Pitch Angle Control System Design for Wind Turbine

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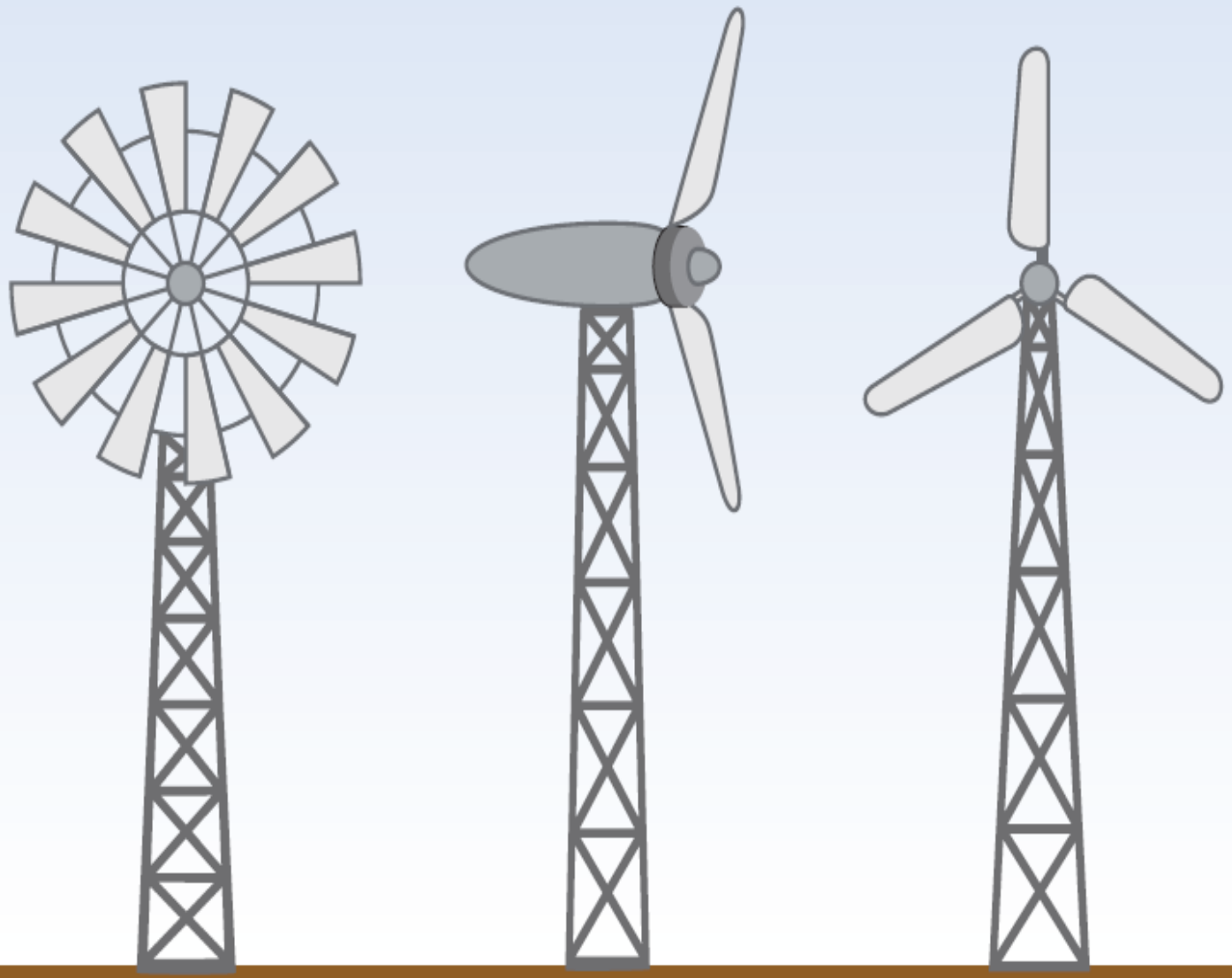
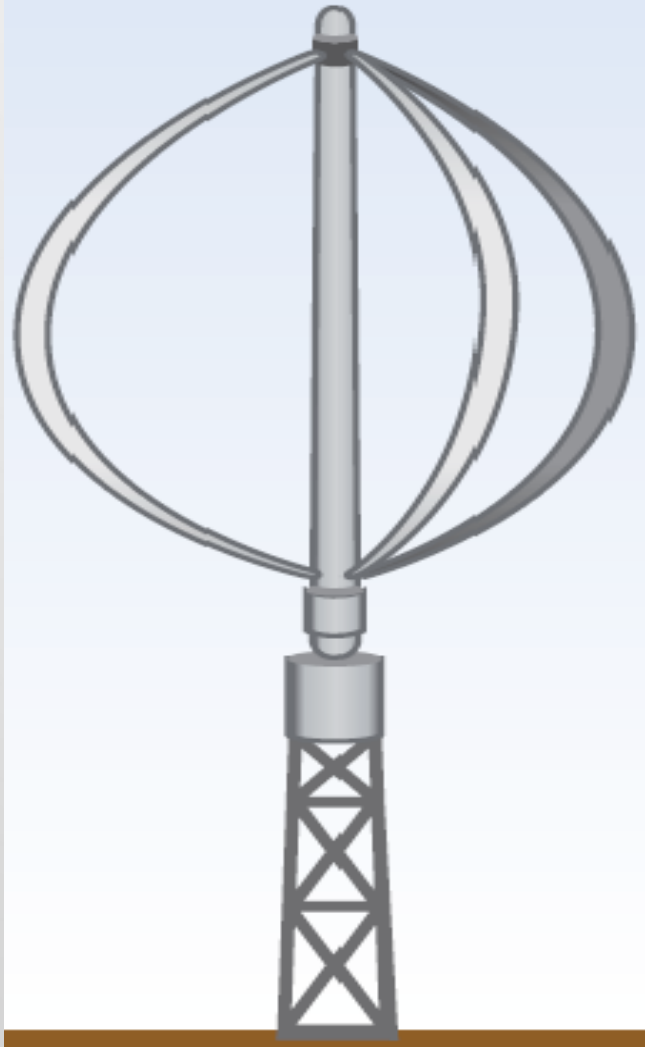
Introduction

