

**STATE OF VERMONT
PUBLIC SERVICE BOARD**

Joint Petition of Green Mountain Power Corporation,)	
Vermont Electric Cooperative, Inc., Vermont Electric)	November 22, 2010
Power Company, Inc., and Vermont Transco LLC,)	
for a Certificate of Public Good, pursuant to 30 V.S.A.)	Docket No. 7628
Section 248, for authority to construct up to a 63 MW)	
wind electric generation facility and associated facilities)	
on Lowell Mountain in Lowell, Vermont, and the)	
installation or upgrade of approximately 16.9 miles of)	
transmission line and associated substations in Lowell,)	
Westfield and Jay, Vermont.)	

**PREFILED REBUTTAL TESTIMONY OF DR. T. RAY LOVKO M.D.
ON BEHALF OF ALBANY, VERMONT**

Summary: The purpose of Dr. Lovko's testimony is to highlight the shortcomings of the report (Exhibit DPS-WEI-2) submitted as part of the pre-filed testimony of the Vermont Department of Health on behalf of the Vermont Department of Public Service, and to list some of the issues that were not addressed by the VDH report.

**PREFILED REBUTTAL TESTIMONY OF DR. T. RAY LOVKO M.D.
ON BEHALF OF ALBANY, VERMONT**

1 Q-1 Please state your name, current position, employer and business address.

2 A-1 T.(Teddi) Ray Lovko M.D. I currently work as a board certified physician in Internal
3 Medicine at Family Medicine in Rutland, Vermont and as a Hospitalist at Rutland Regional
4 Medical Center in Rutland, Vermont.

5

6 Q-2 Please state your qualifications to provide testimony in this matter?

7 A-2 My curriculum vitae is included as ALB-TL-1. I spent one year of post graduate training in
8 the Ecology and Evolutionary Biology program at Indiana University. I graduated from the
9 University of Virginia Medical School in 1995. While in graduate school I did research on sex
10 ratios in *C. elegans* (unpublished data) and in medical school conducted studies on *Legionella*
11 *micdadei* and antibiotic susceptibilities (unpublished data). I did my residency training at
12 Dartmouth Hitchcock Medical Center in Internal Medicine. Since that time I have been working
13 as a physician in Internal Medicine in Rutland, Vermont.

14

15 I became involved in looking at the issue of health effects of wind turbines after being
16 approached by another physician who was concerned about the effects that these installations
17 might have on people in Rutland County. Since that time I have read extensively on these issues,
18 attended several forums on wind turbine noise and health and helped organize an educational
19 conference at Rutland Regional Medical Center on wind turbines and health.

20

21 Q-3 Have you ever testified before the Vermont Public Service Board?

22 A-3 No.

23

24 Q-4 Do you have any specific expertise on wind turbines or the potential health impacts
25 experienced by people living in proximity to wind turbines?

26 A-4 As a physician in Internal Medicine I am called upon to treat a large number of health
27 issues. As part of my training and job requirements I have to review scientific and medical
28 literature on a regular basis to make sure I stay abreast of new diseases, treatments and public

1 health related issues. I also have to be able to interpret these studies and apply them to real
2 world situations. It is these same skills that I have put to work reviewing the scientific and
3 medical literature about wind turbines and their effects on health.

4
5 Q-5 Have you reviewed the report entitled “Potential Impact on the Public’s Health from Sound
6 Associated with Wind Turbine Facilities”, dated October 15, 2010, prepared by staff at the
7 Vermont Department of Health and submitted in this matter as Exhibit DPS-WEI-2 (hereinafter
8 the “VDH Report”)?

9 A-5 Yes.

10

11 Q-6 Have you reviewed the papers and other sources cited by the VDH Report?

12 A-6 Yes, I have reviewed the papers they cite in their report. I have also read many other
13 reports in the acoustic literature, health literature, other health experts’ testimony on the issue,
14 lay press reports, and I have reviewed a number of non-peer reviewed surveys and unpublished
15 papers, and had personal communications with other experts in the field.

