Author's response to reviews

Title: An investigation of wind energy and health: quantifying electromagnetic fields around wind turbines in Canada

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Author's response to reviews: see over
December 31, 2013

Dear Editor in Chief and Editorial Board of Environmental Health,

My co-authors and I would like to thank the reviewers for taking time to provide comments on our submission:

*An investigation of wind energy and health: quantifying electromagnetic fields around wind turbines in Canada*

Since receiving your email on November 20, 2013 we have taken care to update the manuscript in light of the reviewer’s comments. You will find below a point-by-point response to the reviewer’s comments and how they were considered in the revised manuscript.

Based on these comments the manuscript has been retitled:

*Measuring electromagnetic fields (EMF) around wind turbines in Canada: Is there a human health concern?*

We look forward to hearing from you and the review team.

Yours sincerely,

Christopher Ollson, Ph.D.
Senior Environmental Health Scientist
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Reviewer 1: sukrı ozen

Reviewer's report:

The aim of the study is to investigate the magnetic field around the wind turbines in Ontario, Canada.

This manuscript presents the results dealt with the measurement of magnetic field around the 15 Vestas 1.8MW wind turbines, and the results were compared with the 500kV power lines magnetic field and other some devices magnetic fields in homes.

This study is mainly dealt with wind turbines magnetic field measurement. It has not a technical evaluation and, very simple, it has not scientific evaluation. The presented work may be a technical report. The idea and the analysis are clear.

**Authors’ Response:** The reviewer has not provided substantive comments on the manuscript. Based on the other two reviewers’ comments we believe that the work demonstrates clear scientific merit and adds to the current body of knowledge on wind turbines and human health.
Reviewer 2: Wendy Heiger-Bernays

Reviewer's report:

This paper examines the electromagnetic fields (EMFs) around 15 wind turbines in Ontario, Canada. The issue of EMFs has been studied in many systems and the lack of clear, consistent results relating exposure to adverse health outcomes results in guidelines that include measurements of levels from common sources. In regard to EMFs from wind turbines, the authors correctly identify the public’s concern and the lack of measurements to document the levels of EMFs at and at distance from turbines. The measurements are compared with recommendations of regulatory and guidance setting bodies.

Is the question posed by the authors new and well defined? Yes, the question posed by the authors is well defined and while it is not a new question, it fills a gap in the existing data obtained about wind turbines.

Authors’ Response: Acknowledged, thank you for your review. No further response required.

Are the methods appropriate and well described, and are sufficient details provided to replicate the work? Yes and No. The methods are appropriate and are in line with many other measurements of magnetic field strength near power lines. The methods are not well described.

Authors’ Response: Acknowledged. Please see the comment responses below for manuscript revisions.

Are the data sound and well controlled? The data are sound, although there is at least one instance when they could be better controlled in order to draw the conclusion that the authors draw. Specifically, statements are made by the authors that the magnetic fields associated with wind turbines appear to be related to the control and maintenance elements in the substation. An estimate of the total power dissipation consumed by these elements should be included; this estimate should be compared to the power usage in a typical household.

Authors’ Response: Acknowledged. Please see the comment responses below for manuscript revisions.

Does the manuscript adhere to the relevant standards for reporting and data deposition? Yes, with the exception of complete citations in the reference section.

Authors’ Response: Acknowledged. Please see the comment responses below for manuscript revisions.

Are the discussion and conclusions well balanced and adequately supported by the data? Yes, although the reader must sort through the measurements to

Authors’ Response: The above comment appears to have been cut off.

Do the title and abstract accurately convey what has been found? No, the title is misleading. This paper focuses on the measurements of EMFs at multiple sources and does not investigate health outcomes. As such, the title should reflect the work conducted.

Authors’ Response: The title has been revised to reflect that measurements of EMF were conducted and that the results were evaluated in the context of potential human health concerns.

Is the writing acceptable? The text should be revised to eliminate redundancies and value statements.

Authors’ Response: Acknowledged. Please see the comment responses below for manuscript revisions.

Please make your report as constructive and detailed as possible in your comments so that authors have the opportunity to overcome any serious deficiencies that you find and please also divide your comments into the following categories:

Major Compulsory Revisions:
1. The descriptions of the “health” guidelines and studies needs to be carefully reviewed and corrected. For example, WHO does not categorize carcinogens, but adopts the IARC definitions.

**Authors’ Response:** We note that IARC is in fact a WHO agency and the manuscript was revised to clearly outline where we were referring to IARC WHO and other areas where it was appropriate to reference the WHO alone.

2. The measurement methodology should be explained more fully. The magnetic fields being measured are varying with the associated currents (at 60 Hz), although the lack of specificity in the details provided do not allow for replication of the work. Are the measurements documenting the rms value of the sinusoidal field strength? The peak value? How long is each measurement averaged?