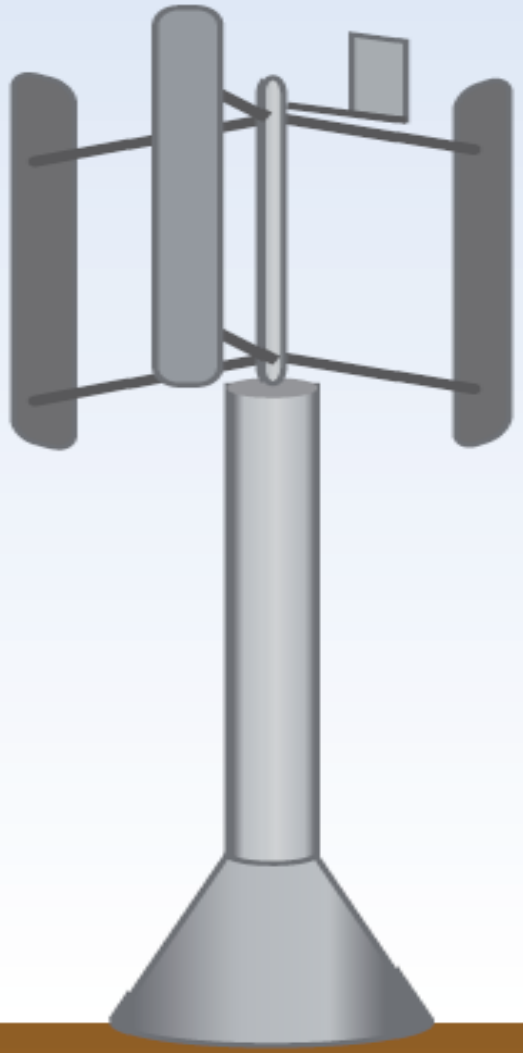
- Wind turbines are designed to produce electrical energy as cheaply as possible. Wind turbines are therefore generally designed so that they yield maximum output at wind speeds around 15 meter per second. Its does not pay to design turbines that maximize their output at stronger winds, because such strong winds are rare.
- In case of stronger winds it is necessary to waste part of the excess energy of the wind in order to avoid damaging the wind turbine. All wind turbines are therefore designed with some sort of power control. There are two different ways of doing this safely on modern wind turbines.
- **Pitch Controlled Wind Turbines** On a pitch controlled wind turbine the turbine's electronic controller checks the power output of the turbine several times per second. When the power output becomes too high, it sends an order to the blade pitch mechanism which immediately pitches (turns) the rotor blades slightly out of the wind. Conversely, the blades are turned back into the wind whenever the wind drops again.