16

17 Q-7 Do you support the conclusions of the VDH Report?

18 A-7 I do in part. I agree with the VDH Report that there is evidence of adverse health effects
19 and sleep disturbance related to nighttime sound levels from wind turbines.

20

21 However, my review of the literature and available evidence does not support their
22 recommendation that limiting nighttime sound levels from wind turbines to 40dB as measured at
23 the exterior facade of the dwelling averaged over 12 months will be protective of public health.

24

25 There is also not enough available evidence to support their conclusion “that there is no direct
26 health effect from sound associated with wind turbine facilities” or to rule out other ways in
27 which wind turbines may be having adverse health effects on people.

28

29 Q-8 In what way is the recommendation “that nighttime sound levels from wind turbines be
30 limited 40 decibels or less, as measured at the exterior facade of the dwelling and averaged over

1 12 months of exposure” not sufficient to protect the public health?

2 A-8 There is well accepted evidence in the medical literature that shows noise can cause adverse
3 health effects on people, including hypertension, heart disease, hormonal stress reactions, and
4 sleep disturbance, as well as many other problems (WHO 2009). The WHO 2009 Report on
5 nighttime noise gives a good overview of the mechanisms and effects of noise on health. It is
6 believed that many of these effects arise as a result of sleep disturbance, although there are other
7 pathways by which sound can also have adverse health effects on an individual both directly and
8 indirectly (WHO 2009).

9

10 The recommendation in the VDH Report regarding sound levels is taken from the WHO 2009
11 Report which was based on studies of various noise sources and their effects on health. The
12 WHO 2009 paper, while an excellent general overview on nighttime noise and health issues, is a
13 general guideline and will not be equally applicable to all situations as the paper itself
14 acknowledges. For example, the paper says that lower sound level limits will need to be
15 provided for noise sources with high levels of low frequency sounds (such as wind turbines) as
16 these sources are more likely to create health problems. Lower sound limits will also be required
17 when sounds are not continuous (i.e. fluctuate like wind turbine noise) and in areas where
18 background sound levels are low (such as rural areas like Lowell/Albany) (WHO 1999). It must
19 also be kept in mind that the WHO 2009 Report does not make any specific references to wind
20 turbine noise or cite any studies on wind turbine noise. Most of the studies they refer to are
21 based on road noise, air traffic, and community noise.

22

23 Wind turbine sound has a number of attributes which make it different than these other
24 commonly studied noise sources. Wind turbines are frequently placed in rural areas which often
25 have very low background sound levels of 20-30dB. Wind turbines emit large amounts of low
26 frequency and infrasound that travels farther than higher sound frequencies and which is poorly
27 attenuated by walls and windows and is capable of causing noise related to the vibration of these
28 structures (Colby et al 2009, Hanning 2010, Minnesota Department of Health 2009, Roberts and
29 Roberts 2009). Wind turbine sound often shows amplitude modulation, a pulsatile nature to the
30 sound that has been shown to be more annoying than steady noise (Bradley 1994, Holmberg et al

1 1997). Wind turbines will often be as loud or louder at night than they are during the day (van
2 den Berg 2008). Wind turbines can be a source of continuous fluctuating sound for long periods
3 of time depending on wind conditions. This unique combination of features makes it plausible
4 that wind turbines might have adverse health effects more frequently and at lower sound levels
5 than the noise sources cited in the WHO 2009 report.

