Annexure C

Components of a wind turbine

Wind turbines can rotate about either a horizontal or a vertical axis. Turbines used in wind farms (see **Figure 1**) for commercial production of electricity are usually horizontal axis, three-bladed and pointed into the wind by computer-controlled motors, as is proposed for this project. These have high tip speeds of over 320 km/hour, high efficiency, and low torque ripple, which contribute to good reliability.

The main components a wind turbine is made up are listed and described below (see **Figure 2**):

- Rotor and blades;
- Nacelle;
- Generator;
- Tower; and
- Foundation.

Figure 1: Brazos Wind Ranch located in Texas, USA[1]

http://en.wikipedia.org/wiki/Wind_power_in_Texas

[1] (accessed 14/06/12)

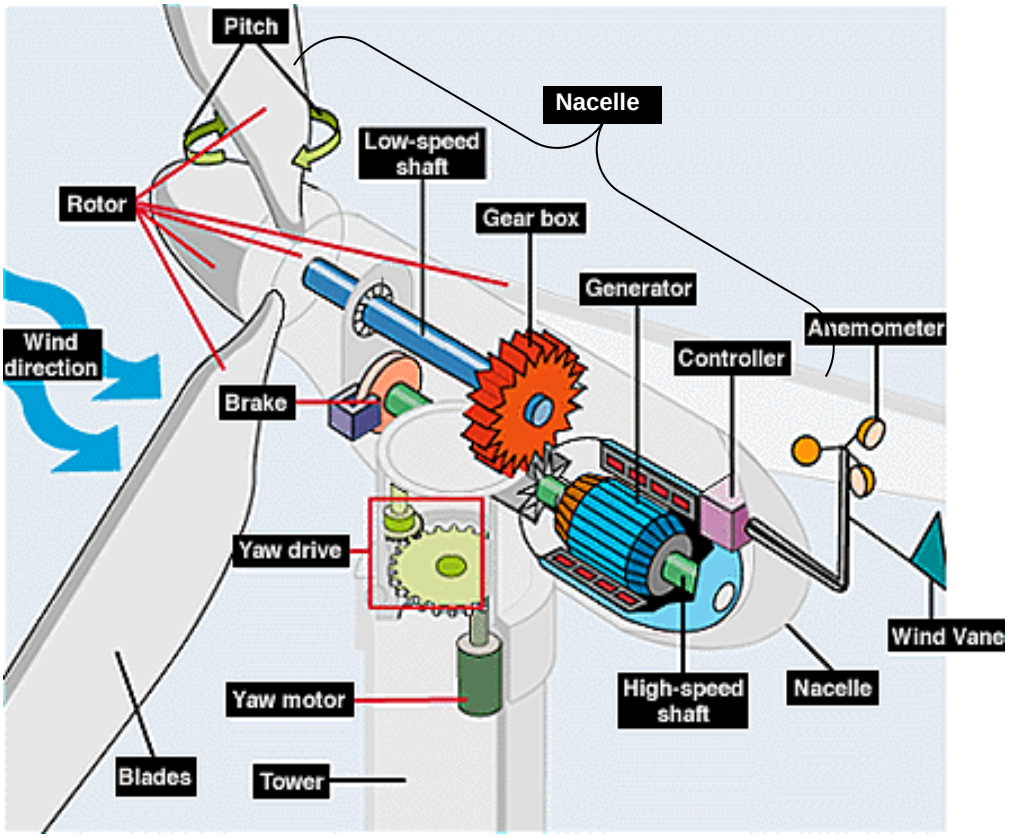

Figure 2: Typical components of a horizontal axis wind turbine

(Source *http://www1.eere.energy.gov/windandhydro/images/illust_large_turbine.gif*)

Rotor and blades

The rotor has three blades that rotate at a constant speed, approximately 6-15 revolutions per minute (rpm) in the case of the turbines being considered at Springbok. The blades are usually coloured light grey and, in the case of the proposed project, would be approximately 40 – 60 m long (80 – 120m rotor m diameter).

Nacelle

Larger wind turbines are typically actively controlled to face the wind direction measured by a wind vane situated on the back of the nacelle. By reducing the misalignment between wind and turbine pointing direction (yaw angle), the power output is maximised and non-symmetrical loads minimised. The nacelle can turn the blades to face into the wind ('yaw control').

All turbines are equipped with protective features to avoid damage at high wind speeds. By turning the blades into the wind ('furling') the turbine ceases its rotation, accompanied by both electromagnetic and mechanical brakes. This would typically occur at very high wind speeds, typically over 72 km/h (20 m/s). The wind speed at which shut down occurs is called the cut-out speed. The cut-out speed is a safety feature which protects the wind turbine from damage. Normal wind turbine operation usually resumes when the wind drops back to a safe level. The turbine controls the angle of the blades ('pitch control') to make optimal use of the available wind and avoid damage at high wind speeds.

The nacelle also contains the generator, control equipment, gearbox and wind speed measure (anemometer) in order to monitor the wind speed and direction.

Generator

The generator converts the turning motion of the blades into electricity. A gear box is commonly used for stepping up the speed of the generator. Inside the generator, wire coils rotate in a magnetic field to produce electricity. Each turbine has a transformer that steps up the voltage to match the transmission line frequency and voltage for electricity evacuation/distribution.

Tower

The tower is constructed from tubular steel and supports the rotor and nacelle. For the proposed project the tower would be either 60 or 120 m tall, depending on the selected turbine. Wind has greater velocity at higher altitudes, therefore increasing the height of a turbine increases the expected wind speeds.

Foundation

Foundations are designed to factor in both weight (vertical load) and lateral wind pressure (horizontal load). Considerable attention is given when designing the footings to ensure that the turbines are adequately grounded to operate safely and efficiently. The final foundation design of the proposed turbines is dependent on a geotechnical investigation; however it is likely that the proposed turbine foundations would be made of reinforced concrete. The foundations would be approximately 20 m x 20 m and an average of 3 m deep. The foundation would be cast *in situ* and could be covered with top soil to allow vegetation growth around the 6 m diameter steel tower.