Comments
Ontario Power Authority (OPA)
Discussion Papers # 4, # 5, # 6, # 7
Integrated Power System Plan (IPSP)

By
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These comments are provided after review of the Discussion Papers and after having participated in the Stakeholder Dialogue / Consultation Workshop on November 22 to 24 in Toronto:

Discussion Paper 4: Supply Resources (DP4)
Discussion Paper 5: Transmission (DP5)
Discussion Paper 6: Sustainability (DP6)
Discussion Paper 7: Integrating the Elements (DP7)

The comments are provided in one integrated document, due to the close relationship between the discussion papers. Where applicable attached reference documents are provided which provide supplemental information. At times comments will refer to the discussion presented at the Stakeholder Dialogue / Consultation Workshop where relevant, and where these comments might influence the final papers. Some of the comments go beyond the content of the Discussion Papers and relate to the Minister of Energy's Directive to the OPA, as a copy of these comments will also be routed to the Minister.

Summary Comments:

The Minister of Energy's Directive has severely limited the scope of the energy professionals at OPA to identify an integrated supply that is optimal for Ontario. The Ministry directive calls for the IPSP to:

- Increase the installed capacity of new renewable resources by 2,700 MW from the 2003 base by 2010, and increase the total capacity of renewable sources to 15,700 MW *(from about 8073 MW – or by about 7627 MW)* by 2025
- Plan for coal-fired generation *(6434 MW, operating at about 55% capacity factor)* in Ontario to be replaced by cleaner sources in the earliest possible time frame that ensures adequate generating capacity and electric system reliability in Ontario.
- Reduce Peak Load through conservation 6,300 MW by 2025 *(including fuel switching, customer based generation of 10 MW or less, small-scale natural gas co-generation, and generation encouraged by net metering)*
- Plan for nuclear to meet baseload electricity requirements but limit in-service nuclear power to no more than 14,000 MW *(an increase of no more than about 1100 MW from current committed generation – only coming back to the nuclear generation existing in Ontario in 1990 – even though baseload in Ontario will have increased considerably from 1990 to 2025 even with conservation demand management)*
- Use natural gas at peak times and pursue applications that allow high-efficiency and high-value use of the fuel *(an increase in Natural Gas by about 6000 MW to about 11,000 MW by 2012 is proposed)*

There are a number of issues with the Minister's Directive that should be identified through the process of the IPSP:

- The Directive failed to adequately address the issue of "energy-use" in Ontario, and focused on the shifting of generating systems for electricity without addressing the optimum environmental and sustainable options. For example, encouraging "fuel shifting" only moves the impact from electricity to other sectors. To address sustainability and the environment requires looking at a wider picture than just electricity generation. As an example, encouraging natural gas as an electricity generating fuel is justified only if

one restricts the view to the actual burning the gas in the generating process. If one considers that in the Canadian Natural Gas industry "sour gas" (contaminated with sulphur) amounting to about 30% of the total production is typically flared, and that additional CO2 is stripped from the natural gas before is it transported across the country, one rapidly finds that the actual impact of shifting from coal to natural gas does not have nearly the desired impact on greenhouse gas emissions (and hence global warming) that is supposed considering only the generator.

- Because the Minister's Directive has not allowed for an increase in nuclear generation from 1990 levels there is no matching of the nuclear capability to increasing baseload that has occurred in the electrical grid between 1990 and 2025. Currently, overnight baseload of about 15,000 MW is being provided by round the clock operation of some coal and gas fired generation on top of all available nuclear and hydro generation. Not increasing nuclear generation with a corresponding restriction on coal use means that natural gas consumption will increase dramatically for base load as well as peak, and hence green house gas emissions will continue to increase.
- The Minister's directive to increase renewable resources rapidly, and significantly, has resulted in a rapid proliferation of wind generation projects without adequate directives to ensure public safety. The proponent driven environmental screening process has failed to result in setting adequate guidelines, and this has resulted in problems already with wind farms installed. There is an urgent necessity to ensure that the rush to implement the Minister's directive does not compromise public safety and health. Details of the issues of concern are identified in two attached documents:
    - Setbacks to Wind Turbines in Ontario – an Engineering Justification based on Public Safety Risk and Ontario Noise Regulations
    - Wind Turbines – The Issues, the Hype, the Truth, and Unresolved Questions

Specific Comments Related to Discussion Paper 4: Supply Resources

An overview reading of the Discussion Paper makes it clear that this paper which should provide a non-biased, balanced technical description of the supply options is obviously biased towards some technologies, speaking in glowing terms of their merits while diminishing their drawbacks, while for others, just the opposite treatment is given, focusing on drawbacks, while diminishing advantages. The most obvious difference is seen when comparing the descriptions for nuclear power to the description for wind generators.

When discussing the nuclear option, the issue of used nuclear fuel for power reactors in Ontario, Quebec, New Brunswick is listed. For no other option do we discuss the negative effects in other provinces, such as describing the amount of land flooded by hydraulic generation projects in Quebec. However, there is no discussion that the nuclear option uses the least land per MW considering fuel supply and plant output. Neither is there discussion that the nuclear option offers the ability of rehabilitating over 1000 MW of generation currently not planned at Pickering A, units that are built, licensed, and with staff available. OPG decided against rehabilitation of Pickering A Units 2 and 3 only because they were unable to enter an acceptable agreement with OPA, an option that would have offered sure power at a cost lower than wind, which cannot provide assurance of peak availability.

When discussing the wind option, the Helimax calculation of available resources provided high estimates by calculating wind availability in excess of 8 MW/km^2, without identifying that a wind collection density of this would require 20 x 1.65 MW turbines in a 2 km x 2 km typical "block" in southern Ontario to collect the 32 MW. Even close spacing the turbines on a 400 metre grid would place turbines within 200 – 300 metres of sideroads and houses on the block. It is inappropriate to use this sort of density of turbines in Southern Ontario where there are well established homes on farms, particularly when some landowners do not even want to be wind turbine leaseholders. Realistically, to achieve wind turbine installations which do not compromise public safety and health the attachment on Setbacks to wind Turbines in Ontario show that

setbacks of 2 times tower and blade height need to be established to lot lines and roads, and setbacks of 1000 metres to residences need to be established. Given these setbacks, in Southern Ontario, this allows a turbine density of only 3 or 4 in a "block" which would achieve a wind collection density of 1.25 to 1.65 MW per km^2 if using 1.65 MW turbines, even if all landowners in a block are participants. This would indicate that the total wind resource available to be collected in the OPA report should be reduced from some 8.2 GW to 1.3 to 1.7 GW. As a result the costs for a wind farm will also be improperly calculated in the OPA reports.

When discussing the contribution of wind to the Ontario peak, the example of August 1 is championed as an example of wind contributing over 50% of the available capacity during the Ontario peak, as if this was a typical contribution (Figure 3.9). This was an inappropriate example, as for example on the two days before, over peak hour, wind contributed about 6% of its capacity on July 31, and 5% on July 30. In the 100 days ending August 31, there were 49 days in which wind turbines contributed less than 10% of their capacity during the peak hour, and only 9 days when they contributed 50% or over. It is inappropriate to use a non representative example without referring to the actual truth of what actually occurs. This needs to be corrected, and the biases removed so that the OPA documents are an accurate representation of facts rather than a platform for any particular interest group.

Please refer to the attachment titled, "Wind Turbines – The Issues, the Hype, the Truth, and Unresolved Questions" for additional issues of concern related to the endorsement of wind turbines without adequate controls in pace to protect public safety and health. This attachment also discusses concerns related to the lack of information in the GE integration study for wind and the failure to adequately recognize the experience of Europe with integration of wind. Examples from the E.On-Netz (largest wind system operator in the world) are quoted below from in the attachment.