6
7 Indeed the literature on this topic does show annoyance (an adverse health effect in its own right
8 according to the WHO 2009 Report) and sleep disturbance from wind turbines at lower sound
9 levels than for most other noise sources. Two of these studies done in Sweden show levels of
10 annoyance and sleep disturbance starting to rise at or below 35dB, with 28% showing annoyance
11 at sound levels of 37.5-40dBA and continuing to rise as sound levels increase above
12 40dB(Pedersen and Persson 2004, Pedersen and Persson 2007). When looking at both studies,
13 almost 50% of people reported annoyance at sound levels greater than 40dBA and in one of the
14 studies 64% of those suffering annoyance also reported sleep disturbance. People living in rural
15 areas also tended to suffer more annoyance from wind turbines, as did those living in ‘complex’
16 or hilly terrain (Pedersen and Persson 2007). Another study from the Netherlands showed wind
17 turbine noise to be “more annoying than transportation noise or industrial noise at comparable
18 levels, possibly due to specific sound properties such as a ‘swishing’ quality, temporal variability
19 and lack of nighttime abatement” (Pedersen et al 2009) This same study showed 18% of people
20 annoyed at 35-40dBA and evidence of sleep disturbance. Given these studies that indicate
21 adverse health effects correlating with sound levels as low as 35dB from wind turbines, the
22 recommendation of 40dB in the VDH Report is too high to be protective of health.

23
24 The WHO 2009 report relied on by VDH in fact specifically makes the point that 40dB is a
25 threshold level of noise, and that once noise exceeds that level you are likely to have an adverse
26 impact on public health. This does not even take into account the unique sound characteristics of
27 wind turbines, as discussed above, and therefore, a noise limit must be set for this project that
28 takes into the nature of wind turbine noise, the low existing background levels, and the WHO
29 findings which suggest that even a 35dBA limit may result in annoyance and sleep disturbance.

30

1 Another problem with the recommendations in the VDH Report is the fact that they are
2 recommending that sound levels be averaged over a period of 12 months. The WHO 2009 report
3 states that “instantaneous effects such as sleep disturbance are better (correlated) with the
4 maximum level per event LAMax” than with long term sound averages. Averaging sound levels
5 over this long period of time would allow sound levels to rise high enough to cause health
6 problems and sleep disruption, while still being in compliance as long as there were periods of
7 low sound levels to average out these higher peaks. The fact that wind turbine sound often
8 shows amplitude modulation makes it even more possible for this to occur. It has been shown
9 that these pulses of sound can occur over a range of 5dB, meaning that the sound could spike
10 into ranges disruptive of sleep, and yet the average sound level would suggest that the sound
11 levels are within the prescribed limits and protective of health and sleep when in fact they are
12 not. It does not take prolonged noise elevation to disrupt sleep and these brief peaks of noise
13 have the potential to disrupt sleep many times during a night. If the main goal is to prevent sleep
14 disturbance, sounds should not be averaged or would need to be averaged over very short time
15 periods, otherwise the ‘peaks’ of sound that are enough to disrupt sleep will be undetectable
16 when averaged out with quieter times. If this is not done, compliance becomes uncoupled from
17 the goal that it was set out to achieve, which is prevention of sleep disruption.

18
19 The literature indicates that the recommendation in the VDH Report of a 40dB standard is too
20 high and the 12 month average is too long to protect public health. Both of these factors would
21 mean that people would be likely to suffer adverse health effects and sleep disruption from wind
22 turbine noise, and therefore in my opinion the VDH recommendations would not be protective of
23 public health.

24
25 Q-9 Please explain how you researched the issue of health impacts related to turbine noise, and
26 compare your review to the review conducted by VDH.

27 A-9 I undertook a review of the published literature on wind turbines and noise as well as
28 reading review papers on the issue by other experts, much like VDH. Unlike the VDH report, I
29 also attempted to read the primary source articles on wind turbines and health when available,
30 rather than just the review papers. I also reviewed many unpublished case series, papers,

1 surveys, and press reports that were available to me. Some of these studies represent examples
2 of case crossover studies and are highly suggestive that wind turbines are causing the health
3 issues described (Phillips 2010). While these nonpeer reviewed surveys and case reports may
4 not be a basis for drawing definitive conclusions in and of themselves, they are relevant in that
5 the spectrum of complaints and levels at which complaints occur are remarkably consistent
6 across these reports. They represent real world examples of what would be expected from the
7 available literature on noise and health in general and in particular with wind turbine noise and
8 health effects. Thus they support the research that is available as being accurate.

