

**STATE OF VERMONT
PUBLIC SERVICE BOARD**

Docket No. 7250

Amended Petition of Deerfield Wind, LLC for a certificate)
of public good authorizing it to construct and operate 17 turbine,)
34 to 35.7 MW wind generation facility, and associated transmission)
and interconnection facilities, on approximately 80 acres in the)
Green Mountain National Forest, located in Searsburg and)
Readsboro, Vermont, with 7 turbines to be placed on the east side)
of Route 8 on the same ridgeline as the existing GMP Searsburg)
wind facility (Eastern Project Area), and 10 turbines along the)
ridgeline to the west of Route 8 in the northwesterly orientation)
(Western Project Area))

PREFILED REBUTTAL TESTIMONY OF JOHN ZIMMERMAN

ON BEHALF OF DEERFIELD WIND, LLC

July 3, 2008

Summary:

Mr. Zimmerman's rebuttal testimony responds to the direct prefiled testimony of several parties in this case and provides certain revised exhibits for the 15-turbine project layout described by the Habig/Goland/Cherian witness panel.

1 **Q. Please state your name.**

2 Response: John L. Zimmerman.

3

4 **Q. Have you previously filed testimony in this matter?**

5 Response: Yes, I provided direct testimony on January 8, 2007 and in two
6 supplemental filings on July 30, 2007, and December 4, 2007.

7

8 **Q. What is the purpose of your testimony?**

9 Response: My testimony responds to the direct prefiled testimony of several parties
10 in this case and provides certain revised exhibits for the 15 turbine project layout
11 described by the Habig/Goland/Cherian witness panel.

12

13 **Q. Please describe the exhibits that have been revised to reflect the refinements**
14 **to the project.**

15 Response: The July 2008 refinements to the Project, described in more detail in the
16 Habig/Goland/Cherian panel testimony, necessitated that corresponding changes be
17 made to certain previously-filed exhibits included in my prior testimony. The revised
18 exhibits are as follows:

- 19
 - **Exhibit DFLD-JZ-30a – Overall Site Plan – 15 Turbine Layout.** This map
20 supersedes all previous versions. It illustrates the revised project layout (15
21 turbines), which is described in the rebuttal testimony of the
22 Habig/Goland/Cherian panel. **Exhibit DFLD-JZ-30b** is the site plan showing

1 a comparison of the revised 15-turbine layout and the prior 17-turbine layout
2 (July 2007).

- 3 ■ **Exhibits DFLD-JZ-31a, b – Shadow Flicker Analysis.** This exhibit contains
4 potential shadow flicker maps for the Project’s configuration as described herein.
5 It has been modeled using a similar methodology as previous versions, and the
6 output format has been retained as much as is practical. The original
7 memorandum from AWS Truewind that was part of my Exhibit DFLD-JZ-18
8 remains valid.
- 9 ■ **Exhibits DFLD-JZ-32a, b – Sound Modeling Maps.** This exhibit updates
10 the projected sound levels to reflect the revised 15-turbine project. The rebuttal
11 testimony of Kenneth Kaliski describes the results of his updated sound
12 modeling.

13
14 **Q. Ms. Matthews for the Town of Wilmington claims that as a region, Vermont is**
15 **not as well-suited for wind development as other states since its overall wind**
16 **resource is small (Matthews pft at 4). How do you respond to this claim?**

17 Response: In mountainous areas such as interior New England the strongest wind
18 resources are to be found along the higher-elevation mountain ridgelines. The
19 strong correlation of wind speeds with elevation has been substantiated by the
20 research of many organizations over many years, perhaps most notably from a
21 historical perspective, by the meteorological research conducted in connection with
22 the Smith Putnam Project in Vermont in the 1940s. More recently this effect has
23 been substantiated by decades of wind measurement activity by Green Mountain

1 Power Corp. and other wind power developers in the New England region. In the
2 last decade the results of sophisticated computer modeling of wind flow patterns
3 across the northeast such as those conducted by AWS Truewind have become
4 common and widely available and continue to substantiate this strong relationship.¹
5 While the best winds in Vermont are confined to a relatively small portion of the
6 overall land area – that along the higher ridgelines – it is not accurate to interpret this
7 as the State having an insignificant or small wind resource potential. In fact, studies
8 conducted by the Vermont Department of Public Service have shown that
9 approximately 7,000 MW of wind resource is available on the hundreds of miles of
10 Vermont’s windiest ridge lines, within three miles of existing transmission lines.²
11 Assuming that 10 MW of wind turbine generation can be installed on a mile of
12 ridgeline on average (Deerfield’s modified configuration is >13 MW per mile), even a
13 relatively small portion of total ridgeline available such as 5% could produce over
14 10% of the state’s present annual electricity consumption of approximately 6,000
15 GWH.³

16
17 **Q. Mr. Shea expresses concern about light flicker. He alleges that Deerfield**
18 **Wind’s flicker analysis shows that his residence will receive 10-20 hours of flicker per**
19 **month and that this amount would make it undesirable to occupy his property. He**

¹ AWS Truewind’s New England Wind Map can be found at <http://truwind.teamcamelot.com/ne/>.

