Chapter one

1. INTRODUCTION

1.1 INTRODUCTION :

A wind turbine is a device that converts the kinetic energy of wind into electrical energy We consider rotors with blades similar to airplane wings, sometimes mis-leadingly called ‘propeller type’. The dominant driving force is lift. Blades on the rotor may be in front (upwind) or behind (downwind) of the tower. Wind veers frequently in a horizontal plane, and the rotor must turn in the horizontal plane (yaw) to follow the wind without oscillation. . Upwind turbines need a tail or some other yawing mechanism, such as electric motor drives to maintain orientation. . Downwind turbines are, in principle, self-orienting, but are more affected by the tower, which produces wind shadow and extra turbulence in the blade path. Perturbations of this kind cause cyclic stresses on the structure, additional noise and output fluctuations[1]

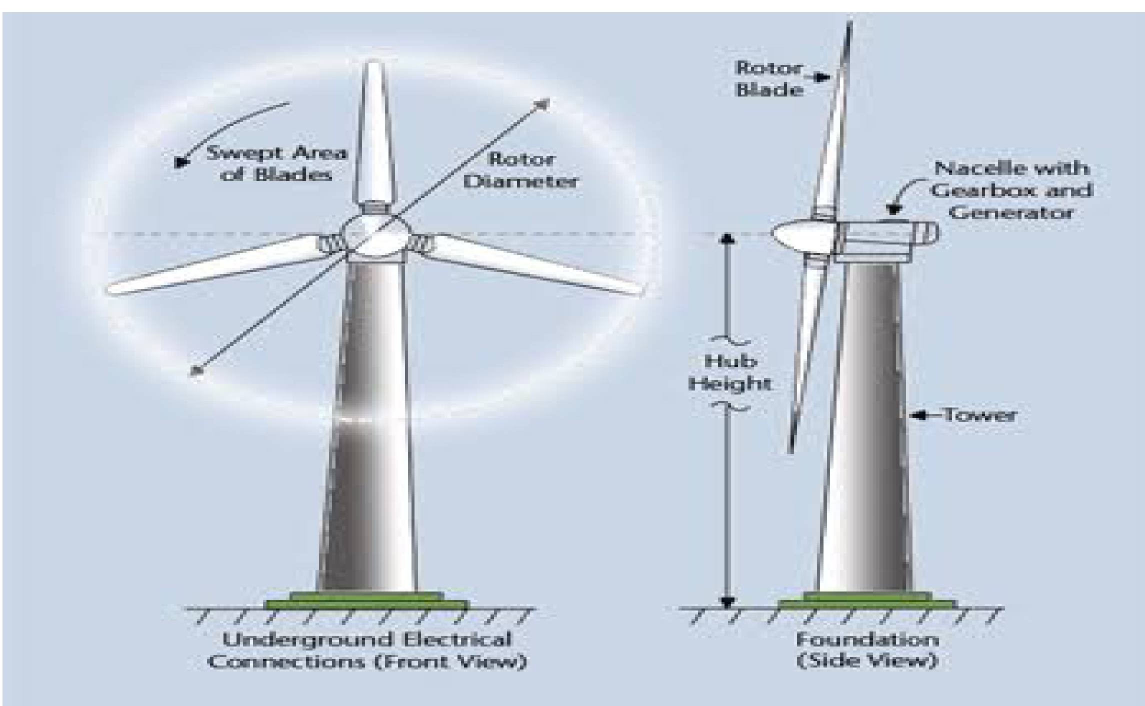

Figure 1-1: horizontal wind turbine

1.2 ROTATIONAL SPEED:

The loads on both horizontal axis wind turbines (HAWTs) and vertical axis wind turbines (VAWTs) are cyclic; that is, the thrust and torque acting on the blades is dependent on where the blade is. In a horizontal axis wind turbine, both the apparent wind speed seen by the blade and the angle of attack depend on the position of the blade. This phenomenon is described as rotational sampling. This article will provide an insight into the cyclic nature of the loads that arise because of rotational sampling for a horizontal axis wind turbine.

Rotational sampling can be divided into two parts: deterministic and stochastic. Deterministic processes present themselves as spikes on a power spectrum, whereas stochastic processes are broader i.e. spread over a wider frequency range.[2]

1.3 POWER:

A single, modern-day offshore wind turbine can generate more than 8 megawatts (MW) of energy, enough to cleanly power nearly six homes for a year. Onshore wind farms generate hundreds of megawatts, making wind energy one of the most cost-effective, clean and readily available energy sources on the planet.

Horizontal axis wind turbines (HAWTs) are the dominant wind gathering technology because they have higher efficiency ratings [14]. Their main advantage is that their blades move perpendicular to the flow of wind so energy can be generated the entire way through a rotation.[3]

1.3.1The power produced by a wind turbine depends on

- Rotor area

• Air density

• Wind speed

• Wind shear

1.3.3Machinery Limitations.

• Wind shear is a difference in wind speed and direction over a short distance and is caused by mountains, coastlines and weather patterns.

• Air density increases with colder temperatures, decreased altitude, and decreased humidity.

• Wind speed increases the farther you get away from the ground.

• To maximize the power output of wind turbines, rotors are tilted slightly upwards.[4]

1.3.4 Wind Concentrators.

• Turbines draw power from the intercepted wind, and it may be advantageous to funnel or concentrate wind into the turbine from outside the rotor section. Various systems have been developed or suggested for horizontalaxis propeller turbines,

such as:

1. Blade tips Various blade designs and adaptations are able to draw air into the rotor section, and hence harness power from a cross-section greater than the rotor area.

2. Concentrating structures Funnel shapes and deflectors fixed statically around the turbine draw the wind into the rotor. Concentrators are not yet generally used for commercial machines.

1.3.5 Evaluation of Wind Power Plant .[6]

Power Coefficient: CP = power out / power in the wind

Capacity Factor (average power assumed to be 30 to 40% during design can be measured after 1 year)

CF = (AKWH/8760) / Rated Power

Rated Power = Generator Size (GS is in kW (given specification))

Annual Energy production (kWh/yr)

AKWH = CF * GS * 8760

1.3.6Torque

• The previous calculation of axial thrust on a wind turbine provides an opportunity to introduce definitions for the torque causing rotational shaft power. At this stage no attempt is made to analyze angular momentum exchange between the air and the turbine. However, it is obvious that if the turbine turns one way the air must turn the other; full analysis must eventually consider the vortices of air circulating downwind of the turbine. • The maximum conceivable torque on a turbine rotor would occur if the maximum thrust could somehow be applied in the plane of the turbine blades at the blade tip furthest from the axis. For a propeller turbine of radius R, this 'base-line' criteria would be:

1.3.7Tip-speed ratio calculations

• The tip-speed ratio or TSR, denoted by λ, is the ratio of the blade-tip linear speed to the wind speed. The TSR determines the fraction of available power extracted from the wind by the wind turbine rotor. In a fixed-speed wind turbine, the blade tip speed is held relatively constant since the rotor is connected directly to the induction generator via a gearbox, and the induction generator is directly connected to the grid

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[1][2]