9

10 Q-10 What sound level does the literature you have reviewed suggest would be protective of
11 public health?

12 A-10 The available studies do not provide a definitive answer as to what the exact sound levels
13 and distances need to be to be protective of the public health. The ideal studies to show exactly
14 at what distances and sound levels people's health will not be affected have not been done.
15 Furthermore, even if those studies were available they would not be applicable to every location,
16 type of wind turbine and circumstance that would arise and would still require interpretation as
17 to how to apply them to any given situation. Therefore we must use the best evidence available
18 to try and meet the needs of protecting the public health, and must also err on the side of caution
19 as this is still an emerging scientific issue.

20

21 If using 40dB as a threshold for nighttime sound levels is a general guideline for protecting
22 health (pursuant to WHO 2009), it follows that for a sound source such as wind turbines, which
23 cause annoyance and sleep disturbance at lower levels than most noise sources (due to amplitude
24 modulation, low frequency noise and their locations in quiet rural settings) that the 40dB
25 recommendation will be too high and a lower level will be required.

26

27 The best available studies on wind turbines show that the levels of self reported annoyance and
28 sleep disturbance start to rise at about 35dB as measured outside the building. The studies from
29 Sweden and the Netherlands referenced above have some important limitations and may
30 underrepresent the problems we might see with current wind turbine proposals in Vermont. It is

1 important when looking at these studies to remember that the Swedish studies were done looking
2 at wind turbines which are significantly smaller than the sizes of most current wind turbines,
3 were placed in smaller numbers per array, and often on flat terrain. The study from the
4 Netherlands also did not closely match conditions in Vermont. Current wind turbine proposals
5 in Vermont are likely to show even higher levels of annoyance and sleep disruption as evidence
6 suggest that sound levels and annoyance are likely to be worse as turbines get larger (more
7 noise), there are more turbines in an area (more noise), and when they are placed on hills or
8 ridgelines (more noise which carries farther).

9

10 When looking at the Pedersen studies it is also important to take into account, as Dr. Christopher
11 Hanning points out (Hanning 2010), that these events are self reported and that unrecalled
12 arousals from sound events are likely much higher, and thus sleep disturbance is likely much
13 worse than is being reported. These arousals can occur at sound levels around 35dB exterior and
14 are not generally recalled, but do show adverse changes in heart rate and blood pressure each
15 time they occur. Given that sleep research suggests arousals can start to occur at sound levels
16 around 35dBA (Hanning 2010) and current studies show a marked rise in annoyance and sleep
17 disturbance at sound levels greater than 35dBA, 35 dB exterior or below is likely to be protective
18 of public health.

19

20 Below are some recommendations from other health and sound experts that I have relied on, who
21 support similar sound levels as noted in Hanning's 2010 paper. Hanning's paper *Wind Turbine*
22 *Noise, Sleep and Health* is submitted as ALB-RJ-4.

23

24 -Phipps, based on his research on wind turbines in hilly and mountainous regions in New
25 Zealand, recommended sound levels not to exceed the background sound level (L95) by more
26 than 5dBA, or a level of 30dBA L95, whichever is less (Hanning 2010).

27

28 -Hanning, a world renowned expert on sleep and well versed on wind turbines and health,
29 recommends a maximum external limit of 35dBA in the absence of excessive modulation
30 (Hanning 2010)

1 -Kamperman and James suggest turbine noise should not be more than 5dBA above background
2 levels and should not exceed 35dBA within 30 meters of any occupied structure. (Hanning
3 2010).

4
5 -New Zealand Standard 6808 provides that the evening and nighttime levels may be set at 35dB
6 La90(10min) or 5dB above the background level, whichever is higher. (Hanning 2010).

