

**STATE OF VERMONT  
PUBLIC SERVICE BOARD**

Docket No. \_\_\_\_\_

Petition of UPC Vermont Wind, LLC for a Certificate of )  
Public Good pursuant to 30 V.S.A. section 248, )  
authorizing it to construct up to a 52 MW wind electric )  
generation facility, and associated transmission and )  
interconnection facilities, in Sheffield and Sutton, Vermont, )  
and operate the same. )

**PREFILED DIRECT TESTIMONY OF  
DANIEL R. CROCKET, P.E.**

**ON BEHALF OF UPC VERMONT WIND, LLC**

February 21, 2006

Summary:

Mr. Crocket's testimony provides a description of the interconnection facilities, which include the electrical collection and the substation infrastructures, for UPC Vermont Wind's Sheffield Wind Farm. He explains the alternatives considered and why the proposed design was selected, and studies that are presently being conducted by ISO-NE. He discusses why the Project will likely not have an adverse affect on system stability and reliability, and summarizes the benefits of the Project to the transmission network.

1 **Q. Please state your name, business address and qualifications.**

2 Response. My name is Daniel R. Crocket. My business address is E/PRO  
3 Engineering & Environmental Consulting, LLC, 7 Green Mountain Drive,  
4 Montpelier, VT. I am an electrical engineer with professional engineering licenses in  
5 the states of Vermont, New Jersey, and Pennsylvania. I have worked as an electrical  
6 engineer in the utility business for 24 years. I have experience in transmission,  
7 distribution and substation design, operation and planning. My resume is attached as  
8 ***Exhibit UPC-DC-1.***

9  
10 **Q. What is the purpose of your testimony?**

11 Response. My testimony provides a description of the interconnection facilities  
12 which include the electrical collection and the substation infrastructures (the  
13 “Facilities”) for UPC Vermont Wind’s Sheffield Wind Farm (the “Project”). I  
14 explain the alternatives considered and why the proposed design was selected, and  
15 studies that are presently being conducted by ISO-NE. I discuss why the Project will  
16 likely not have an adverse affect on system stability and reliability, and summarize the  
17 benefits of the Project to the transmission network.

18  
19 **Q. Have you previously testified before the Vermont Public Service Board (the  
20 “Board”)?**

21 Response. I have testified as an expert witness in a number of venues including the  
22 Vermont Public Service Board. Significant dockets that I have submitted pre-filed  
23 testimony on are the AgriMark Substation and the Washington Electric Cooperative

1 Coventry Landfill Gas Generation project. In addition, I testified in a number of  
2 Dockets on behalf of the Vermont Electric Cooperative while I was their  
3 Engineering and Operations Manager.  
4

5 **Q. Please briefly describe the Project leading to the need for the proposed**  
6 **Interconnection Facilities.**

7 Response. The Project is a wind generation facility to be located in the Towns of  
8 Sheffield and Sutton, Vermont. It would have a nameplate capacity of up to 52 MW,  
9 consisting of 26 - 2 MW Gamesa wind turbines (or the equivalent), located in the  
10 vicinity of and on either side of the VELCO 115kV transmission line  
11 interconnecting the St. Johnsbury and Irasburg substations. The layout envisions 26  
12 turbines, with 20 sited north and 6 sited south of the transmission line. The Project  
13 is described in detail in UPC's overview testimony,  
14

15 **Q. Please describe the proposed Facilities.**

16 Response. The Facilities are broken into three parts: Collection, Substation and  
17 Transmission.

18 Electrical Collection System: The collection system is separated into two  
19 portions: the underground portion and the overhead portion. To reduce the visual  
20 impacts of this project, an underground collection system between the ridgeline  
21 turbines was decided upon over an overhead collection system. Further, the  
22 underground line would be more reliable given that it is out of the elements, which  
23 can be significant at this elevation. The underground collector system will consist of

1 buried conduit holding conductors that transmit the power from the turbines to a  
2 transition point. At this point, the underground collector line will transition to an  
3 overhead system. The overhead system will proceed off the ridge to the substation  
4 and will consist of Hendrix style construction on low poles (nominal 35 foot) unless  
5 additional span and clearance is required to reduce or avoid impacts to wetlands or  
6 other sensitive environments. In these areas, up to 65 foot poles are assumed. The  
7 northern array consists of 8,200 feet of underground collector and 4,050 feet of  
8 above-ground collector. The southern array has 15,000 feet of underground collector  
9 and 10,550 feet of above-ground collector. The power generated by the turbines  
10 would be converted to 34.5 kV via a dry transformer located in the nacelle. The  
11 power would be conducted to ground level internally within the tower to a switch  
12 located in the base. From this point, the turbine would be connected to the electrical  
13 collection system designed by E-PRO for this project. Our report on the collector  
14 system, along with supporting diagrams, is provided as *Exhibit UPC-DC-2*.