E.On-Netz identifies the following statements in their Wind Report 2005:

- "Traditional power stations with a capacity of 90% of the installed wind capacity must be permanently online in order to guarantee power supply."
- "Wind power feed-in can only be forecast to a limited degree. … The feed-in capacity can change frequently within a few hours. … Handling such significant differences in feed-in levels poses a major challenge to system operators."
- "As wind power capacity rises, the lower availability of the wind farms determines the reliability of the system as a whole to an ever increasing extent."
- "Even simple grid problems can lead to significant failure in wind power production. Large thermal power generators do not disconnect from the grid even following serious grid failures, and generally trip into auxiliary services supply and support the grid. Windfarms, however, have so far disconnected themselves from the grid even in the event of minor, brief voltage dips. Experience has shown this can lead to serious power failures."
- "On very windy days, normal operation of the transmission grid is sometimes no longer possible. Special switching measures are needed, in order to prevent wind power-induced grid overloads and consequently supply failures occurring."

Because of the significant proposed increase in natural gas consumption as part of the electrical generating system, the sensitivity to future natural gas prices is critical. The price forecasts shown in the OPA report (Figure 4.11) are not consistent with many private sector forecasts. The NRCan forecast notes the link between the Canadian Gas price and the US price, and recognizes that prices are closely linked to the crude oil price. The report then goes on to project a crude oil price of under $50 a barrel. That figure, as well as the projection for long term lowered natural gas prices are not shared by many industry or financial analysts, and some even perceive the low price projections to be a US government "wish" when simply trying to cling to power. Particularly since the OPA plan projects a significant increase in natural gas consumption, it is neither prudent nor proper to project low gas prices without at the minimum a sensitivity analysis for significant increases in prices.

It was stated at the OPA stakeholder session that the OPA plan was in part considered appropriate since it was considered that to meet summer peak, it would be using non-utilized pipeline capability. This view fails to recognize that in the summer the gas pipelines are still in use rebuilding storage stocks in Ontario, and significant increase in summer consumption still will impact winter storage capability and hence price. The gas price estimates in the OPA plan are a significant weakness and need more work.

I would echo the view stated by many speakers that the plan to significantly increase gas consumption is neither sustainable, nor economically wise.

The Conservation aspect of the plan is badly lacking. While there are targets for significant load reduction, questions asked at the workshop brought only the response that it was a significant and aggressive plan – without detail. Without details, I can only conclude that the plan is unformed, and this is a serious and unacceptable drawback of the OPA plan. It takes very little thought to consider that a significant contributor to the energy consumption in Ontario is water heating – typically the value quoted is 30% of the total energy cost of a home. Whether this energy is supplied by electricity or natural gas is not important. A significant incentive to encourage homeowners to install solar water heaters would have a dramatic reduction in total energy consumption in the summer – freeing electricity for use, and natural gas for electricity generation if in short supply. While this would not be an appropriate solution for all Ontario residents (for example it is of limited value for a high rise dweller with a northern exposure, the contribution of an aggressive program to install solar water heaters could have a dramatic effect on Ontario summer energy consumption, yet the fact is not even mentioned in the OPA report. Why not?

Specific Comments Related to Discussion Paper 5: Transmission

A significant short term need identified in the report is to enable additional transmission capability from the Bruce area to ensure a pathway to market for both 8 operating Bruce Units, and the potential of new nuclear unit build at the Bruce as well as potentially a large renewable wind generated resource. The options discussed include several options which will result in a significant risk to Bruce nuclear unit operation, both through installing capacitors for series compensation, and by installing two unit rejection. Any increase in risk to operation of nuclear units that can result in additional threats to power system availability must not be considered lightly. One has to significantly consider if the benefit to society from intermittent wind generation for which line “load space” has to be blocked is justified by the additional threat on Bruce nuclear unit stability. This is a public safety issue as well as an economic issue. Having been involved in the risk assessment for the Bruce Units 3 and 4 restart, I must identify professional concerns that any additional threat to power system stability would have to be addressed due to the public safety implications.

The transmission report needs a manner of developing a “value” assessment for the installation of new transmission facilities. For example, a 1000 MW capable corridor that serves a plant with an 80% capacity factor should have a different value than a similar 1000 MW corridor serving a plant with an annual capacity factor of 27% or so.

Recognizing the significant impact on transmission to the GTA of having generation nearer than distant, one must conclude that refurbishment of Pickering Nuclear Units 2 and 3 should have a high priority, since they are located close to the GTA, and offer considerable advantages than distant generation requiring new corridors for James Bay, for example.

Specific Comments Related to Discussion Paper 6: Sustainability

The Sustainability Paper does seem weak. While it includes a certain amount of background drivers, it fails to actually make any significant contribution to actually forwarding the principle of sustainability. Excuses given that the current structure makes it difficult now that the vertical bundling of Ontario Hydro have been broken are of little value.

There is an opportunity in the Sustainability paper to make a positive contribution towards driving conservation, Sadly it is absent. Similarly the ability to consider electrical generation as only one aspect of the energy usage in the province – which must all be considered in its entirety is absent. For example I found the thrust of the plan towards natural gas generation considering only the emission when the fuel was actually burned in the generator to be significantly flawed for a program that is supposed to consider sustainability. The fact that for every cubic foot of gas burned, producing its quantity of green house gases, has an almost similar quantity of green house gases produced when sour gas produced alongside the used gas is burned, and when carbon dioxide is stripped out at the "pipe line head end" is not even mentioned. Conservation is hardly mentioned, and then only without details to show that there actually is a program, and the discussion of carbon credits only is a recognition that as a society we are considering it our right as wealthy nations to continue to pollute while we pay poor nations to not develop.

Any attempt at sustainability would have to recognize that for our future to be sustainable we have t reduce our natural resource requirements such as natural gas, not to significantly increase them.

Specific Comments Related to Discussion Paper 7: Integrating the Elements

One of my most significant concerns with the integration plan is that the plan to meet the system demand shows the stacking of resources including wind as contributors to system peak. Now that the plan brings in non-dispatchable resources such as wind, it is essential that the contribution of wind NOT be included in the total system resource histogram, as there is no assurance that it will actually be available during system peak. The representation in Figure 1.2 and 1.3 which includes wind as part of the resource reaching towards system peak is a misrepresentation. It is appropriate to consider wind as a contributor to energy supply, but not to peak.

In the integration plan, I believe that the durations to establish transmission line corridors was underestimated.

The air emissions from Natural gas fired generation has been underestimated in the report as there should be a recognition that the emissions should include the total emission during the entire fuel production and use cycle. Doing so, one rapidly finds that substituting natural gas for coal has little impact on greenhouse gas emissions, but at a high coat and at a risk of rapidly depleting a scarce and valuable resource. See my earlier comments regarding sensitivity of natural gas prices for expected price increases too.

My earlier comments with respect to the availability of wind resources, also apply. The plan assumes wind resources are available at a density of in the order of 8 MW per km2. As pointed out earlier that figure is inappropriate in Southern Ontario where there are already existing houses and roads. The density of wind energy collection should not be more than 1.25 MW per km2 – even where all landowners agree, and where there are no restriction of location of turbines and access roads due to environmental hazards. For example in Denmark, the average wind energy density is in the order of 75 kW per km^2. It is inappropriate for us to consider a wind energy density of 8000 kW per km^2, or even a density of 1.25 kW per km^2 (the maximum possible). This will have implications on the availability of wind, and on the cost of this resource.

Should proper siting guidelines be developed as called for in the attachments, the wind energy density will be considerably less, and this will have impact on the integration plan.

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Attachments:

- Setbacks to Wind Turbines in Ontario – an Engineering Justification based on Public Safety Risk and Ontario Noise Regulations
- Wind Turbines – The Issues, the Hype, the Truth, and Unresolved Questions

Setbacks to Wind Turbines in Ontario

An Engineering Justification

Based on Public Safety Risk

and Ontario Noise Regulations

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Outline:

1. Summary
2. Background - Why This Work Was Necessary
3. Public Safety Risk
4. Ontario Noise Regulation
5. Conclusions
6. Qualification of the Justification
7. References

Appendices:

a. Extracts from Guidelines on the Environmental Risk of Wind Turbines in the Netherlands - H. Braam and L.W.M.M. Rademakers, ECN Wind Energy, Feb. 2004

b. Extracts from Permitting Setbacks for Wind Turbines and the Blade Throw Hazard Scott Larwood, California Wind Energy Collaborative, presented to 2004 Forum

c. Extracts from Ontario Ministry of the Environment "Interpretation Applying MOE NPC Technical Publications to Wind Turbine Generators"

d. Examples of Noise from Wind Turbine which would require (unavailable) masking.