7
8 -The Dutch National Institute for Public Health and Environment recommend an outdoor Lden
9 limit of 40dBA as the “no effect level” (Hanning 2010).

10

11 -Thorne concludes that unreasonable noise occurs at noise levels above 30dBA L90 in the
12 presence of amplitude modulation and with van den Berg states that 30dBA L95 in conditions of
13 low wind speed with modulation restricted to 3dB would likely be protective of health and from
14 annoyance. (Hanning 2010).

15

16 -The Minnesota Department of Health paper on wind turbines and health comments that
17 complaints rise with sound levels above 35dBA. (Minnesota Department of Health 2009).

18

19 -A summary report by the Ohio Department of Health on wind turbines suggests “that
20 operational noise levels at these distances should be kept to levels at or below 35dBA.” (Ohio
21 Department of Health 2008).

22

23 Q-11 Are there studies or papers that you are aware of that were not reviewed as part of the VDH
24 Report that you think should have been included?

25 A-11 There is a growing body of data showing health complaints from people living near
26 turbines. Much of this data is unpublished, self reported or in the lay press. While these reports
27 reinforce the fact that people living near wind turbines are suffering from a large number of
28 complaints, they do not tell us at what sound levels or distances these effects would be mitigated.
29 A very important review of wind turbines and health by Dr. Christopher Hanning, a sleep expert,
30 is important to read as it gives an excellent and thorough review of what we know about wind

1 turbine sound and health. As mentioned, it has been submitted with the rebuttal testimony of
2 Rick James as ALB-RJ-4. It is an excellent complement to the WHO 2009 paper in that it looks
3 specifically at the data on wind turbines and sleep, which was not covered in the WHO reports.
4 It helps to illustrate clearly how and why the sound limits proposed by the VDH are too high and
5 not protective of health.

6
7 Additionally, an unpublished case control study by Dr. Michael Nissenbaum on wind turbines
8 and health effects in Mars Hill, Maine is important to review. The study closely mimics
9 conditions in Vermont (due to similarities in topography and ridgeline turbine placement) and
10 thereby gives us a look at what kind of effects we might expect to see here. It is also one of the
11 only studies to use a control group to compare the health of those near turbines (within 3500
12 feet) with those far away (3 miles). While this study does not define a safe sound level, it
13 suggests that those within 3500 feet may suffer rates of sleep disturbance up to 82%, decreased
14 quality of life in 95%, increased rates of use of prescription medications, headaches, stress, and
15 depression (Nissenbaum 2010). This study emphasizes how important it is that sound levels be
16 set at proper levels, as the adverse health effects can be very significant – however it must be
17 noted that the Mars Hill project consisted of smaller 1.5 MW turbines, and therefore the effects
18 of the current proposed project may be even greater due to increased noise levels from the larger
19 turbines.

20
21 Q-12 In your opinion, does the Petitioner’s failure to address infrasound mean that they have not
22 fully characterized the potential health effects of this project?

23 A-12 Yes. I think there is preliminary evidence to suggest that infrasound may have more
24 physiological effects than was previously appreciated. There are number of studies in animals
25 and some in humans to suggest that these sounds may have effects that were previously
26 unappreciated (Pierpoint 2010). It will take more research to determine what clinical
27 significance these may have in the long term, however by not addressing this issue, the Petitioner
28 has not fully characterized the potential health impacts of the project.

29 Q-13 The Public Service Board has previously (in other dockets relating to wind turbine
30 development) used a noise standard of 45 dBA (exterior)(Leq)(1hr). In your opinion, is this

1 standard protective of public health?

2 A-13 No. 45 dBA is too high and will not protect people from the health effects and sleep
3 disturbance they will experience at these sound levels. These levels are higher than those
4 recommended in the WHO 2009 report. The studies I have discussed earlier show significant
5 sleep disturbance and annoyance at levels much lower than this. You could possibly see levels
6 of annoyance in as many as 50% of people at these sound levels. I am not aware of any studies
7 on wind turbines that show that these sound levels would prevent annoyance and sleep
8 disruption. This standard is not protective of public health.