15 Substation: The new substation will be located immediately adjacent to the  
16 existing VELCO 115 kV transmission line which runs for approximately 36.5 miles  
17 from St. Johnsbury to Irasburg. (This transmission line has recently been  
18 reconfigured as part of VELCO's Northern Loop Project). The location of the  
19 interconnection of the Sheffield Wind Farm to the VELCO system is approximately  
20 19.2 miles from the St. Johnsbury substation. The new substation has been designed  
21 to convert the power from the 34.5 kV coming from the turbines to 115 kV suitable  
22 to enter the VELCO bulk transmission system. The proposed substation will  
23 incorporate two new 115kV breakers to interrupt the Sheffield to Irasburg and

1 Sheffield to St. Johnsbury lines, plus a new 115kV breaker between the 115kV line  
2 tap and the new 115/34.5kV transformer. There will be a 34.5kV breaker between  
3 the low side of the 115/34.5kV transformer and a 34.5kV bus. Two 34.5kV breakers  
4 will be installed between the 34.5kV bus and each of the two connections to the  
5 Project collectors systems on the north and south side of the 115kV transmission  
6 line. Our report on the substation design, including plane view, elevation view and  
7 one-line diagrams is included as *Exhibit UPC-DC-3*. E/PRO has worked closely  
8 with VELCO on the substation design process. VELCO has reviewed and accepted  
9 the preliminary design of the substation (see *Exhibit UPC-DC-4*). This  
10 coordination will continue through final design and construction with approvals  
11 being received from VELCO prior to construction and connection to their system.

12 Transmission: One significant advantage to constructing the proposed wind  
13 farm in this location is the close proximity of the existing 115 kV transmission line:  
14 VELCO's St. Johnsbury to Irasburg 115 kV transmission line runs between the  
15 northern and southern arrays. The presence of this infrastructure allows for  
16 connection of the proposed generation asset without the requirement to construct  
17 long distances of transmission line. This not only reduces the overall cost of the  
18 project, but also reduces potential visual and environmental impacts.

19

20 **Q. Who will own and be responsible for maintaining the new Substation?**

21 Response. As stated above, UPC has worked closely with VELCO on the substation  
22 design, and has also reached preliminary agreement on ownership of the facilities.  
23 The substation will be developed as a single common facility, to minimize cost,

1 visual and environmental impact, as if it were owned by a single entity. VELCO will  
2 own the 115kV equipment, including the dead ends and other related 115kV  
3 structures. VELCO will also own and be responsible for operating and maintaining  
4 the balance of the 115kV substation equipment including, but not limited to, bus  
5 work, switches, breakers, metering, protection and control, SCADA, control house,  
6 fencing and the VELCO portion of the substation yard. The point of ownership  
7 demarcation will be between the 115kV breaker and 115kV transformer. There will  
8 be a fence within the substation dividing the VELCO facilities from the UPC  
9 facilities. Separate entrances to the substation and control room are provided to  
10 complete the separation between these entities. UPC will own and be responsible for  
11 the balance of equipment from the point of demarcation, including the transformer  
12 and all remaining 34.5kV facilities.

13

14 **Q. Who will be responsible for the initial investment and ongoing maintenance**  
15 **expenses?**

16 Response. UPC will be responsible for all costs that are incurred as a result of  
17 interconnecting the wind farm to the transmission grid in accordance with the  
18 Minimum Interconnection Standards (MIS) as defined in the ISO-NE Transmission  
19 Tariff. As stated previously, VELCO will be responsible for the ongoing  
20 maintenance associated with the high side of the substation. UPC will be responsible  
21 for the maintenance on the low side of the substation.

22

23 **Q. How will UPC maintain its part of the Facilities?**

1        Response. UPC will likely retain an outside contactor to perform maintenance on  
2        this facility. However, a definite decision has not been reached on this yet.

3

4        **Q.    What alternatives to the Facilities did you consider, and why did you choose**  
5        **the proposed Facilities?**

6        Response. UPC investigated several configurations, including a possible  
7        interconnection to the VEC area 48kV sub-transmission system. However,  
8        interconnection to the 115kV line as proposed makes the most sense, primarily due  
9        to the scale of the proposed Project and relatively close proximity of the Project to  
10       the St. Johnsbury to Irasburg transmission line.

11

12       **Q.    Did you consider any potentially lower cost options?**

13       Response. Yes. UPC proposed a simpler configuration in its Interconnection  
14       Request to ISO-NE. That configuration, which UPC believes meets the New  
15       England MIS, envisioned 115kV circuit switchers in place of the 115kV breakers.  
16       However, ISO-NE requested that breakers be substituted to allow more flexibility  
17       with system operation. This requested modification is provided for the current  
18       design.