1. Summary

The Environmental Screening report of the Enbridge Ontario Wind Project stated setbacks from wind turbines to lot lines, and from wind turbines to houses without adequate justification. As part of the public review of the Screening Report, formal questions were raised on May 4th and May 18th requesting Enbridge to provide the basis for the statements. Inadequate responses from the proponent, and lack of adequate provincial agency guidance, made it impossible for municipal authorities to assess the situation in a defensible manner that would not be subject to challenge.

This engineering justification provides a basis for the siting of wind turbines in Ontario that can be applied by municipal authorities in a defensible manner, based on public safety risk and noise calculations to meet Ontario Regulations. The following setbacks are justified:

- ◇ Public safety setback from lot lines of neighbours who do not have a wind turbine agreement with proponent - 2 times (Height of turbine tower + Blade radius)
- ◇ Noise setback from single turbine to homes to meet Ontario Noise Regulations - at least 900 metres required, 1000 metres recommended to prevent subsequent turbine shutdown if over noise limits due to subsequent blade wear

These setbacks protect the public and provide a basis for enable land owners to utilize wind energy.

2. Background - Why This Work Was Necessary

The Environmental Screening Report for the Enbridge Ontario Wind Project LP (Enbridge) issued April 19, 2006 for public consultation noted "Any interested person or party with a concern, issue or information request regarding this project should contact Enbridge." The "Notice of Completion" continued "If Enbridge and the concerned person or party are unable to resolve the matter, the concerned party may make a written request to the Ontario Ministry of the Environment to elevate the project."

Formal identification of concerns made to Enbridge included questions on the basis for the project setback limits identified in Section 3.3.1 of the Screening Report as:

- residence 350 m
- secondary roads 50 m
- rear and interior lot lines 50 m

Since there was no reply to this question by the final date to file an elevation request, it was necessary to file a request with the Director of the Environmental Assessment and Approvals Branch on May 18th.

A reply was received from Enbridge in a letter dated June 6th which stated a somewhat different set of setbacks than identified in the Environmental Screening Report and identified rationale as follows:

- Community boundary 600 m
- Residences (point of reception) 350 m (MOE noise guidelines)
- Primary highway 151.25 m (1.25 x total height of the turbine)
- Municipal road (front or exterior side yard) 111.0 m (turbine height - 1/2 right of way)
- Rear or interior lot line 50.5 m (blade length + 10 m)

The reply continued "The setbacks to reduce potential noise impacts to the nearest off-site dwelling of 350 m are more than sufficient to provide safety from ice throw or blade failure. A study completed reviewing wind turbine failures in Europe and the United States by Alexi Clark, concluded that 'the risk of being hit within 210 m of a wind turbine is comparable to the risk of dying from a lightening strike.' " The reply went on that "In a study completed by Derek Taylor in Dyfed County, Wales, a 50 to 100 m setback was sufficient to protect the public using nearby roadways."

Copies of the references were not made available with the reply, which made review impossible. On June 26, a letter was received from William Pol, Manager of Planning of IBI group, the planning firm for Enbridge titled, "References for the Setbacks as provided by Enbridge" to which were attached photocopies of several pages from books that referred to these references (but still not the papers themselves). The pages identified that the Alexi Clarke paper was written in 1989, "after investigating several wind turbine failures in Europe and the United States." Wind turbines installed before 1989 were generally all smaller than 30 metres in height, and, the investigation of "several" failures could well have included even smaller turbines as were the norm in early installations.

Similarly, the pages showed that the paper by Derek Taylor was issued in 1991, titled, "How to Plan the Nuisance out of Wind Energy" when the first wind turbines were connected to the grid in the UK. At that time, turbines installed in Wales were 300 kW machines on 100 foot towers (30 m) reaching 135 feet (41 m) at blade tip.

Use of these two references by the proponent to justify suggest safe setback distances to the public raises several difficult questions. Was the proponent simply unaware that it was

unjustified to use the example of 300 kW turbines on 30 metre towers with 11 metre blades (or smaller) studied in the "several accidents" to justify safe setbacks to 1650 kW turbines (5.5 times larger) on 80 metre towers (2.7 times larger) with 41 metre blades (3.7 times larger)? Was the proponent not capable of determining the factors that impact public safety? Or was the fact that the references were used in response to specific questions without identifying when they were issued, and without any details of the much smaller turbines they were based on, a deliberate omission which might give a reader the impression that conditions were not what they actually were?

The noise assessment in the Enbridge Ontario Wind Project Environmental Screening Report identifies a similar lack of clarity. Formal letters of concern questioned if the noise assessment had fully appreciated and factored in the work of G.P, van den Berg of the Netherlands published in 2004, who had investigated "the difference between night and daytime wind turbine sound at some distance from the turbines." A copy of the van den Berg paper was provided to the proponent. One has to wonder if the response in the June 6th Enbridge letter totally misunderstood the question? The response stated that the "Van den Berg paper you referred to is in specific reference to UK approaches." (Although the work referred only to research in the Netherlands.) It went on to say, "For our study, no assumption about wind speed at night was made. A range of wind speeds have been used and compared against MOE criteria, regardless of whether day or night." The response totally failed to respond to the point that the issue was the change between high and low level winds at night, which results in a higher noise perceived on the ground at night.

Questions must be asked if the Enbridge Screening report and response letter do not understand the regulations that require the monitoring of noise under "worst case scenario"? The Ontario Ministry of the Environment regulation is found in "Sound Level Limits for Stationary Sources in Class 3 Areas (Rural), publication NPC-232 dated October 1995 and the MOE document, "Interpretation For Applying MOE Technical Publications to Wind Turbine Generators", of July 6, 2004. The latter shows that for BACKGROUND wind speeds in excess of 6 metres per second the masking effect of the higher speed winds can be credited, but clearly states that noise impact assessment must be performed under a "worst case scenario" at "Points of Reception". The worst case occurs when the wind speed at the ground is low, and the wind speed at the turbine height is high. The noise assessment of the Enbridge Screening Report takes credit for the masking effect of wind speeds above 6 metres per second in every case. This infers that masking from winds at the ground can always be credited and ignores the case of low wind speed at the ground.

Since identification of the original concern, research into the Ontario situation shows the case of having winds at the ground fall in speed at night while winds at the turbine hub level increase as identified in the work done by Dr. van den Berg is applicable here. Correlation of the output of the three operating Ontario wind farms, to the Environment Canada "ground level" wind speeds shows clearly that on the MAJORITY of days between mid May and the end of July, the method used in the Enbridge report will result in exceeding Ontario noise Regulations. Masking is often not available as ground speed winds are low, while turbine output shows high wind speeds exist at the turbine.

This required a reevaluation of the noise based setbacks to match reality. Applying the method shown in the noise assessment of the Enbridge Screening Report will result in over 87 % of homes at distances of up to 900 metres above the Ontario standard for noise at times when masking is not available. 169 homes - some at distances of up to 928 metres from the nearest turbine, will be subject to noise above Ontario standards. Others will be just at the standard - which itself is well above background, allowing no tolerance for increased noise as turbine blades wear, or for the fact that the manufacturer states their noise data is subject to some variation.

3. Public Safety Risk

The intent of this document is to provide councillors and planners a proper engineering justification they can use to ensure that their responsibility for public safety can be assured.