² See the *Vermont Comprehensive Energy Plan 2009*, Public Review Draft, May 2008, on Page III-61, available on the DPS website: <http://www.publicservice.vermont.gov>.

³ Id.

1 **also asserts that by his own estimate, his residence will receive a minimum of 40**
2 **hours per month (Shea pft at 7). How do you respond to these claims?**

3 Response: The maps and testimony previously presented by Deerfield Wind
4 (**Exhibits DFLD-JZ-Rev18a, b**) express shadow flicker impacts in terms of hours
5 per year, not hours per month as Mr. Shea contends in his testimony. His
6 estimation of the amount of flicker his property will receive is therefore substantially
7 overstated and incorrect.

8 Our earlier analysis indicated that the Shea residence would not be unduly
9 affected by shadow flicker. With existing vegetation considered, the modeling
10 showed that there would be no shadow flicker at that residence. Even when we used
11 the overly conservative assumption that no shielding vegetation existed in the area,
12 the residence would have potentially received a total of 1-10 hours per year of
13 shadow flicker (not 10-20 hours per month as he contends).

14 The shadow flicker analyses have been updated to reflect the revised 15-
15 turbine layout. *See Exhibit DFLD-JZ-31a, b*. In addition, we have made our
16 modeling assumptions more conservative by extending the analysis to a distance of
17 2,000 meters from the wind turbines (rather than 1,000 meters, as in the original
18 analysis). The new results reflect the removal of the southern three turbines in the
19 Western Site Area, which were generally to the southwest of the Shea residence. As
20 a result, the already low potential for shadow flicker at the Shea residence is further
21 lessened. With existing vegetation considered, the revised modeling shows that
22 there would be no shadow flicker. Even with vegetation not considered, the
23 residence would potentially receive a total of 1-10 hours per year of shadow flicker.

1 **Q. Ms. Linowes for IWAG includes a quotation from an e-mail sent in 2000 from**
2 **John Zimmerman to an American Wind Energy Association mailing list in which he**
3 **discusses ice accumulation on wind turbines as loud and seemingly dangerous**
4 **(Linowes pft at 12). Do you have a response?**

5 Response: The quotes are from the casual communication and are accurate for the
6 time – eight years ago – though taken out of context. Now, with the benefit of eight
7 more years of experience, let me more specifically address the icing issue. The large
8 piece of ice referenced in the e-mail was observed in the winter of 1996 – 1997 when
9 the Searsburg plant was not in service as the turbines were awaiting commissioning.
10 Ice built up on the top of the nacelle when the turbines were not yet in service, slid
11 off the nacelle’s fiberglass surface when the temperature warmed, and landed at the
12 base of the tower. Since that time, the plant has been in service over the winter time,
13 and this phenomenon has not been experienced again. Nevertheless, ice buildup on
14 any overhead structures should be viewed as potentially dangerous to humans
15 underneath. The risk due to falling ice is a factor routinely considered in the alpine
16 ski, winter construction, and utility industries, as it is for wind turbine technicians in
17 the northeast as well. In this respect it is instructive to note that in its 11 years of
18 operation, there have been no known incidences of injuries as a result of ice falling
19 or being thrown from GMP’s wind turbines.

20

21 **Q. Mr. Shea states that turbines pose a safety concern due to the possibility of ice**
22 **shed during the winter (Shea pft at 6). How do you respond to this claim?**

1 Response: As stated above, ice on overhead structures does pose a danger to
2 anyone directly underneath or in close proximity to the structures. Working with
3 the Forest Service, Deerfield Wind will develop plans to control public access to the
4 turbines when dangerous icing conditions exist. As explained in my direct testimony,
5 ice falling from turbines or being shed by a rotating blade should not pose an
6 unacceptable risk to the public as the turbines will be located at sufficient distances
7 from private residences and public roads.

8 The wind turbines Deerfield Wind proposes to use for the Project
9 automatically go into standby mode when the generator speed falls below 850 RPM.
10 Significant ice build up will cause the generator speeds to fall; thus, when significant
11 ice buildup has been detected on a turbine, that turbine will automatically go into
12 standby mode and operational personnel will determine whether to implement “ice
13 rules.” When ice rules are implemented a safety radius is to be established around
14 the tower base. While the turbine is on-line, service personnel will not be allowed
15 within the safety radius and service vehicles will not be allowed to stop within the
16 safety radius. Turbines can remotely be taken off-line from the Operations building
17 as necessary. Ice rules will be rescinded when conditions improve and operation
18 personnel otherwise determine that site conditions warrant it.

