

DeWind D8.2 HE 50Hz Veladero, Argentina

Introduction

Barrick Gold contracted with the Seawind Group to carry out the necessary studies and provide them with a turnkey solution for their mine sites. The first site to be considered was Veladero in the north east of Argentina near the Chilean border in the Andes Mountains. This site is at an elevation of 4,300 meters (14,000 ft approx.) which poses severe problems for typical “utility scale” wind turbines that rely on power conversion electronics.



Geographic Location of Veladero Mine
Courtesy of Barrick Gold

The DeWind D8.2 turbine is an ideal solution for this challenge since it avoids power conversion electronics and instead achieves variable speed operation using a hydrodynamic WinDrive© developed by Voith Turbo of Germany. This directly coupled to a 4 pole synchronous generator allows power to be produced at 6.6kV, which is ideally suited for the mine’s electrical grid. In addition to the technical challenges, there were also many logistical challenges to be overcome, not least of which was the winding road to the site. Special transport was developed to allow the large wind turbine components to be taken up the mountain, an example of a specialized blade trailer can be seen below.

The DeWind D8.2 HE with a 80m rotor was installed at Veladero on a 65m tower. The generator voltage was 6.6kV to allow the turbine to function at the high elevation and to integrate to the mine grid without the need for a transformer. The turbine is shown below installed at the Veladero mine site.



A short video showing the unique transportation solution for the wind turbine and its installation of can be found on the Barrick web site at:
http://www.barrick.cl/noticias/detalle_comunicados.php?id=81&info=Noticias



Mine Site

The Veladero mine is located in San Juan Province, Argentina, immediately to the south of the Pascua-Lama Property, approximately 320 kilometers northwest of the city of San Juan in the highly prospective Frontera District. The property is located at elevations of between 4,000 and 4,850 meters above sea level.

Technical Challenges for High Altitude Wind Turbines

At an altitude of 4,300 m (14,000 ft approx.) the air pressure is approximately 600 mbar and the air density is approximately 0.74 kg/m³, which is extremely low when compared to a standard sea level air density of 1.225 kg/m³. The lower air density has an influence on the turbine in the following ways:

- Aerodynamic behavior of the turbine changes
 - The turbine will produce less energy for a given wind speed at lower air densities, but this also means that the turbine can operate at higher wind speeds and stay within the certified load spectrum.
- Lower cooling effect from the air
 - The DeWind D8.2 has cooling systems that are working well within their capability to ensure the turbine will operate within its temperature range even at these lower air densities. The generator runs well



within its rated temperature range at 2 MW, no de-rating is required due to the lower air density.

- Reduces the basic Insulation levels of electrical insulation systems.
- The basic insulation properties of electrical components are reduced due to the lower air densities. Wind turbines that utilize power conversion electronics are affected by the low air density and cannot be used above 2,000 m elevation.
- The DeWind D8.2 does not use power conversion electronics and is not affected by this problem. The DeWind D8.2 has been designed to be suitable for the elevation at this site by using the 15 kV insulation system of the generator but equipping it with a 6.6 kV winding which is the required voltage for the mine electrical grid.

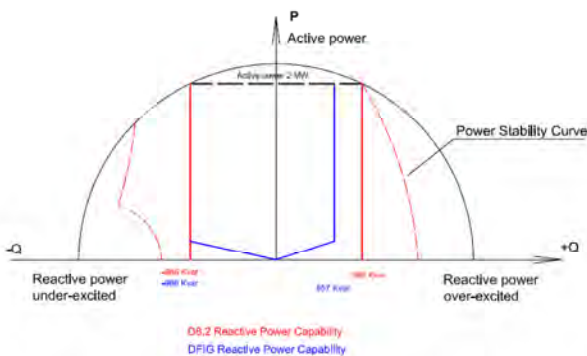
The turbine is connected to a 6.6kV electrical grid which is a stand-alone system with a capacity of approximately 13.44MW of diesel generation. The local load is between 4 and 6 MW of electrical power, and the generation is located 6 km from the mine which is connected by a 6.6kV overhead line.

The configuration of the DeWind D8.2, using a directly connected synchronous generator is particularly suitable for connecting to this relatively “weak” electrical grid and helps maintain system stability.

The 4x short circuit capability of the generator allows for direct on-line starting of the large mine motor without the electrical grid fluctuations causing loss of synchronization of the wind turbine.

Dynamic Reactive Power Capabilities

The PQ stability curve for the D8.2 is shown below in red, compared to an enhanced DFIG in Blue



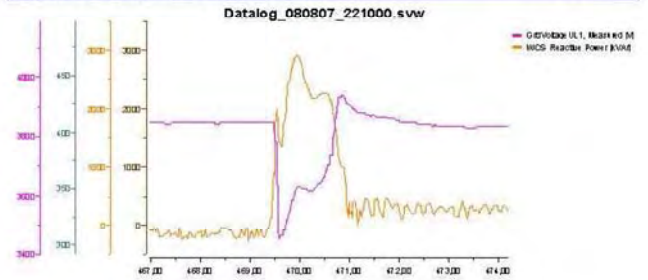
The 0.9 Lag to 0.9 Lead capability is further enhanced by the Dynamic VAr ability of the D8.2.

The start of the 1MW gold mine stone crusher, located close to the turbine, 6km from the 14MW of Diesel Generation, produces a transient voltage drop in the islanded 6.6kv grid system.

The grid-voltage drops from 3848V to 3465V (-11%) during the start up event.

With the Turbine in “Voltage support “mode, the Generator provided 3MVAr “transient” voltage support that prevented the voltage dip being much bigger.

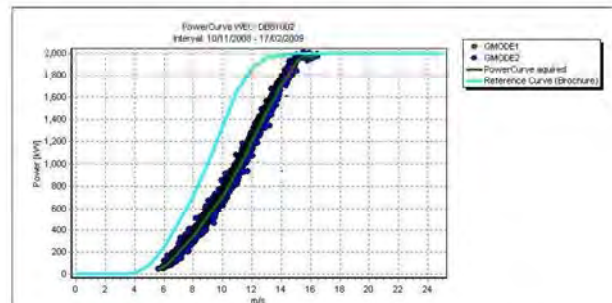
D8.2 Veladero P_{Ref}=2000kW and Voltage Control 100%
07/08/2008 Transient Voltage Drop II D8.2 Veladero



• AVR in voltage control mode and D8.2 synchronous generator supports weak grid with high transient reactive power peak.

Power Performance

The “screen shot” below shows nacelle anemometer based power performance data, dark blue dots. A sea level power curve, pale blue solid line, is also shown.



Power performance data from SCADA system

The effect of the lower air density can be clearly seen in the reduction in power at specific wind speeds when compared to the sea level reference curve.

This is the 2nd D8.2 Turbine and was installed in December 2007 & has been running throughout 2008

At the end of Jan 2009, the Turbine has run for 2400hrs synchronized with the Grid and generated 2.4GWh

For further information on DeWind Turbines please contact us at (949) 428-8500 or (940) 455-7450