In any discussion of public safety risk, it is important to define what is meant by "risk", as it is a term that is often used without clarity. "Risk" relates to the "likelihood" of an event happening (how often in a timer period) times the "consequences" of the event if it does happen. In order to properly assess risk, it is necessary to ensure that the cases being studied as examples actually are representative. Then, one has to ensure that sufficient data is available to ensure that it accurately can represent the normal variation that occurs over time. For example, the justification by Enbridge of setbacks based on a paper that analysed "several accidents" of much smaller turbines done over 17 years ago is inappropriate.

A better and more complete assessment of accidents is provided by the "Guidelines on the Environmental Risk of Wind Turbines in the Netherlands", published in February 2004, as paper ECN-RX--04-013 by H. Braam and L.W.M.M. Rademakers of ECN Wind Energy of the Netherlands. This paper describes the "Handbook for Risk Assessment of Wind Turbines" prepared for the Netherlands Agency for Energy and the Environment (NOVEM). The failure events of turbines to be determined in risk analysis were determined by "analyzing over 200 severe incidents and accidents in Denmark, Germany, and the Netherlands ... representing approximately 43,000 turbine years." The data is collected based on recent experience of similar turbines as are proposed for this project. Vestas turbines as proposed in this project are widely used in Europe. The Handbook summarizes relevant accident scenarios and their recommended likelihood of failure for calculations.

Scenario	**Recommended Value [events per turbine per year]**
Loss of entire blade	8.4×10^{-4}
Loss at rated speed	*4.2×10^{-4}*
*Loss at 1.25 * rated speed*	*4.2×10^{-4}*
*Loss at 2 * rated speed*	*5.0×10^{-6}*
Loss of blade tip	2.6×10^{-4}
Collapse of entire turbine at tower foot	3.2×10^{-4}
Collapse of rotor and/or nacelle	1.3×10^{-4}
Falling down of small parts from nacelle and hub	1.7×10^{-3}

It is reasonable to apply these recommended values to this project, as the Vestas turbines proposed are represented by the data. Applying these recommended values to a project of 121 turbines shows that a major accident (loss of entire blade, collapse of entire turbine, or collapse of rotor and / or nacelle) will occur every 6.4 years.

The frequency of accident over the project is calculated as follows:

Frequency of major accident = 121 [(loss of entire blade value) + (collapse of entire turbine value) + (collapse of rotor and / or nacelle value)]

$= 121 [(8.4 \times 10^{-4} \text{ per year}) + (3.2 \times 10^{-4} \text{ per year}) + (1.3 \times 10^{-4} \text{ per year})]$

$= 121 [1.29 \times 10^{-3} \text{ per year}]$

$= 0.156 \text{ per year}$

Thus the time between failures is 1 / 0.156 per year = 6.4 years.

This short time interval between major accidents calculated from a large representative set of data (43,000 turbine years) clearly indicates that action to protect the public is required if the consequence of failure could have impact on the public.

The greatest contributor to the accident rate is loss of the entire blade. (It contributes over 65% of the failures). To determine if loss of an entire blade has impact on public safety risk, it is necessary to show if there is any consequence if the 10 tonne blade which is 41 metres long hits a member of the public (which means any person not involved with the project, such as a neighbouring landowner) who has every right to be walking along their side of the fence, mending the fence, working the fields, or tending grazing livestock up to the fenceline. It is clear that if a blade hits the member of the public, there is a severe consequence.

In this case, to assess the risk, we have a high likelihood (as shown by the accident occurring in a short time interval) and a severe consequence. Throw of an entire 41 metre - 10 tonne blade, part of that blade, or even ice chunks from turbine blades will certainly cause many adverse effects as defined in the Environmental Act if they cross the property line. That knowledge creates an absolute loss of enjoyment of property for land owners, as has been expressed in submissions to council.

Three current realistic blade throw distances were considered in this assessment:

- the 2005 Caithness Windfarm Information Forum Wind Turbine Accident Data (http://caithtnesswindfarms.co.uk/pages/accidentData.htm) identifies cases of turbine blades actually being thrown over 400 metres
- the 2004 paper describing the Handbook for Risk Assessment of Wind Turbines of the Netherlands identifies a maximum throwing distance of a blade during an overspeed (two times rated rotor speed) of between 300 metres and 400 metres, and a distance of throw at nominal speed of 145 metres.
- A paper from 2004 titled “Permitting Setbacks for Turbines and the Blade Throw Hazard” by Scott Larwood for the California Wind Energy Collaborative, identifies the most complete review of the subject. The paper includes a literature review of blade failure calculations, examples of failures, and recommendations for a path forward. A useful feature of this paper is a graph that shows blade throw for full blades and blade fragments as a function of the nominal tip speed. For turbines in the 1.5 to 2.0 MW range, they show full blade throws of 2.5 times the overall turbine height at 2 times rated speed, and 1.4 times the overall turbine height at nominal speed. Fragment blade throws of up to 4 times the turbine height at the normal blade speed, and over 6 times the turbine height at 2 times rated speed are shown. One conclusion of this paper of 2004 is the statement “blade failure is surprisingly high and not showing improvement.”

To determine an appropriate blade throw distance for evaluation of public safety risk requires looking at the fact that the Netherlands Handbook for risk assessment of wind turbines identifies that the likelihood of blade throw at 1 times rated speed is the same as the likelihood of blade throw at 1.25 times rated speed. Examination of the Larwood paper shows that to provide a defensible criteria for this somewhat increased blade speed would require a minimum setback distance to the property of a non participating neighbour of at least 2.0 times the overall height of turbine and blades.

It is noted that this criteria does not give full protection for the distances shown for throw of "blade fragments" or "loss of blade tip" which are shown to travel up to 4 times the overall height of tower and blades at nominal speed. The rationale for allowing this increased distance for partial blade throw is that the piece thrown is smaller, and the frequency of throw is about 30% of that of the full blade. This combination of a lower likelihood and perhaps smaller consequence (although it could still injure or kill) means that risk is somewhat smaller. From a public safety risk point of view, so long as the throw distance is shorter than the distance to houses, where people can be expected to be at all hours of the day, a case can be made that this risk might be within normal planning expectations that any activity approved does increase risk. As will be shown below, noise setbacks to houses where people can be expected to be will provide protection for partial blade throws, so the acceptance of a setback of 2.0 times the overall tower plus blade height meets a reasonable compromise between absolute protection (which would require setbacks at least twice as large again) and the recognition that any endeavor may result in some increased risk to neighbours. The intent is to establish an engineering basis for a reasonable setback that takes account for normal planning expectations, so that councillors and planners have something other than "opinion" on which to base their approval of a project so that public safety is adequately considered. Approval of a project setback without a justification to fall back on, such as the Enbridge request for a 50.5 metre setback which has been shown earlier to be without merit, could be considered irresponsible.

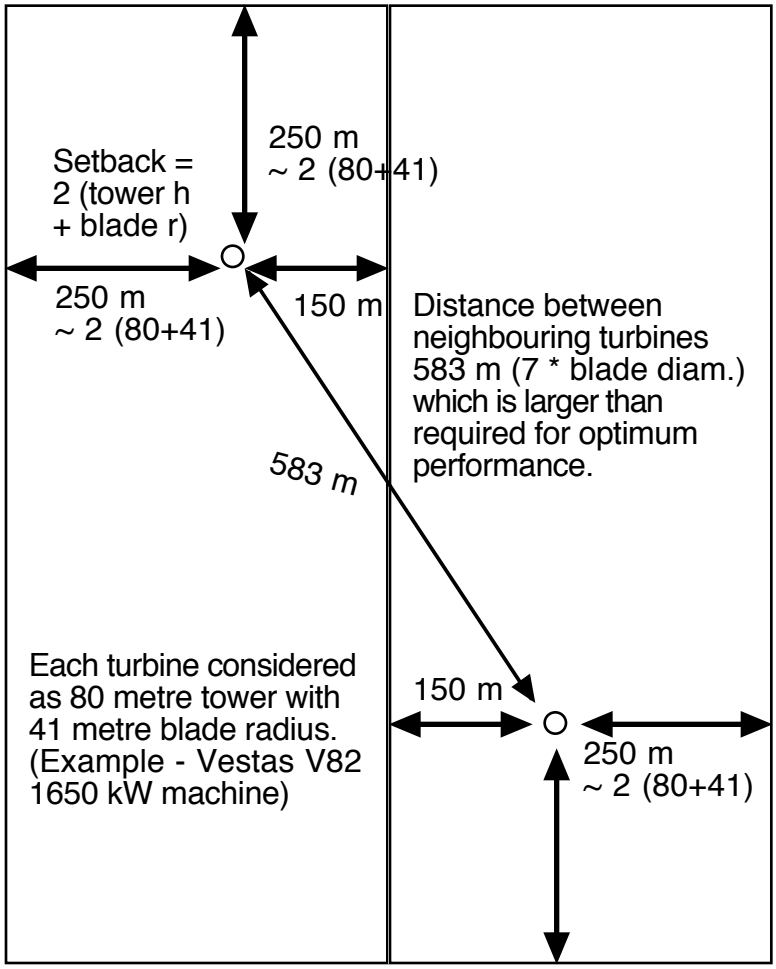
Two key factors need to be made clear to responsibly protect both participating land owners and non participants. Since this information has not been accurately presented by the project proponent, municipal authorities who approve the project need to ensure the true situation is presented because of their responsibility for public safety:

- Individuals participating in the project need to understand the risk they are incurring by involvement, so that they can decide if they wish to adapt the usage of their property based on factual evidence.
- Property setbacks must be chosen based on factual evidence, such as presented in this justification, so that non-participating land owners can continue to use their property without having to significantly adapt their usage patterns - this is a fundamental premise of the Ontario Provincial Policy Statement for regulating the development and use of land ... without adverse effects as defined in the Environmental Protection Act, including, "harm or material discomfort to any person, an adverse effect on the health of any person, impairment of the safety of any person, loss of enjoyment of normal use of property and interference with normal conduct of business."

It is important to note that the safe setback distance from property lines is based not on a simple value, but on a multiple of total height of the tower plus blades. Consider the recent challenge of the Saugeen Shores comprehensive zoning bylaw by the County of Bruce. The Saugeen Shores bylaw proposed a setback of 250 metres from turbines to lot lines. Recognizing that current discussion has been focussing on an example of a 80 metre turbine tower with a 41 metre blade radius, and a blade hub slightly above the top of the tower, it can be seen that the 250 metre setback is very near the 2.0 times turbine tower plus blade radius value of 2 (80m + 41m) = 242 metres. For this turbine, the setback is quite reasonable, but it may not be applicable in every case. The Shoreline Beacon of

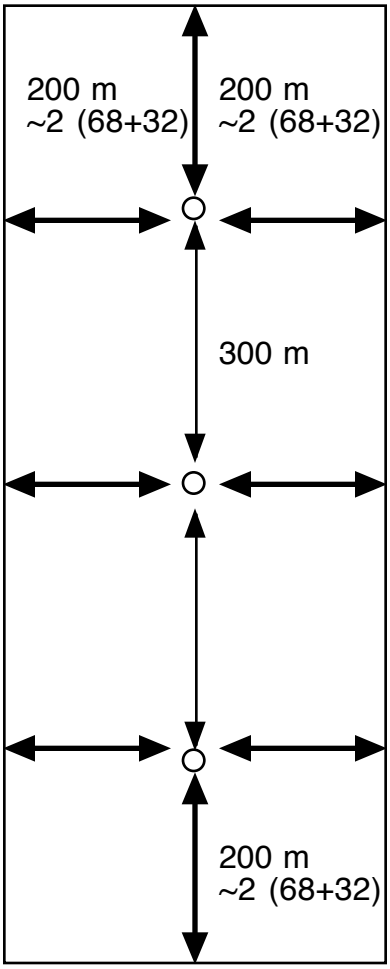
July 26, 2006 quotes the Director of Planning of Bruce County to say, “Based on the required minimum setback of 250 metres from any lot line, the by-law does not permit a wind turbine on a 100 acre farm parcel”. That statement too is valid only for the case of a particular turbine size. To find a reasonable compromise, it is necessary to look instead on a criteria based on a safe protection for the public from any turbine, not just a specific example being considered today, as turbine and tower sizes vary, and are increasing.

The figure below shows that a case could be made to permit two adjoining 100 acre farms to each install a wind turbine with an 80 metre tower and 41 metre blades so long as each waived the 250 metre setback to their common boundary. Typical dimensions of 400 metres by 1000 metres on each 100 acre plot would permit the landholders to work together to install turbines on each farm while still allowing for reasonable distances between turbines, so long as other noise setback restrictions to neighbouring houses were met.



This figure shows that a 2 times tower height plus blade radius could be applied for the 80 metre towers currently being considered, and would not restrict farmers who wanted to work together to develop the wind resource.

Additionally, using a setback distance of 2.0 times the tower height plus blade radius, a single 100 acre farm, even without having to partner with a neighbouring farm would be able to install up to three wind turbines with a total height of tower plus blades of 100 metres (typically 1000 kW machines) although meeting all other noise restrictions to neighbouring farms on either side would be challenging unless those farms were vacant, and planned to stay that way. This could permit a single farm to install up to about 3 MW of wind turbine generation peak rating.



Each turbine considered as 68 metre tower with 32 metre blade radius. Example - 1000 kW machine. Up to three turbines could be installed on 100 acres with distance between neighbouring turbines of 300 m (4.7 * blade diam) which is larger than required.

These two simple examples show that identification of a setback to neighbouring farms based on 2 times turbine tower height plus blade radius is preferred to describing setback in terms of an absolute single value.

It also will allow planners to assess applications for taller towers (e.g., 100 m towers, or 120 m towers) as are being installed elsewhere, or to assess an application from a homeowner on a typical country 2 acre lot to install a personal turbine, typically on a 10 to 20 metre (33 to 68 foot) tower, with a blade radius of 2 to 4 metres (6 to 12 feet), by use of a consistent and reasonable standard. Use of a single 250 metre setback, while appropriate for the specific case of the Enbridge example with 80 metre towers and 41 metre blade radius is too limiting to be used for other possible planning applications.

4. Ontario Noise Regulation

The establishment of an engineering justification for setbacks according to Ontario noise regulations is quite simple. The Ontario Ministry of the Environment has established a standard for "Sound Level Limits for Stationary Sources in Class 3 Areas (Rural)" Publication NPC-232. The publication clearly identifies objectives as follows:

> *"The sound level limit at a point of reception must be established based on the principle of "predictable worst case" noise impact. In general, the limit is given by the background sound level at the point of reception, The sound level limit must represent the minimum background sound level that occurs or is likely to occur during the operation of the stationary source under impact assessment."*

The MOE provides further guidance for the noise from wind turbine generators in the document "Interpretation for applying MOE NPC Technical Publications to Wind Turbine Generators." This document identifies the Noise Limits for rural settings in a table as follows

Wind Speed (m/s)	4	5	6	7	8	9	10	11
Wind Turbine Noise Criterion NPC-232 (dBA)	40	40	40	43	45	49	51	53

The "Interpretation" document includes a template for a "Wind Turbine Noise Impact Assessment Summary Table" that uses "Sound Level Limits" as per the table above. These limits apply ONLY if the background sound level at the point of reception is influenced by a ground wind speed as shown on the table. Work documented by G.P. van den Berg of the University of Groningen in the Netherlands identified that at night, the wind speed at ground level falls, while the wind speed at the turbine hub increases. As a result, it is not appropriate to take credit for the masking effect of high speed background winds at the receptor (located on the ground). Using the terms of the MOE document, the "worst case scenario" would clearly be if wind speed at the ground was low so that no masking effect was present, while the wind speed at the turbine level was high enough to create a noise that would be above 40 dBA once attenuated by distance to the "receptor."

