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Technical Memorandum

Date: September 29, 2004
To: Joan Stewart, FPL Energy
From: Wallace Erickson
Re: Diablo Winds Turbine Siting Compliance Report

This document describes our evaluation of the proposed Diablo Winds turbine layout as it relates project design standards described within the 1998 Repowering Program EIR and more recent recommended design standards described in Smallwood and Thelander (2004).

Project Description

Altamont Power, LLC will install thirty-one Vestas V47 turbines on the Elworthy property and two 50-m (164 ft) concrete monopole met towers. The project includes the removal of one hundred and sixty-nine FloWind model F-17 and F-19 turbines, as well as the removal of 8 miles of overhead electrical line and one guyed 30-m (98-ft) met tower and thirty-six 18 m (60 ft) free standing lattice met towers.

The Vestas V47 is a 660-kW rated turbine. It is an up-wind, three-bladed, horizontal axis machine mounted on a steel tubular tower with neutral gray non-reflective coloring. The Vestas turbine has a rotor diameter of 47 m (154-ft). The hub height for twenty-four of the turbines is 50-m (164 ft) and seven turbines have a hub height of 55 m (181 ft). The blades rotate at 28.5 rpm at wind speeds between 6 and 56 miles per hour. Both turbines have a tower that is fitted with an internal ladder to access the nacelle. Electrical and communication cables will be placed underground. The project includes two 50-m (164 ft) self-supporting anemometer towers.

Turbine Design Standards – Repowering Program

The design characteristics considered as design standards within the Repowering Program and the specific designs for the Diablo Winds project are described in Table 1. The Diablo Wind Energy Project meets each of these standards.

Table 1. Turbine Design Standards as outlined in the Repowering Program EIR.

Design Characteristic	Repowering Program Design Standard	Diablo Winds Design
Rated Capacity	500-1,000 kW	660 kW
Axis	horizontal	horizontal
Rotor orientation	primarily upwind	upwind
Cut-in speed	6 – 9 mph	6 mph
Number of Blades	primarily 3-bladed	3 bladed
Rotor diameter	138 – 197 ft	154 ft
Tower type	tubular with internal ladder to the nacelle	tubular with internal ladder to the nacelle
Tower height	114-193 ft	Hub height – 24 turbines at 164 ft and 7 at 181 ft
Total height (to top of rotor at 12 o'clock position	200-291 ft maximum	24 turbines at 241 ft and 7 turbines at 258 ft
Rotational speed	22 – 35 rpm	28.5 rpm
Color	white and gray	gray
Nacelles	fully enclosed	fully enclosed
Transmission lines	predominantly below ground	below ground
Meteorological towers	guyed or unguyed, guyed must used at least 4/0 wire size, and markers on wires	Unguyed spun concrete monopoles

Turbine Siting Standards – Repowering Program

In addition to turbine design standards, the 1998 Repowering Program EIR outlined specific siting standards for avoidance and minimization of bird mortality. The following topographic features were identified in the 1998 Repowering Program EIR for guidance in avoiding siting turbines in areas of perceived higher risk:

Dip: "A depression (or saddle) along the linear axis of a ridge whose lowest point is at least 25 feet below the highest adjacent point along the linear axis of the ridge within a distance o 150 feet. The side slopes of a dip have a gradient equal to or greater than 1:6 (17% slope), where the horizontal of the slope is six times greater than the vertical component".

Notch: a depression (or saddle) along the linear axis of a ridge line with a side slope gradient o 1:4 (25% slope).

Draw: a depression (or saddle) along the linear axis of a ridge line with a side slope gradient of 1:3 (33% slope)

Canyon: a depression (or saddle) along the linear axis of a ridge line with a side slope gradient o 1:2 (50%).

Based on the information from the various studies conducted prior to the 1998 EIR (e.g., Orloff and Flannery 1992, 1996) the following siting standards were set:

a. No turbines will be permitted on any slope where the slope gradient is >25%, unless specifically approved by the Technical Advisory Committee and accepted by the County. This will ensure that turbines are not sited on slopes o draws or canyons.
b. No turbine will be permitted within a dip or notch (as defined above) if the cross axis o the ridge is less than 300 feet-wide and the slope gradient along the cross axis is 25% or greater.
c. No turbines will be permitted in a dip or notch if it converges with a draw or canyon.
d. No turbines will be permitted in a dip or notch that is in line with another dip or notch on a parallel ridge in the direction of wind currents.
e. At dips and notches, no turbines will be permitted within a space of at least 200 feet on either side of the lowest point of the dip or notch to maintain a space o a least 400 feet-wide between tower locations.

Table 2 describes characteristics of each turbine location. Based on review of the turbine locations overlayed on the 5-ft contour maps (Figure 1, all turbines appear to meet the BRMP requirements identified above. No turbines are located on slopes steeper than 25%, or in dips or notches.

Table 2. Attributes of new turbine locations.