**Authors’ Response:** Spot measurements of magnetic field (i.e., magnetic flux density measured in units of milliGauss or mG) were obtained using a factory calibrated F.W. Bell ELF Gauss/Tesla Meter (model number 4180). The peak value is measured from three planes (X,Y,Z) and the maximum value obtained over a 5 second period was recorded. These details have been added or clarified in the methods sections of the manuscript.

3. A map showing the location of the individual turbine sites, nearby houses, and the measurement locations would enable the reader to understand the spatial relationships.

**Authors’ Response:** A new figure showing the study site, including turbine locations, collector lines and substations, has been provided with the manuscript as Figure 1. Given that there were over 600 measurements collected throughout this wind farm, it is not feasible to show all sample locations as part of the figure.

4. An analysis section showing how the measured values vary with range, and comparing those curves with simple power law models (e.g. 1/r, 1/r^2) would be very helpful. This would also help to justify the assumptions about the relative independence of measurements from nearby wind turbines.

**Authors’ Response:** We acknowledge and appreciate the reviewers comment; however, the intention of the study is to show the actual magnetic field exposures that people may encounter when living in the vicinity of wind turbines. These results have been presented in a series of comprehensive figures and the authors do not believe an additional section will provide any further clarity regarding the relationship between measured magnetic flux density and distance from the source. To address the second part of the comment, the authors’ assumption about the ‘relative independence of measurements’ is based on the consistency of the actual readings taken in the field where magnetic fields around the wind turbines dropped off to background levels within 2 m and remained at background out to the furthest distances measured (200-500 m). These readings increased only when in the vicinity of another potential source of EMF including overhead transmission lines, substations and occupied homes.

5. It appears that the comparison with powerline magnetic fields accounts only for the one-way current. The authors should be cognizant of the fact that the current paths that cause powerline magnetic fields usually include a return path (in other words, the current flows in a loop), which means that the associated fields partially cancel. Accounting only for the one-way current would be a conservative assumption.

**Authors’ Response:** We appreciate the comment and note that the measurements were collected to ascertain actual exposures that people may have in proximity to these EMF sources and acknowledge that our intention throughout the design, implementation and analysis was to be conservative but to measure actual exposures.

6. Statements are made by the authors that the magnetic fields associated with wind turbines appear to be related to the control and maintenance elements in the substation. An estimate of the total power dissipation consumed by these elements should be included; this estimate should be compared to the power usage in a typical household.
Authors’ Response: We appreciate the reviewers comment; however, this information is not available to us and given the extremely low-level measurements collected around the wind turbines under all three operational scenarios, although this detail might be of interest, is not pertinent to our study and would not have any major implications on the results or conclusions.

7. General comment on the “Background” section: The text needs to be clarified and condensed. The text documenting the evidence and basis for conducting the measurement campaign can be shortened. The material on page 6 is a slightly different presentation of that presented on page 4.

Authors’ Response: Acknowledged, the background section of the manuscript has been revised with this in mind.

Minor Essential Revisions:

8. P 4. EMF as an acronym is used, the term had not yet been defined.

Authors’ Response: The correction has been made in the manuscript.

9. P4. Final sentence: “The authors…” not needed since the thought is already presented earlier and the tone of this note is derogatory.

Authors’ Response: This was not the intention of the authors. We have removed the sentence from the paper.

10. p. 5. The extended description of the epidemiological and animal data that for the basis for the categorical definition of EMF by IARC & WHO is redundant and not correct.

Authors’ Response: Respectfully, we disagree with this comment as we believe that it sets the stage for the study and feel that description of the epidemiological and animal data is correct. There was one minor wording error regarding the state of evidence ("less than sufficient" was changed to "inadequate") in our categorical definition that has been revised in the manuscript.


Authors’ Response: Acknowledged, a reference to Chapman et al., 2013 was added to the text.

12. p. 6. The text that outlines the ICNIRP is not clear. The reader is left figuring out exactly what is useful and what is redundant.

Authors’ Response: We have removed the later part of the paragraph and condensed the text to improve the clarity of this section.

13. p. 7. The first sentence is neither clear nor convincing. Isn’t the fact that evidence is either lacking or suggestive reason to conduct the study so that the data can be used to inform the decision-making process?

Authors’ Response: Acknowledged, we have removed the sentence.

14. p. 11. Statement made about the slight elevation above background measured outside these homes is presumed to be related to EMF generate within the home. What exactly does this mean?

Authors’ Response: Additional text has been added to the manuscript in order to clarify and expand upon our original discussion.

15. p. 12-13. A table that presents the range of measurements at the homes and comparisons with guidelines (ICNIRP, WHO) and other source data is valuable. This way the discussion can focus on the
comparison. The comparison IARC and WHO (?) values should not be repeated. They are presented here and in the Background.