G.P, van den Berg further refined his work in a dissertation titled "The sound of high winds: the effect of atmospheric stability on wind turbine sound and microphone noise" submitted to the University of Groningen in support of granting a doctorate in math's and natural science. In the dissertation he explained that while the sun is heating the earth, the atmosphere is generally unstable, and mixed, but shortly after the sun goes down the atmosphere becomes stable, and wind velocities fall at ground level, but increase at the height of typical wind turbines. The phenomenon is most pronounced on clear nights.

To determine if this effect is observed in Ontario, a correlation was made between the hourly electrical output provided on the Independent Electricity System Operator (IESO) web site for the three Ontario Wind Farms, at Kingsbridge (Goderich), Melancthon (Shelburne), and Erie Shores (Port Burwell) and the Environment Canada hourly records of weather conditions at the weather stations representative of the wind farm locations. This correlation has been tracked from mid May until mid July (and is continuing). Observation of the data confirms the phenomena reported by Dr. van den Berg. On the majority of nights of the study period - particularly on nights when the Environment Canada observed conditions were clear or mostly clear, after sunset the ground speed wind decreased, while the wind turbine output increased. Several examples of this are shown in the Appendix.

The IESO web site shows the hourly electrical output of each wind farm individually, and the

capability of electrical output of the wind farm. From this it was possible to determine the % loading of each turbine. By observing the noise produced by wind turbines as a function of output from either the Vestas data or the Valcoustics noise assessment, it is simple to determine that on the majority of nights, the turbine outputs were large enough to require masking from ground wind speeds to prevent being over Ontario regulations, while none was available as ground speed winds were low.

Referring to the Valcoustics noise assessment report for the Enbridge Wind proposal it is easy to determine the following summary:

- 169 houses in the study area will be above the Ontario Standard of 40 dBA at some time, unless masking from ground speed winds is available. Clearly there are many nights in the spring and summer when masking by ground level winds are not available, yet turbine output is high enough to require it.
- Houses at up to 928 metres from the nearest turbine will be above the Ontario Standard.
- Houses at up to 957 metres will be just at the Ontario standard allowing no tolerance for changes in noise as turbine blades wear from dust particles, etc.
- 87% of all houses at a distance of up to 900 metres are above the Ontario Standard for noise at some times. Many of the remaining 13% are just at the Ontario standard, again allowing no tolerance from the increase in noise that occurs as blades wear - they do not become quieter!

The evidence makes it clear that to prevent being above the Ontario standard, no wind turbine with a noise characteristic such as the Vestas V82 can be located nearer than 900 metres from any house. In some cases, the noise setback needs to be greater than 900 metres depending on grouping of turbines. To prevent having to shut down a turbine / or turbines in the case of post installation monitoring determining conditions above the Ontario standards, particularly given that noise will increase as turbine blades wear, a noise setback to any home should be 1000 metres.

Field measurements using a professional sound level meter at monitoring sites near the Huron Wind turbine site confirms that as night ground level winds fall, background noise levels are below 35 dBA several kilometres from the site. At distances of 500 metres from the nearest wind turbine, sound levels exceed the Ontario standard of 40 dBA by up to 6 dBA. At distances of about 1000 metres from the nearest turbine, sound levels are just at the Ontario standard of 40 dBA. A distance of about 1600 metres would be needed to keep the noise at the current background levels.

5. Conclusions

This engineering justification provides a basis for the siting of wind turbines in Ontario. It can be applied by municipal authorities in a defensible manner, based on public safety risk and noise calculations to meet Ontario Regulations.

The following setbacks are justified:

- ◇ Public safety setback from lot lines of neighbours who do not have a wind turbine agreement with proponent - 2 times (Height of turbine tower + Blade radius)
- ◇ Noise setback from single turbine to homes to meet Ontario Noise Regulations - at least 900 metres required, 1000 metres recommended to prevent subsequent turbine shutdown if over noise limits due to subsequent blade wear

These setbacks protect the public and enable land owners to utilize wind energy.

6. Qualification of the Justification

William K.G. Palmer prepared this Engineering justification. His qualifications include:

- Bachelor of Applied Science and Engineering - University of Toronto
- Licensed Professional Engineer of Ontario - previous Chair of Georgian Bay Chapter
- Certificate Holder - Reactor Safety and Risk Assessment - Massachusetts Institute of Technology

Prior to retirement, Mr. Palmer had the opportunity while employed by Bruce Power and its predecessors, to be responsible for public safety assessment while an Authorized Nuclear Shift Supervisor at Bruce Nuclear Generating Station A, and subsequently as a Technical Superintendent and Section Manager with responsibility for training and safety, reactor safety, dealing with regulatory agencies, and quality assurance. Mr., Palmer was a team member for the Bruce NGSA Unit 3 & 4 Restart Environmental Assessment and for the Bruce NGSA Unit 3 & 4 Restart Risk Assessment.

Grateful acknowledgment is made for the review of this paper by the following individuals, and others, who have expressed general concurrence with the paper. Many comments provided by the reviewers were incorporated into the final version to improve clarity and content.

- Tony Clark, founder of the Windfarm Action Group of Bruce County provided general review and support.

- Ron Mattmer provided review and specific comments related to the public hearing process.

- PK Walsh B. Sc. (Physics) M. Sc. (Astronomy) reviewed the assessment of Public Safety Risk contained in section 3. Prior to retirement, PK Walsh was Principal Safety Consultant at the nuclear engineering company NNC Limited (now AMEC-NNC) based in Knutsford, Cheshire, England. Mr., Walsh acted as Technical Manager for NNC in preparing the Bruce A Probabilistic Risk Assessment used in support of Bruce Power's submissions associated with the restart of Bruce A Units 3 and 4.

- Fred Kwan, B. A. Sc. P. Eng. provided general review of the paper, and specific review of calculations and the logical sequence of arguments.

- Dave Walsh, B. Sc. (Physics) provided general review of the paper and specific comments to improve readability.

- Kathy McCarrel B.A. B. Ed. provided general review and specific comments to improve readability.

7. References

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- Letter - W. Palmer to Project Manager, Enbridge Ontario Wind Project, dated May 4, 2006

- Letter - W. Palmer to James O'Mara, Director, Environmental Assessment and Approvals Branch, Ontario Ministry of the Environment, May 18, 2006
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- Permitting Setbacks for Wind Turbines and the Blade Throw Hazard - Scott Larwood, for the California Wind Energy Collaborative, 2004 Forum Palm Springs
- Vestas V82-1.65 MW brochure - Creating More from Less, dated 03-05
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- "The Sounds of High Winds: the effect of atmospheric stability on wind turbine sound and microphone noise" by G.P. van den Berg, 210 pages, published June 2006, available from http://dissertations.ub.rug.nl/faculties/science/2006/g.p.van.den.berg/
- Shoreline Beacon, July 26, 2006. "Bruce County appeals Saugeen Shores zoning"

Appendices:

a. Extracts from Guidelines on the Environmental Risk of Wind Turbines in the Netherlands - H. Braam and L.W.M.M. Rademakers, ECN Wind Energy, Feb. 2004

b. Extracts from Permitting Setbacks for Wind Turbines and the Blade Throw Hazard Scott Larwood, California Wind Energy Collaborative, presented to 2004 Forum

c. Extracts from Ontario Ministry of the Environment "Interpretation Applying MOE NPC Technical Publications to Wind Turbine Generators"

d. Examples of Noise from Wind Turbine which would require masking, but ground level wind is low.

Wind Turbines – The Issues, the Hype, the Truth, and Unresolved Questions

A Closer Look at Public Safety, Health Effects (from noise), Electrical System Security, and Sustainability

We hear a lot about wind turbines. They seem to be the "poster child" for the "green" movement. The hype about wind turbines from their advocates (including the Ontario Minister of Energy) would lead the public to believe that only self-serving NIMBY's who don't like any development oppose them. Let's look at the issues, the hype heard, the actual truth, and significant unanswered questions.