19

20       **Q.    How did the original configuration that was submitted in the Interconnection**  
21       **Request evolve to the proposed Facilities?**

22       Response. VELCO initially asked that the circuit switcher between the tap and  
23       transformer be replaced with a breaker. VELCO was also interested in having two

1 separate substations: one a VELCO substation for the 115kV equipment; the second  
2 a UPC substation for the transformer and balance of 34.5kV equipment. Working  
3 together to achieve common objectives, VELCO and UPC agreed on a compromise  
4 solution. The compromise entailed building a single substation on a common site  
5 with the high voltage facilities demarcated by fencing and gates, with the low voltage  
6 side adjacent the VELCO equipment, thereby minimizing the total footprint.  
7 Consolidating construction helps to minimize cost while also minimizing  
8 environmental and aesthetic impact. This agreement helped to justify the cost  
9 associated with two additional 115kV breakers. Overall, the substation has been  
10 designed to VELCO's standards and procedures. They have acknowledged that this  
11 preliminary design meets their standards and is an acceptable basis with which to  
12 move forward to final design.

13

14 **Q. Are there other modifications being considered for this substation?**

15 Response. Yes. VELCO and UPC are discussing moving the entire substation  
16 directly under the 115 kV transmission lines. In this configuration, the high end side  
17 would be located within the existing VELCO right-of-way, and UPC's low side  
18 equipment would be located immediately adjacent but outside the existing ROW.  
19 However, since these discussions are currently ongoing, we felt it was more  
20 appropriate to represent the substation as a stand-alone facility. The facility  
21 proposed and represented in this testimony is the lowest cost, least intrusive facility  
22 possible as a stand-alone facility. If the facility is moved under the transmission lines,  
23 it will be constructed at slightly lower cost and have lower impact since it will make

1 use of the existing cleared right-of-way. However, we do not feel that this reduction  
2 will be significant in the overall scope of this project.

3

4 **Q. Were there any other transmission system upgrades considered in the design?**

5 Response. Yes. We assumed the Northern Loop Project (the “NLP”) and the  
6 Lamoille County Project (the “LCP”) would be completed before the Project would  
7 be interconnected. The NLP has recently been completed. The LCP has not  
8 received a Certificate of Public Good but, according to VELCO, assuming no  
9 significant issues are encountered, will be constructed in 2007. Other project  
10 upgrades within the New England region are consistent with the anticipated  
11 completion date of the UPC project.

12

13 **Q. Who is performing the study to determine the implication of interconnecting**  
14 **the Project to the regional power grid?**

15 Response. The study is being performed by ISO-NE. ISO-NE has contracted with  
16 GE Energy. GE Energy is conducting the entire Interconnection System Impact  
17 Study (the “ISIS”). The ISIS includes a steady state analysis (load flow), commonly  
18 referred to as a Feasibility Study, plus a dynamic analysis consisting of short circuit,  
19 stability and system protection studies. E/PRO developed input for this modeling  
20 based on the use of Gamesa wind turbines.

21

22 **Q. What criteria were followed for the ISIS?**

1        Response. The study is performed in accordance with "NEPOOL Reliability  
2        Standards", "NEPOOL Minimum Interconnection Standards" and the Large  
3        Generator Interconnection Procedures and Agreement (LGIP/LGIA). These criteria  
4        are requirements of the ISO-NE Tariff that apply to large generator  
5        interconnections, wherein large generators are defined as greater than 20 MW.

6

7        **Q.    Are you relying on the ISO-NE study to meet the section 248 criteria?**

8        Response. Yes, in part. I based my testimony on preliminary results of the Load  
9        Flow analysis prepared by ISO-NE's contractors and the E/PRO Dynamic Model  
10       prepared in support of the completion of the Feasibility Study. The studies  
11       completed by ISO-NE include a steady state analysis and a short circuit analysis.  
12       These reports are in draft form, and as such, have not yet been reviewed by ISO-NE.  
13       Therefore, these reports are not available to UPC for detailed review and evaluation.  
14       However we have received a summary of the conclusions as they stand to date. This  
15       summary indicates that overall the Sheffield Wind Farm "does not have a significant  
16       impact on the system, positive or negative."

17

18       **Q.    Can you provide specifics on the preliminary, draft interim results?**

19       Response: Yes. The steady state analysis was performed with and without the  
20       proposed Sheffield Wind Farm. When the proposed Project was turned on, an equal  
21       amount of generation from the Comerford and Moore hydroelectric facilities was  
22       removed. The results indicated voltage and thermal violations. However, none of  
23       these were related to the operation of the proposed Project. Indeed, the violations

1 either remained the same or were slightly reduced by the operation of this generation  
2 asset.

