Wind Energy Harvesting 2.1 Introduction Wind is a renewable energy source used to generate electricity through wind turbines, which convert its kinetic energy into electrical power.VAWTs: Vertical axis, no yaw mechanism, less efficient."The best sites for wind turbines are areas with calm, steady winds, such as water surfaces or seas. Betz's law defines the maximum energy that can be extracted from the wind, and it depends on the difference in wind speed before and after passing through the turbine."The "cut-in" speed is the minimum wind speed required to start the turbine, while the "cut-out" speed is the speed at which the turbine stops to avoid damage. The curve also shows that the output power decreases when the wind speed exceeds 20 m/s. After the nominal speed (the speed for which the turbine is designed), the turbine's power remains constant to avoid damage. The "power coefficient" indicates the turbine's efficiency and is the ratio of the electrical output power to the total wind power.Although wind energy currently contributes only 1% globally, its growth is rapid, with countries like Denmark and Germany relying heavily on wind power.Later developments focused on improving turbines, creating wind farms, and establishing offshore sites to increase efficiency.A wind turbine consists of three main parts: the blades that capture wind energy, the rotor that connects the generator to the turbine, and the tower that supports other components.The turbine also includes a pitch system to maintain a constant speed, brakes to reduce speed, and a generator that converts mechanical energy into electricity.Roughness Classes: Terrain is classified from 0 (water surface) to 4 (dense cities or forests), impacting wind speed.It reaches its maximum value at the optimal wind speeds, where the turbine operates at high efficiency.**Tower Height**: - Offshore towers are shorter than onshore ones, but taller towers are better for wind energy harvesting.**Nacelle**: - Contains the gearbox, generator, and electronics to adjust the turbine based on wind speed and direction.Terrain Roughness: Affects wind speed and turbine efficiency, with rough terrain reducing performance.Wind Speed Reduction: Affected by terrain height and friction, calculable by specific formulas.Offshore turbines have a higher power coefficient than onshore turbines due to different optimal speeds.**Yaw Mechanism**: - It aligns the turbine with the wind and monitors cable twisting.Winds are influenced by Earth's rotation and the Coriolis force, which causes winds to shift direction in each hemisphere.1.2.3.4.