The Issue	The Hype	The Truth	Unresolved Questions
Public Perception	We hear Canadians love wind turbines because they are "green", and the only opponents are those who are caught in the dark ages, and would oppose anything.	After studying the issues carefully, one finds that there are real questions that need to be addressed. Folks trying to bring the truth to the table are environmentally aware, and well informed. They do raise real questions.	As the public becomes educated about the issues, risks, and concerns of large industrial wind turbines, how will perception change? Do large wind turbines contribute to a sustainable future, or pose significant adverse impacts?
Impact on the cost of power	We hear the wind is free, and limitless. Even better, we hear installing wind turbines will not cost the power customer anything. Financiers with a social conscience are willing to install the turbines at their risk. What could be better? We hear that Ontario has the ideal situation, as hydraulic generation can replace wind on windless days, saving water "in the bank" above hydro generators on windy days.	The wind blows when it wants, not when we want! On hot summer days (e.g. May/June/06 when real power costs were over $500 a MWh), there was no wind anywhere in Ontario. On stormy winter days (e.g. Dec 1 and 2/06) most Ontario wind turbines produced no power as they were all shut down in the gale. Then there are those snapping cold still winter nights, when you can cut the air with a knife – again no wind! When we most need wind generation, it is not available. In fact, mostly wind turbine output is highest at night while we sleep and electrical demand is lowest, and falls	Developers that install wind turbines stand to profit very nicely from their investment. They have long term guarantees that whatever they produce will be bought – at a premium price. The consumer will pay dearly to repay those investments. Exactly who benefits most from installation of wind turbines? Consumers or the developers? Is it curious that many developers have close links to the government – or were financial supporters?

		off as the sun comes up and we plug in our coffee pots. An electrical utility must have a backup generator equal in size to the wind turbine connected and idling at low load (and low efficiency) - ready to load at all times wind generators are on line. Wind turbines do contribute energy, but cannot be counted on to contribute to system peak, as we cannot be assured there will be wind! We cannot expect existing stations to replace wind at peak, as at peak load times, Ontario now runs all available hydraulic, nuclear, and fossil generators on peak.	Why should we pay a premium price for a generating source that is not available when we need it?
Public Health and Safety	Hype says that no member of the public has ever been hurt by a wind turbine. The example of the demonstration turbine at the CNE in Toronto is used to assure us that they must be safe, as it has never had an accident.	While the CNE wind turbine has not failed catastrophically, you cannot get a true measure of safety by examining one turbine for a few years. In 2004, a handbook for the risk assessment of wind turbines was prepared by the Netherlands Agency for Energy and the Environment. The handbook analyzed over 43,000 turbine years of experience in Denmark, Germany and the Netherlands typical of the turbines being installed in Ontario. They found 62 severe incidents and accidents relevant for the safety of those nearby had occurred. The handbook calculated the frequency of occurrence of those actual accidents	If 43,000 turbine years of European operation resulted in 62 severe incidents and accidents relevant to safety, then when Ontario has 3000 turbines (for the 5000 MW of wind generation proposed by the OPA), each year we should expect 4 severe incidents and accidents relevant to safety. Should the public not be protected from accidents such as loss of a 41 metre turbine blade weighing over 10 tons that can travel 250 metres by adequate setbacks?

		to show that either loss of a full turbine blade, or a tower collapse, or the collapse of the turbine from the top of the tower can be expected every 700 turbine years. A group of 100 turbines can expect an accident every 7 years.	Should the public be consoled by apparent safety of a single turbine when proposals will see thousands of turbines installed?
Setbacks of wind turbines for public safety.	The Canadian Wind Energy Association (CANWEA) website includes a proposed official plan for municipalities that would allow construction of wind turbines within the rotor radius plus 10 metres (e.g. about 50 metres) from property lines, from non dwelling buildings, or from road right of ways. They propose that wind turbines can be located within 200 metres of residences. The hype would seem that the industry feels wind turbines are very safe!	The Netherlands risk assessment of wind turbines from actual accidents shows that at a 50-metre setback from wind turbines, the individual risk of death is 0.00001 per year – this may seem to be a small number, but it is 10 times higher than accepted as a Netherlands target for wind turbines, and 10 times higher than the risk accepted in Ontario for other generating stations. If this risk was applied to all persons in Ontario, we could expect to have 120 deaths due to wind turbines in a year. That risk would be unacceptable to the population. A cost benefit study performed for the Ontario Ministry of Energy in 2005 predicted that coal fired generating stations might result in 103 acute deaths per year in Ontario, which is considered unacceptable. The Ontario Provincial Policy Statement, which applies to planning, defines "Adverse Effects" as those that result in "loss of enjoyment of normal use of property."	Why would society impose an additional risk of injury or death upon anyone from a wind turbine on a neighbour's property? Particularly a risk higher than is acceptable in Europe, or higher than the risk from living next to other generating systems? Is accepting a higher acute risk for individuals "across the fence" from wind turbines justified? Is it acceptable to society to place risks above those considered acceptable to everyone on some when it is quite easy to bring risks into acceptable levels by simply increasing setback distances? Why do we think there is a "right" for a farmer with acreages too small to allow adequate setbacks (a 50 acre lot is approved in the Cruickshank proposal in the Municipality of

		To bring risk from wind turbines into an acceptable range (e.g. meeting the Netherlands standard or the Ontario standard for other generation) requires a setback of at least 2 times the total height of a turbine tower and the blade radius – about 250 metres for current tower and blade sizes. Standards should be based on tower height and blade length, as bigger and bigger turbines are being proposed, and simple distance limitations do not address these changes.	Kincardine, for example) to have tall wind turbines if it places risk above socially acceptable on neighbours? Have neighbours no rights to personal safety? Should we not restrict wind turbines to areas where the leaseholder accepts the restriction on activity within the lease area?
Noise impact of wind turbines	The popular understanding is that modern wind turbines are "generally much quieter than most people expect." Many people will state that they have stood at the base of a modern wind turbine and carried on a conversation. The popular belief is that people who complain about wind turbine noise do so only as an excuse for their dislike of the technology. Noise concerns are dismissed as the excuse of the NIMBY set.	Ontario Ministry of the Environment noise standards for wind turbines (prepared in conjunction with CANWEA, the industry advocate group) are not as restrictive as many other countries. For example, the Netherlands, France, Denmark, Germany, and Sweden do not permit as much noise from wind turbines as do the Ontario Standards. The Ontario MOE permits a wind farm to emit noise above 40 dBa for wind speeds above 6 m/s (about 21.6 km/h). This allowance that was requested by CANWEA allows the wind farm to emit more noise when background noise at the receptor location is increased by the wind.	Why are we unwilling to accept the recommendation of the French Academy of Medicine to restrict location of wind turbines closer than 1500 metres to a home until an epidemiologic investigation into the possible medical effects of noise from wind turbines is carried out? o A study released in 2005 by the European Society of Cardiology linked chronic noise exposure to risk of heart attack. o Gordon Whitehead, an experienced audiologist states, "This author is quite firmly of the opinion that infrasonic sound has the

		Experience has shown that many people are troubled by wind turbine noise, especially at night. Investigation by Dr. G.P. van den Berg of the University of Groningen in the Netherlands determined the fact that the profile of the wind at different elevations changes between night and daytime. At night, the atmospheric profile becomes "stable" and there are larger differences between the wind speeds at the ground and at the turbine than in the daytime when the profile is "unstable" or "neutral" due to the heating effect of the sun on the ground. While ground level winds fall at night, the wind speeds at the level of the turbine increases. While turbine output (and noise) increases, the background noise at the ground level falls. Human ears are particularly responsive to differences in sound, so the noise from the turbines is perceived as significantly more troublesome at night even if the noise level only increases somewhat. Work published in the UK (government sponsored) confirmed a hypothesis of Dr. van den Berg, that one of the significant contributors to the annoyance is modulation of the sound from clusters of more than one turbine.	capability of causing dysfunction of the vestibular system (balance portion of the ear), especially in persons susceptible to motion sickness." Is it acceptable that people already living near where wind farms are being installed are forced to be exposed to potential harm to their health against their will before the effects are fully known? There are many examples showing that some people (and some animals) have been adversely impacted by noise from wind turbines – even when the noise is within acceptable dBa standards. Gordon Whitehead, has stated, "Some of the documented court challenges against wind farms around the world have used the rebuttal that if it (very low frequency sound) is inaudible, it cannot hurt you. This is untrue." He points out "Legislation pertaining to wind farm generated noise and vibration does not extend beyond noise levels which have