**Authors’ Response:** The authors agree that comparisons among the available data and guidelines is valuable; however, we have chosen to present this information in graphical form since it is generally easier to assimilate. Figure 3 (updated to Figure 4 in the revised manuscript) shows measured levels (mG) around wind turbines, near the 500 kV line and in close proximity to common household devices, with all of these data being compared to the ICNIRP guidelines. To further address the comment, the manuscript has been revised with the intention of reducing repetition.

16. p. 13. The sentence that begins “moreover” seems to indicate that limited EMF levels indicates that contribution form the turbines is negligible to human exposure. This paper does not evaluate human exposure, but does evaluate EMFs and can compare with magnetic field levels associated with household appliances. Without a robust examination of the physics and biology, it is best if the authors focus on EMF measurements and not venture into the area of human exposure.

**Authors’ Response:** The authors disagree with the reviewer’s comment requiring examination of physics and biology to discuss human exposure. The exposure in this case refers to the level of EMF (characterized by magnetic flux density) that a person living near a wind farm may be exposed to as a result of their proximity to various sources (i.e., wind turbines, power lines, substations). The measured levels were then compared to common sources of EMF that people encounter every day in order to provide a relevant comparison of exposure and to provide context. Additionally, the international guidelines referenced in this study are based on the protection of human health from exposure to EMF which is highly relevant to our study.

17. p.13. EMF levels were 0.9 mG. Mean levels? Maximum?

**Authors’ Response:** We have updated the text to clarify that this value is the mean (n=11) of all measurements collected at the base of the turbines.

18. p.13. As written, the EMF levels decreased to background within 2 m of the turbines and remained at background out to 200 m and in one case out to 500 m. Does this mean that they then increased above background? If so, then the measurements should have been taken out beyond these distances. If not, then the sentence must be rewritten.

**Authors’ Response:** Acknowledged, the sentence has been revised to clarify that for each turbine measurements were collected out to 200 m where the levels remained at background and in a few instances, where the surroundings allowed us to take readings out further, the levels remained at background (to a maximum distance of 500 m).


**Authors’ Response:** The discussion and conclusions sections have been revised with this in mind.

20. Reference Section lacks complete citations (no dates) for web-based materials and needs to be corrected.

**Authors’ Response:** We appreciate the comment; however, as per the Environmental Health “Instructions for authors” as outlined on their website (http://www.ehjournal.net/authors/instructions/research#formatting-references), the citations for web-based materials do not stipulate the inclusion of dates. This change has not been made in order to remain consistent with the journal’s instructions.

21. Figure 2 presents magnetic fields in a scale that demonstrates that the mG near the turbine are “0”. Is this the intention? Are these the mean values from all measurements? Please clarify.
**Authors’ Response:** Figure 2 (which has been changed to Figure 3 in the updated manuscript) shows a comparison of the magnetic fields (mG) measured near wind turbines (mean, n=11) and a 500 kV power line. Since the average magnetic field level at the base of the turbines was 0.9 mG and decreased to background by 2 m, this is what was presented in the graph. Due to the range of values on the axis (from 0 mG to 50 mG), such low values appear to be close to zero. The purpose of this figure is to show the data collected from the 500 kV line and compare those levels to the average levels measured around the wind turbines, which are much lower.

**Discretionary Revisions:**

22. The paper would be strengthened by including a section on basic physics - including clarification of electric fields vs low frequency due to infrasound waves. These are "extremely low frequency" fields (less than 100 Hz), and are therefore well approximated as static fields. This means that unlike radio waves, the magnetic and electric fields operate independently from one another. Electric fields are relatively easily attenuated by any number of common materials, as well as any electrical conductors between the point of measurement and the source. Magnetic fields, in contrast, are quite difficult to attenuate and are little affected by most building materials. The strength of quasi-static magnetic fields is measured in Gauss - typical background levels are on the order of 1 mG. The magnitude of magnetic fields associated with power lines is proportional to 1/distance from the current-carrying wire, and directly proportional to the current (measured in amps). There are many examples of modeling power line magnetic field strengths, with corroborating measurements (for instance, see Progress In Electromagnetics Research B, Vol. 37, 343-364, 2012 ACCURATE CALCULATION OF THE RIGHT-OF-WAY WIDTH FOR POWER LINE MAGNETIC FIELD IMPACTASSESSMENT, F. Moro* and R. Turr).

**Authors’ Response:** Acknowledged, additional text of this nature was added to the start of the Discussion section of the manuscript.

**Level of interest:** An article of importance in its field

**Quality of written English:** Acceptable

**Statistical review:** No, the manuscript does not need to be seen by a statistician.

**Declaration of competing interests:** I declare that I have no competing interests
Reviewer 3: Ray Copes

Reviewer's report:

Minor Essential Revisions

1) p.5 The IARC classification of 2B applies to 'extremely low frequency magnetic fields' specifically rather than 'EMF' overall. The IARC rating of the animal evidence was reported in the monograph as 'inadequate' rather than 'less than sufficient'. These statements also appear on p.13 and should be changed there as well.