Id	Approximate % Slope	Approximate Cross-Axis Distance	Relief Category	String position
1	15-20	>300	slope	end
2	5	>300	peak	int
3	15-20	>300	slope	end
4	9	>300	ridgecrest	end
5	5	>300	ridgecrest	end
6	10	>300	ridgeline	end
7	<5	>300	ridgecrest	int
8	10	~300	ridgeline	end
9	<5	>300	ridgecrest	isolated
10	<5	>300	peak	end
11	15-20	<300	slope	int
12	15-20	>300	slope	end
13	<5	>300	peak	end
14	10	>300	slope	int
15	10	>300	slope	end
16	<5	>300	ridgecrest	isolated
17	6	>300	ridgecrest	end
18	<5	>300	ridgecrest	int
19	10	>300	ridgeline/slope	end
20	5	>300	ridgecrest	end
21	<5	>300	ridgecrest	int
22	<5	>300	ridgecrest	int
23	<5	>300	ridgecrest	end
24	<5	>300	peak	isolated
25	<5	>300	peak	isolated
26	<5	>300	peak	isolated
27	<5	>300	peak	end
28	<5	275	ridgeline/slight depression	int
29	<5	>300	ridgecrest	int
30	10-15	>300	slope	int
31	10-15	275	slope	end

New Turbine Design and Siting Recommendations

Recent investigations into avian mortality and behavior at the Altamont has resulted in some new recommendations regarding wind project and wind turbine siting (Smallwood and Thelander 2004). These recommendations are outlined in Table 2, including a description of the relevant characteristics from the Diablo Winds Project. The Diablo Winds Project appears to meet most of these design and siting recommendations with a few exceptions.

Table 3. Recommended Turbine Design and Siting Characteristics from Smallwood and Thelander (2004) and Diablo Winds Project Design Characteristics.

Recommended Design Characteristics	Diablo Winds Project Characteristics
1. Do not install perch guards on turbines	No perch guards
2. Do not provide alternative perches	No alternative perches
3. Cease rodent control	No financial support for rodent control program, landowner's may continue program
4. Move rock piles farther from turbines	Any rock piles created during excavation are used in foundation creation
5. Replace the WRRS monitoring approach with a more scientifically defensible monitoring program	2 years of standardized fatality monitoring, continue WRRS for life of project. Monitoring program allows for some evaluation of effectiveness of WRRS.
6. Reduce vertical and lateral edge in slope cuts and nearby roads	Turbines not located on steep slopes. Most turbines located along primary roads without spur roads. Turbine 12 needs a spur road according to construction specifications, roads to turbines 10 and 11 may be modified to reduce vertical/lateral edge.
7. Retrofit tower platforms to prevent under-burrowing by small mammals	Gravel a minimum of 20 feet out from tower foundation. Gravel and concrete slurry poured around foundation will limit burrowing under lip of foundation.
8. Remove broken and non-operating wind turbines and other project facilities[1]	169 FloWind turbines removed, 8 miles of road reclaimed, 28.8 miles of wire from vertical axis turbines removed, 8 miles of overhead wire removed
9. Implement the means to effectively monitor each wind turbines output	Scada system allows continous monitoring of wind turbine operations, and FPLE has agreed to allow use of this information in analysis of monitoring data
9. Retrofit, using APLIC guidelines, noncompliant power poles	All electrical is underground
10. Avoid siting turbines in canyons	Based on "canyon locations" in Smallwood and Thelander (2004), no new turbine sites were classified as canyons. Turbine 31 in "greenfield area" may have been classified as a canyon location. No formal definition of a canyon provided in Smallwood and Thelander (2004). Turbine 17 is adjacent to a FloWind turbine previously classified as canyon by Thelander and Smallwood (2004) but data may be in error, since adjacent turbines farther down the slope are not classified as a canyon.

[1] we added the statement "and other project facilities"

Recommended Design Characteristics	Diablo Winds Project Characteristics
11. Repower using turbines with high rotor planes Preferred design should have rotor planes with the lowest reach no lower than 29 m above ground	24 of the turbines will have rotor clearance of 26.5 m above ground. 7 turbines will have rotor clearance of 31.5 m above ground.
12. Create busy project designs, avoid isolated turbines.	Most turbine strings include at least 3 turbines. 4 turbines are isolated by themselves (9, 16, 24, 25) but are located on ridgecrests or peaks and one string consists of two turbines (4 and 5) also located on ridgecrest/peak.

References

Orloff, S. and A. Flannery. 1992. Wind turbine effects on avian activity, habitat use, and mortality in Altamont Pass and Solano County Wind Resource Areas, 1989-1991. Final Report to Alameda, Costra Costa and Solano Counties and the California Energy Commission by Biosystems Analysis, Inc., Tiburon, CA.

Orloff, S. and A. Flannery. 1996. A continued examination of avian mortality in the Altamont Pass Wind Resource Area. Final Report to the California Energy Commission by Biosystems Analysis, Inc., Tiburon, CA.

Smallwood, K. S. and C. G. Thelander. 2004. Developing methods to reduce bird fatalities in the Altamont Wind Resource Area. Final Report by BioResource Consultants to the California Energy Commission, Public Interest Energy Research-Environmental Area, under Contract No. 500-01-019 (L. Spiegel, Project Manager).