		Tracking the situation in Ontario for 100 days in the summer of 2006, on 70 out of those 100 days, the turbine output (as reported by the IESO) increased to the point that it indicated wind speeds were high enough to indicate that "masking" of the noise produced by the wind turbines by ground level winds would be required to meet the Ontario standard. At the same time, the Environment Canada wind speed data recorded for stations near the wind farms showed that ground level winds were below the level that masking could be credited. To meet the Ontario standard – even on the dBa scale, current 1.65 MW wind turbines need to be over 900 metres from homes to recognize that at night wind speeds can be high at the turbine while there is no ground speed wind to provide masking – and if allowance is given for gradual increase in noise as blades wear, the distance should be over 1000 metres. Ontario Standards limit noise in terms of dBa, a scale that attempts to represent the response of our ear to noise by diminished sensitivity at low frequencies. If noise from wind	had the low-frequencies filtered out (dBa)." In conclusion he recommends that the government should write legislation for wind farms that addresses noise and vibration, including ground transmitted infrasound, and which addresses wind farm location in relation to existing housing. MOE standards were issued in July 2004. The work by Dr. van den Berg was not published until September of 2004. Why have letters to the MOE requesting that they consider this new information not been answered? Why should the MOE accept that standards of noise at receptor homes are not met on 70 out of 100 nights in the summer? This information was presented formally to MOE staff, but they were unwilling to take any action, or even to agree to follow up. Why? Why does the CANWEA proposed municipal zoning bylaw allow setback distances

		turbines is measured by the dBc scale, which attempts to present a more even response to the energy in sound, it shows a significantly higher reading (typically values measured as 45 to 50 dBa, show values of 65 – 85 dBc). This shows that low frequency component of the sound from wind turbines is significant, but not fully addressed by the current Ontario Standards.	from homes 200 metres, when CANWEA can easily identify that the Ontario standard is not being met?
Electrical system security	Popular belief is that adding many wind turbines scattered across the province ensures that the "wind is always blowing somewhere" and increases system security.	Environment Canada weather data, available on the internet with many years of history, shows that on hot summer days, there can be little wind (calm conditions) simultaneously at Thunder Bay, Sault Ste Marie, Wiarton, London, Goderich, Kingston, Ottawa, and Windsor. The "hype" of diversity is not proven out by fact. The E.On-Netz Wind Report states, "The weather situation determines the wind level. Both cold wintry periods and periods of summer heat are attributable to stable high-pressure weather systems. Low wind levels are meteorologically symptomatic of such high-pressure weather systems. This means that in these periods the contribution made by wind energy in meeting electricity consumption demand is correspondingly low."	Why does OPA accept the idea of diversity of location of wind to supply during summer peaks based on information supplied by CANWEA, the wind advocacy group, when Ontario weather data by Environment Canada shows hot still days with no wind across the province? During hot summer days, much of central North America can be influenced by stable high-pressure weather systems that results in low wind. Is the experience of the world's largest wind system operator not relevant to be considered as a factor?

The Integration of Wind into the Ontario Electrical System	A study conducted for the Ontario Power Authority (OPA) and Independent Electrical System Operator (IESO) by General Electric (GE) - the largest wind turbine manufacturer in North America, with data provided by the Canadian Wind Energy Association (CANWEA) - the industry advocacy group, claimed that it was possible to integrate 5000 MW of wind generation into the Ontario System in 2020 with a system peak of about 31,000 MW, and a system capacity of about 36,000 MW (5000 MW is about 14% of the 36,000 MW system capacity).	The Total German installed wind capacity of 16,394 MW was about 14% of a total German electrical system capacity of roughly 120,000 MW at the end of 2004. The German grid is also strongly tied to other European nations which makes it possible to transfer power to neighbours more easily than in Ontario. E.On-Netz, the system operator of over 40% of the wind generation "has more practical experience in integrating large amounts of wind into the system than virtually any their operator" (quoting the E.On-Netz Wind Report 2005.) E.On-Netz identifies the following statements in their Wind Report 2005: o "Traditional power stations with a capacity of 90% of the installed wind capacity must be permanently online in order to guarantee power supply." o "Wind power feed-in can only be forecast to a limited degree. … The feed-in capacity can change frequently within a few hours. … Handling such significant differences in feed-in levels poses a major challenge to system operators." o "As wind power capacity rises, the lower availability of the wind	Is it curious that a study conducted by a major wind turbine manufacturer, with data from CANWEA, showed the same fraction of Ontario's electrical need can be supplied by wind as is supplied in Germany without identifying the problems that identified by the E.On-Netz Wind Report? Why did the Ontario study not address the fact that Germany has strong interconnections to neighbouring states, which allow flexibility not available in Ontario? Why did the study not show that wind can only replace a small fraction of conventional resources, that changes in wind input can cause a major challenge to system operators, or that even simple grid problems can lead to significant failure in wind power production? Should the power consumer be encouraged that an integration study by wind proponents suggests high connection of wind resources in Ontario without identifying real experience of the world's largest wind operator?

		farms determines the reliability of the system as a whole to an ever increasing extent." o "Even simple grid problems can lead to significant failure in wind power production. Large thermal power generators do not disconnect from the grid even following serious grid failures, and generally trip into auxiliary services supply and support the grid. Windfarms, however, have so far disconnected themselves from the grid even in the event of minor, brief voltage dips. Experience has shown this can lead to serious power failures." o "On very windy days, normal operation of the transmission grid is sometimes no longer possible. Special switching measures are needed, in order to prevent wind power-induced grid overloads and consequently supply failures occurring."	Is it curious that the OPA Integration study shows the example of wind contributing 50% of its capacity on one peak day, but is silent on the fact that wind contributed less than 5% of it's capacity on hot days in May and June? Should Ontario power consumers take comfort that the OPA integration study shows all 5000 MW of proposed wind generation contributing to the Ontario system required generating resources graph without recognizing that on some days there is little wind anywhere in the proposed wind capture area, according to Environment Canada data?
	The OPA Supply Resources Discussion Paper uses the example of wind supplying at a 50% capacity factor during a summer peak day in August 2006 as a representative day. Further the OPA paper states "the capacity factor is generally insensitive to wind penetration level due to good wind geographic diversity".	IESO data for 100 days in the summer of 2006 shows on 49 days Ontario wind turbines contributed less than 10% of their capacity factor at Ontario peak hour. Only on 9 days, did wind turbines have output at 50% of their capacity or higher at the peak hour.	Why does the OPA reports use as an example a condition that applied on only 9% of the days in the summer, suggesting that wind turbine output of >50% was representative, when in fact on 49% of the days, output was actually < 10% during peak? Is this giving the right impression to report readers?

Impact of wind turbines on wildlife	Wind proponents state wildlife effects have been surveyed and researched and are considered to be minimal.	Wind turbine installations often are sited close to wildlife areas, such as near woodlots at the back of farmer's fields. It is known that wildlife will preferentially avoid noisy areas, and will move to areas of lower noise. Siting of wind have also been shown to increase the number of bat kills in Alberta and the United States – with hundreds of dead bats found. As bats are important insect predators, bat mortality imbalances the eco-system. Siting of wind turbines too near flyways have also been found to result in raptor and other bird kills in New Zealand and the United States.	If wildlife move away from areas where wind turbines are located, and concentrate in areas away from the wind turbines, is this not loss of habitat? Southern Ontario wildlife habitat areas are already threatened by other developments, and is the siting of wind turbines not just another pressure on wildlife? Are not sustainable energy projects supposed to have minimal impact on all living creatures?

This table was prepared to help educate the public on the issues surrounding wind turbines. Comments are welcomed.

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