Authors' Response: Acknowledged, thank you for your review. These revisions were made to the manuscript.

2) p.7 When was the meter calibrated, what was the accuracy at the levels measured?

Authors' Response: Measurements were obtained using a factory calibrated F.W. Bell ELF Gauss/Tesla Meter (model number 4180). In order to check to ensure that the meter was working correctly we tested it by placing it in proximity to known sources of EMF; such as a microwave and hair dryer. Some of the meter specifications, including accuracy, have been added to the methods section of the manuscript.

3) p.7 Please provide details on which protocol was followed.

Authors' Response: The methods section has been updated to expand upon the study protocol development, including sources.

4) p.8 Please provide additional details on why 10% of the readings were collected in duplicate and how these were obtained. How much variation was there in the duplicate values?

Authors' Response: Although the protocol documents did not provide specific recommendations on duplicate sampling or frequency we believed it was important to ensure that the study could be reproduced and to check the data for quality assurance. The duplicate readings were identical or varied by ± 0.1 mG. This has been added to the results section of the manuscript. Such a rate of duplicate measurements are common in environmental sampling of other media, such as soil, air and water samples.

5) p.9 Please indicate whether humidity was recorded.

Authors' Response: Relative humidity levels were obtained as part of the MET data and have been added to the methods section of the manuscript.

6) p.10 Please explain why the higher of the two readings was taken for duplicate measurements rather than the average

Authors' Response: Given that the duplicate samples were either identical or varied only by ± 0.1 mG, the authors were aware that the difference was negligible but chose to use the greater of the two values to ensure the data were as conservative as possible.

7) p.11 Support should be provided for the statement that the slight elevation above background is attributable to EMF generated in the home rather than simply presuming this.

Authors' Response: Acknowledged, the discussion was expanded to further clarify our reasoning on this issue. The following text has been added to the manuscript: “It is believed that this slight elevation above background measured outside of these homes is related to EMF generated within the home (i.e., wiring and use of electric devices). This is based on the fact that measurements collected outside of a home with no power connection were within background levels (0.2 mG). Despite this slight difference, the measurements taken outside of homes were all <0.5 mG and considered to be very low.”
Discretionary Revisions

1) p.5 It may be more accurate to say EMF is ‘frequently’ rather than ‘constantly’ raised as a concern

Authors’ Response: Agreed, the manuscript has been revised accordingly.

2) p.5 Consider changing ‘health issues’ to ‘health symptoms’

Authors’ Response: This change has been made in the manuscript.

3) p.9 It would be helpful to the reader to provide a diagram showing where the measurements were taken relative to the wind turbines with the underground collector lines, overhead power lines, substations and residences shown.

Authors’ Response: A new figure showing the study site, including turbine locations, collector lines and substations, has been provided with the manuscript as Figure 1. Given that there were over 600 measurements collected throughout this wind farm, it is not feasible to show all sample locations as part of the figure.

Level of interest: An article whose findings are important to those with closely related research interests

Quality of written English: Acceptable

Statistical review: No, the manuscript does not need to be seen by a statistician.

Declaration of competing interests: I declare that I have no competing interests

Additional Comments (provided via email):

We would be grateful if you could address the comments in a revised manuscript and provide a cover letter giving a point-by-point response to the concerns.

As for the formatting, The title should include the study design, for example "A versus B in the treatment of C: a randomized controlled trial X is a risk factor for Y: a case control study".

Authors’ Response: Acknowledged. Since the study design is measuring electromagnetic fields around wind turbines to address potential health issues, the title has been revised to reflect this. The revised title is: ‘Measuring electromagnetic fields around wind turbines in Ontario, Canada: Is there a human health concern?'

On the title page remove the information below the phrase *Corresponding author. In the Abstract, remove the colons after the headings and move the text below its respective heading.

Authors’ Response: Acknowledged, these revisions have been made to the title page and abstract.

Please create separate Results and Discussion sections.

Authors’ Response: Acknowledged, separate results and discussion sections have been included. Please see the manuscript for revisions.

In the References, bold the volume numbers and remove the issue numbers. Please also ensure that your revised manuscript conforms to the journal style (http://www.ehjournal.net/info/instructions/ ). It is important that your files are correctly formatted.

Authors’ Response: Acknowledged, these revisions have been made in the references section of the manuscript.

We look forward to receiving your revised manuscript by 1 January 2014. If you imagine that it will take longer to prepare please give us some estimate of when we can expect it.
You should upload your cover letter and revised manuscript through
http://www.ehjournal.net/manuscript/login/man.asp?txt_nav=man&txt_man_id=1152950097110049. You
will find more detailed instructions at the base of this email.