equipment, and Wind Energy Facility entrances.

### **Fee Schedule:**

1. For permits: [To be established ]
2. For Bonds: The amount of the bond required will be based on the number of turbines and the estimated total cost to remove the Wind Turbine[s], associated equipment and infrastructure, including to a point three (3) feet below grade.

### **Validity:**

Should any section, clause or provision of this By-law be declared by the courts to be invalid, the same shall not affect the validity of the By-law as a whole or any part thereof, other than the part so declared.

# **Appendix A : Prince Edward County Measurement Protocol for Sound and Vibration Assessment of Proposed Wind Energy Conversion Systems**

## **Introduction:**

The potential sound and vibration impact associated with the operation of wind powered electric generators, including Wind Energy Facilities and Wind Turbine operations, is a primary concern for citizens living near proposed Wind Energy Conversion Systems (“WECS”). This is especially true of projects located near homes, residential neighborhoods, schools, hospitals, churches, places of employment and public libraries. Determining the likely sound and vibration impacts is a highly technical undertaking and requires a serious effort in order to collect reliable and meaningful data for both the public and decision makers.

The purpose is to first establish a consistent and scientifically sound procedure for estimating existing ambient (background) sound and vibration levels in a project area, and second to determine the likely impact that operation of a new wind energy conversion system project will have on the existing sound and vibration environment.

The characteristics of the proposed WECS project and the features of the surrounding environment will influence the design of the sound and vibration study. Site layout, types of wind energy conversion units (“WECU”) selected and the existence of the significant local sound and vibration sources and sensitive receptors shall be taken into consideration when designing a sound and vibration study. An independent, qualified consultant shall be required to conduct the sound and vibration study.

Note: Prince Edward County Planning Department Administration shall be consulted prior to conducting any sound and vibration measurements. These guidelines may be modified (with express written approval of the County Planning Department) to accommodate unique site characteristics. Consult with Planning Department staff assigned to the project for guidance on study design before beginning any sound and vibration study.

During consultation, good quality maps or diagrams of the site are necessary. Maps and diagrams shall show the proposed project area layout and boundaries<sup>22</sup>, and identify important landscape features as well as significant local sound and vibration sources and sensitive receptors including, but not limited to, a residence, school, hospital, church, place of employment, or public library.

## **Measurement of the Existing Sound and Vibration Environment**

An assessment of the proposed WECS project area’s existing sound and vibration environment is necessary to predict the likely impact resulting from a proposed project. The following guidelines shall be used in developing a reasonable estimate of an area’s existing sound and vibration environment. All testing shall be performed by an independent acoustical testing engineer approved by the Prince Edward County Planning Department. All measurements shall be conducted with industry certified testing equipment.<sup>23</sup> All test results shall be reported to the Prince Edward County Planning Department.

## **Pre-construction:**

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22 Project Boundary: A continuous line encompassing all WECU’s and related equipment associated with the WECS project.

23 The Prince Edward County Planning staff acknowledges that few sound level meters are capable of measurement of the 16 Hz center frequency octave band. However, because noise complaints from the public most likely involve low frequency noise associate with proposed WECS, we encourage applicants to pursue the collection of this important background noise data. If obtaining the 16 Hz data presents a problem contact Prince Edward County Planning staff prior to collection of any field ambient measurement data.

Sound level measurements shall be taken as follows:

1. At all properties within the proposed WECS project boundaries
2. At all properties within a one mile radius of the proposed WECS project boundaries.
3. One test must be performed during each season of the year.
  - i. a. Spring (March 15 – May 15)
  - ii. b. Summer (June 1 – September 1)
  - iii. c. Fall (September 15- November 15)
  - iv. d. Winter (December 1- March 1)
4. All measurement points (MPs) shall be located in consultation with the property owner(s) and such that no significant obstruction (building, trees, etc.) blocks sound and vibration from the site.
5. Duration of measurements shall be a minimum of ten continuous minutes for each criterion (See Item 9 below) at each location.
6. One set of measurements shall be taken during each of the following four periods:
  - i. a. Morning (6 - 8 a.m.)
  - ii. b. Midday (12 noon – 2 p.m.)
  - iii. c. Evening (6 – 8 p.m.)
  - iv. d. Night (10 p.m. – 12 midnight)
7. Sound level measurements must be made on a weekday of a non-holiday week.
8. Measurements must be taken at 6 feet above the ground and at least 15 feet from any reflective surface<sup>24</sup>.
9. For each MP and for each measurement period, provide each of the following measurement criteria:
  - i. a. Unweighted octave-band analysis (162, 31.5, 63, 125, 250, 500, 1K, 2K, 4K, and 8K Hz)
  - ii. b. Lave, L10, L50, and L90, in dBA
  - iii. c. Lave, L10, L50, and L90, in dBC
  - iv. d. A narrative description of any intermittent sounds registered during each measurement
  - v. e. Wind speed at time of measurement
  - vi. f. Wind direction at time of measurement
  - vii. g. Description of the weather conditions during the measurement
10. Provide a map and/or diagram clearly showing:
  - i. a. The layout of the project area, including topography, the project boundary lines, and property lines
  - ii. b. The locations of the MPs
  - iii. c. The minimum and maximum distance between any MPs
  - iv. d. The location of significant local sound and vibration sources
  - v. e. The distance between all MPs and significant local sound and vibration sources
  - vi. f. The location of all sensitive receptors including but not limited to, a residence, school, hospital, church, place of employment, or public library.

### **Sound Level Estimate for Proposed Wind Energy Conversion System:**

In order to estimate the sound and vibration impact of the proposed WECS project on the existing environment an estimate of the sound and vibration produced by the proposed WECU(s) must be provided.

1. The manufacturer's sound level characteristics for the proposed WECU(s) operating at full load. Include an unweighted octave-band (164, 31.5, 63, 125, 250, 500, 1K, 2K, 4K, and 8K Hz) analysis for the WECU(s) at full operation for distances of 250, 500, 750 and 1000 meters from the WECU(s).
2. Estimate the sound levels for the proposed WECU(s) in dBA and dBC at distances of 250, 500, 750 and 1000 meters from the WECU(s). For projects with multiple WECU's, the combined sound level impact for all WECU's operating at full load must be estimated.
3. Provide a contour map of the expected sound level from the new WECU(s), using 5dBA increments created by the proposed WECU(s) extending out to a distance of at least fifteen hundred (1500) meters
4. Determine the impact of the new sound and vibration source on the existing environment. For each MP

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<sup>24</sup> Environmental Noise Guidelines: Wind Farms. (ISBN 1 876562 43 9). February 2003. Environment Protection Authority, Adelaide SA.

- used in the ambient study (note the sensitive receptor MPs):
- i. Report expected changes to existing sound levels for Lave, L10, L50, and L90, in dBA
  - ii. Report expected changes to existing sound levels for Lave, L10, L50, and L90, in dBC
  - iii. Report all assumptions made in arriving at the estimate of impact and any conclusions reached regarding the potential effects on people living near the project area.
5. Include an estimate of the number of hours of operation expected from the proposed WECU(s) and under what conditions the WECU(s) would be expected to run.

### **Post-Construction Measurements:**

1. Within twelve months of the date when the project is fully operational, and within two weeks of the anniversary date of the Pre-construction ambient noise measurements, repeat the existing sound and vibration environment measurements taken before the project approval. Post-construction sound level measurements shall be taken both with all WECU running and generating power, and with all WECU off.
2. Report post-construction measurements to the Prince Edward County Planning Department (available for public review) using the same format as used for the pre-approval sound and vibration studies.

**Note:** This protocol is based in part on criteria published in the Standard Guide for Selection of Environmental Noise Measurements and Criteria.<sup>25</sup> and the Public Service Commission of Wisconsin publication Measurement Protocol for Sound and Vibration Assessment of Proposed and Existing Electric Power Plants (February 2002).<sup>26</sup> Canadian documents to comparable standards will replace non-Canadian sources as and when they are published.

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<sup>25</sup> Standard Guide for Selection of Environmental Noise Measurements and Criteria (Designation E 1686-96). July 1996. American Society for Testing and Measurements.

<sup>26</sup> Measurement Protocol for Sound and Vibration Assessment of Proposed and Existing Electric Power Plants. February 2002. Public Service Commission of Wisconsin.