3 This analysis also looked at conditions when the facility is out of service  
4 initially, and then a set of contingencies are simulated subsequent to the initial  
5 outage. The purpose of this N-2 analysis is to determine whether any violations can  
6 be eliminated by operating actions such as generation reductions.

7 The N-2 analysis subjected the system to an initial loss of the Sheffield to St.  
8 Johnsbury line section followed by a loss of the Irasburg to Highgate line. The  
9 results indicated that the Sheffield facility had to run back to approximately 15 MW  
10 after the initial outage. This is compared to the maximum allowed runback of 1200  
11 MW. As with the steady state analysis, violations in the system were identified.  
12 Again, these were not related to the proposed Sheffield Wind Farm, or could be  
13 addressed by generation reduction.

14 The final portion of the interim report was the short circuit analysis. This  
15 analysis was performed with and without the proposed Sheffield Wind Farm. The  
16 analysis showed that the proposed Project will increase the fault duty on the system  
17 by 700 Amps or less at the point of interconnection. The increase will be lower at  
18 points farther from the point of interconnection. For example, it will be 575 Amps  
19 in St. Johnsbury. Right now there is no indication that this situation would result in  
20 breaker interruption capacity being exceeded. (see *Exhibit UPC-DC-5*).

21

22 **Q. What is the next step in this analysis?**

1        Response: The next step will be a discussion between GE Energy, Gamesa and UPC  
2        to direct and facilitate the remaining efforts to demonstrate that this facility will not  
3        have an impact on the reliability of the existing transmission system. We are  
4        anticipating the completion of this work by mid 2006.

5

6        **Q.     Are you able to make a reasonable assessment of the Project's potential**  
7        **impacts based upon the information you have reviewed?**

8        Response. Yes. Based on the summary of the draft preliminary report prepared for  
9        ISO-NE and the dynamic model information (*Exhibit UPC-DC-6*), there is no  
10       indication that the proposed project will have an adverse impact on the transmission  
11       network.

12

13       **Q.     Did the load flow study consider any contingencies?**

14       Response. Yes. The load flow model facilitates this type of analysis through the use  
15       of a contingency processor. Several transmission facility outages were modeled,  
16       including worst case contingencies recommended by VELCO transmission system  
17       planners. The results show that the Project actually improves system performance  
18       for the more severe contingencies including loss of the Irasburg to Highgate 115kV  
19       line and the St. Johnsbury to Sheffield line. This is primarily due to the fact that  
20       added generation in northern Vermont would reduce inflow from adjacent systems  
21       that would otherwise occur to compensate for loss of such a significant transmission  
22       line. None of the contingencies identified in the summary indicate any adverse  
23       impact to the transmission system.

1

2 **Q. Does the Project benefit the transmission network?**

3 Response. Yes. According to the summary, adding generation at the designated  
4 point of interconnection would generally improve system reliability, and under  
5 certain conditions, would reduce system losses. Active and reactive power output  
6 from the Project would help to support transmission system voltage under normal  
7 operating conditions as well as during system contingencies. The steady state analysis  
8 demonstrates that the Project has no significant adverse impact on the  
9 interconnected system's steady state performance or system reliability performance.

10

11 **Q. Can you elaborate on these benefits?**

12 Response. Based upon our experience, we believe that this project will have a  
13 positive effect on the electrical system of Vermont. Specifically, we believe that the  
14 implementation of this project will provide additional generation in an area of  
15 Vermont that has little; it is likely to increase the system's performance by reducing  
16 line loss, and to reduce the loading of interconnections to other states and Canada  
17 that supply power to Vermont. However, until the study is complete, we cannot  
18 confirm these benefits. We are continuing to provide support as needed on this  
19 study, and understand that it is to be completed by mid-2006.

20

21 **Q. Does the project comply with Section 248(b)(3)? Are there any anticipated**  
22 **adverse effects associated with the Project interconnection?**

1        Response. Yes, this design is compliant with Section 248(b)(3). The project should  
2        not result in an adverse impact on the transmission system stability or reliability as  
3        described in the summary of the ISO-NE report.

4

5        **Q.    Is the proposed facility compliant with Section 248(b)(10)?**

6        Response. Yes. The proposed project can be served economically by the existing  
7        transmission facilities without undue adverse effect on VELCO, Vermont utilities or  
8        customers. The above-described connection directly to the VELCO St. Johnsbury-  
9        Irasburg 115 kV transmission line is the most economical alternative in the view of  
10       UPC Vermont Wind. Further, this project will have no cost impact to ISO-NE,  
11       Vermont utilities or their ratepayers.

12

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

14       Response. Yes.