9

10 Q-14 The Petitioner has requested that the Public Service Board impose a noise standard of 45
11 dBA (exterior)(Leq)(8hr). In your opinion, would this standard be protective of public health?

12 A-14 No. This request is even more problematic than 45dBA (exterior)(Leq)(1hr) discussed
13 previously. The 45dBA standard is too high since, as mentioned previously, we see sleep
14 disturbance starting at levels as low as 35dBA. This recommendation simply ignores the
15 updated recommendations of the WHO 2009 paper on lower sound levels. It is also important to
16 note that the WHO 1999 report states that “if the noise is not continuous, sleep disturbance
17 correlates best with LAMax” and that “this is particularly true if the background level is low.” I
18 am not aware of any studies on wind turbines that show that these sound levels would prevent
19 annoyance and sleep disruption.

20

21 Also as discussed previously, the longer the time period over which one averages the sound
22 levels, the easier it becomes to be in compliance with the noise standard while having sound
23 levels present which would be harmful to sleep and health. This standard would therefore not be
24 protective to the public health, as it would allow for noise to exceed 45dB – which the WHO
25 report clearly found to be problematic – for up to several hours during the night, leading to sleep
26 disturbance and health impacts, yet the standard would not be violated. This is simply not
27 protective of public health, and such a standard is not supported by the relevant literature.

28

29 Q-15 The Petitioner’s expert, Mr. Kaliski, testified that “the sound levels from the turbines will
30 not rise to a level that... [would] pose quality of life concerns with respect to sleep

1 disturbance....” Do you agree?

2 A-15 No. The best data available on wind turbines shows that annoyance and sleep disturbance
3 start at levels as low as 35dB. His statement also goes against the updated WHO 2009
4 recommendations with regards to what safe sound levels should be. I do not think his expertise
5 qualifies him to make that statement and the evidence does not support it.

6

7 Q-16 What noise standard do you believe the Board should employ, based on your review of the
8 applicable literature?

9 A-16 I believe that the evidence suggests that nighttime sound levels should be a maximum of
10 35 dBA as measured at the exterior facade of the dwelling in order to be protective of public
11 health and to avoid sleep disturbance and the health effects that go along with it. Any levels
12 higher than this will in all likelihood subject a not insignificant percentage of people to sleep
13 disturbance and adverse health effects. This recommendation supposes accurate sound modeling
14 and monitoring.

15

16 I would also caution that even a maximum exterior sound level of 35 dBA may not be protective
17 in all cases, as there are studies showing sleep arousals and disturbance at or below this level.
18 Additionally, people’s sensitivities to noise can vary, not all the complaints related to wind
19 turbines are likely to be related exclusively to sound levels and sleep disruption, current studies
20 are limited in scope and time, and the effects of infrasound are still being explored. I urge the
21 Board to err on the side of caution when setting levels that are intended to be protective of
22 human health.

23

24 Q-17 If a less protective noise standard is used for this project, what are some of the potential
25 health impacts that neighboring residents may experience?

26 A-17 You would expect to see sleep disturbance, which is a health problem in and of itself but
27 which also can lead to cardiovascular illness, depression, elevated heart rates, changes in stress
28 hormones, impaired glucose tolerance, increased use of prescription medications (for sleep,
29 depression, hypertension), depression, hypertension, weight gain, headaches, tinnitus, decreased
30 attention, accidents, and decreased school performance. These and other effects have been

1 documented in numerous studies on noise and many have also been shown with respect to wind
2 turbines in particular (Colby et al 2009, Hanning 2010, Nissenbaum 2010, Pierpoint 2010, WHO
3 2009).

4
5 Q-18 Does this conclude your testimony?

6 A-18 Yes, and I have provided a list of my references below for the Board's review.

References

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