19

20 **Q. Mr. Hewson for SVR and Ms. Linowes for IWAG state that Deerfield Wind’s**
21 **estimates of the Project’s potential power generation (capacity factor) are much**
22 **higher than those observed at the existing Searsburg project and others in the region**
23 **(Hewson pft at 5-8; Linowes pft at 9). How do you respond to this claim?**

1 Response: The strength and persistence of the wind at the hub-height of a wind
2 turbine are the primary determinates of how much electrical energy a specific wind
3 turbine will generate. Wind conditions are known to vary widely and predictably
4 across mountainous terrain of various landform shapes and differing elevations.
5 Wind conditions also vary significantly at different heights above the ground cover
6 due to the frictional effect of the ground cover. Assuming good exposure to winds
7 from all directions, the higher above sea level the site is located, the better. Likewise,
8 the higher above ground cover a wind turbine's rotor is located, the better from a
9 wind resource perspective. The combination of these two factors largely explains the
10 difference in wind conditions experienced at the existing Searsburg project, where
11 the turbines are installed at elevations above sea level that are relatively low
12 compared to the proposed Deerfield wind turbines. Hewson's and Linowes'
13 statements do not acknowledge the importance of the variability of wind conditions
14 on a wind turbine's productivity.

15 For an illustrative example of the magnitude of the combination of these two
16 effects, assume that the same turbines as the GMP turbines were to be used for the
17 Deerfield Wind project, installed at the high elevation windier site in the Eastern Site
18 Area (meteorological tower # 690) and at the lower elevation site in the Western Site
19 Area (meteorological tower # 735), and that the turbine at the lower elevation site
20 has a hub-height of 40 meters instead of the 78 meters that would ordinarily be
21 specified for a project today. The calculated difference in annual energy production
22 between the two otherwise identical turbines at Deerfield would be on the order of
23 34%.

1 It is not good practice to compare capacity factors between wind turbines or
2 wind projects when different wind turbines are used. Wind turbine capacity factors
3 are strongly related to the meteorological conditions at hub-height, the size (electrical
4 rating) and efficiency of the electric generator, the size of the rotor, the aerodynamic
5 efficiency of the rotor, the control algorithms, and the availability of the wind
6 turbine. Comparing capacity factors between turbines in the same project, let alone
7 projects using different turbines in different regions of the country, without
8 accounting for all of these factors is problematic, and will lead to meaningless or
9 misleading conclusions. For example, considering just the rotor size variable with
10 the turbines proposed for this project: the Gamesa G80 and G87 are basically the
11 same turbine (same tower height, same generator specification etc.) that if installed at
12 the exact same location (in the same meteorological conditions) would produce
13 significantly different capacity factors – with the turbine with the larger rotor
14 producing approximately 9 percent more energy.

15 In Hewson’s comparison of capacity factors between wind plants in the
16 northeast, he does not consider any of the other key variables noted above, let alone
17 the most important one – the magnitude of the wind resource at the project – a
18 critical omission. To illustrate the significance of this omission, assume that the
19 projects cited by Hewson used the same wind turbine technology and physical
20 configuration, and that the turbines were maintained to achieve the same availability
21 (the holding all things equal constraint). Using these assumptions, the wind resource
22 should be the controlling factor. To test this hypothesis, I acquired the approximate
23 mean wind speeds at 50 meters above effective ground cover for projects cited by

1 Hewson using the AWS Truewind wind resource maps.⁴ Then, using the same
2 generic wind turbine power curve, I calculated the approximate gross average output
3 from a turbine at the location of these plants, and calculated the net capacity factors
4 using a consistent gross to net loss factor of 15%. The results are presented in the
5 table below for each hypothetical project:

6	Project	Wind Speed at 50 m	Annual Net
7			Capacity Factor⁵
8	Madison, NY	14.5 – 15.7	23%
9	Fenner, NY	16.8 – 17.9	27%
10	Waymart, PA	15.7 – 16.8	27%
11	Deerfield West, VT	19.0 – 20.1	38%
12	Deerfield East, VT	20.1 – 21.3	41%

13 The results show that wind speeds alone easily account for a wide difference
14 in capacity factors between the projects. The results also show that the Deerfield
15 Wind Project can be expected to enjoy the highest wind speeds of any of the projects
16 that have been installed to date. It is not unreasonable to assume, based on the fact
17 that wind speed increases with elevation above sea level, and that the turbines

⁴ These maps are publicly available for all the states in which the sample projects exist. See http://www.cere.energy.gov/windandhydro/windpoweringamerica/wind_maps.asp.

⁵ Calculation assumes the Rayleigh wind speed distribution using median wind speed in the range provided. Turbine power curve is for the Gamesa G80 2MW turbine scaled to 1.15 kg/m³ air density. Since the calculation assumes a simplified scenario, these net annual capacity factors cannot take into account the specific conditions at each site and are meant for comparison purposes only, not to represent actual energy production at any project site.

1 proposed are on high towers, that the Project, because it is the highest in elevation
2 above sea level, will be one of the best performing project in the northeast to date.⁶
3

4 **Q. Does this conclude your testimony at this time?**

5 Response: Yes it does.

⁶ The projected capacity factor of 36.4% for the Deerfield Wind Project's revised layout is consistent with the newest and largest project in service in interior New England, at Mars Hill in northern Maine. In Mars Hill's first partial year of operation in 2007 (which did not include the windy winter season), this 42 MW plant achieved a capacity factor of approximately 36%.