Horizontal-Axis Turbines



Vertical-Axis Turbines





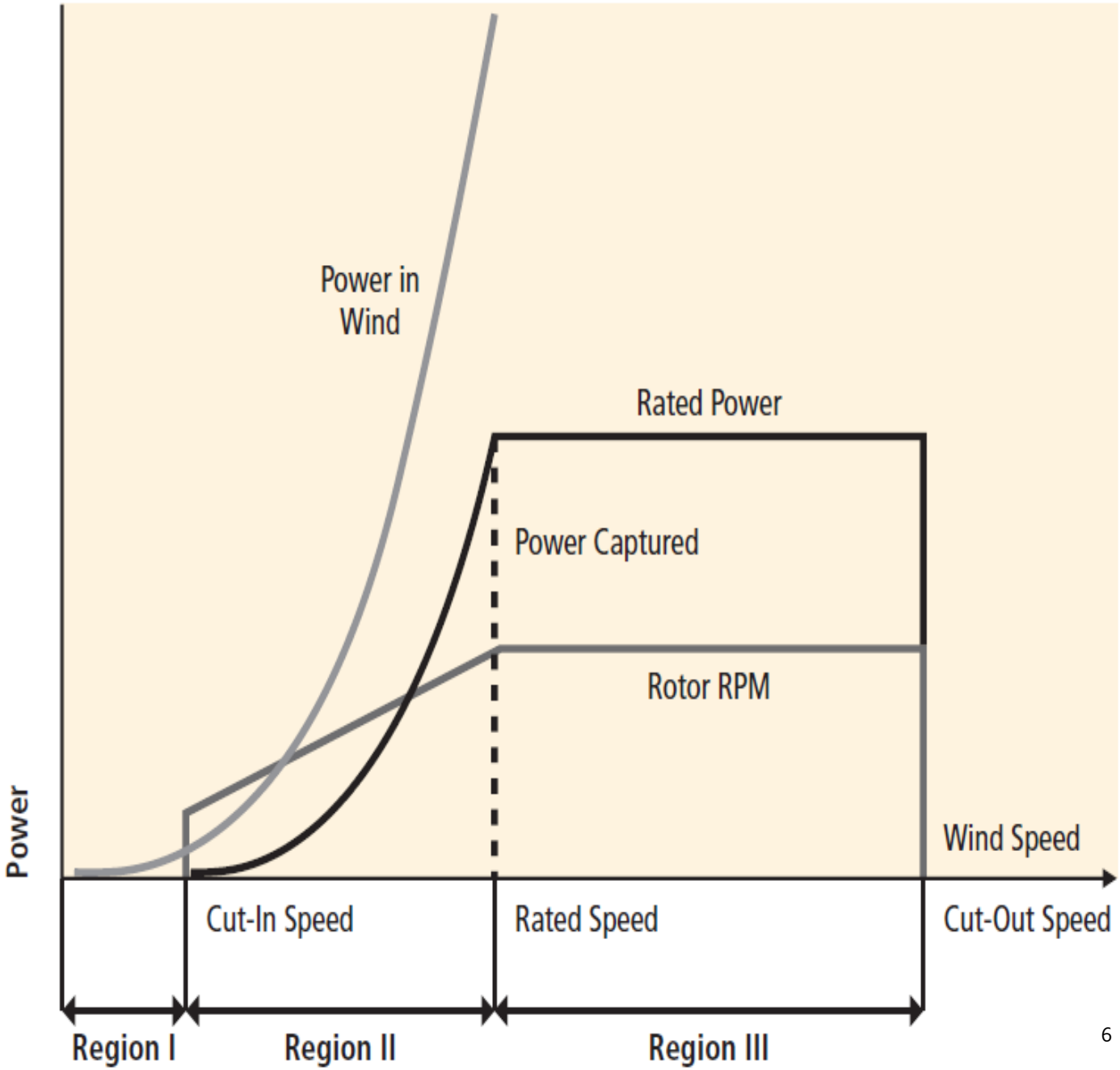
The Aim of Thesis

The aim of wind Generation Wind turbines are used to generate electricity from the kinetic power of the wind. Historical they were more frequently used as a mechanical device to turn machinery. There are two main kinds of wind generators, those with a vertical axis, and those with a horizontal axis. Wind turbines can be used to generate large amounts of electricity in wind farms both onshore and offshore. The articles on this page are about wind turbines.

What's Wind Turbine?

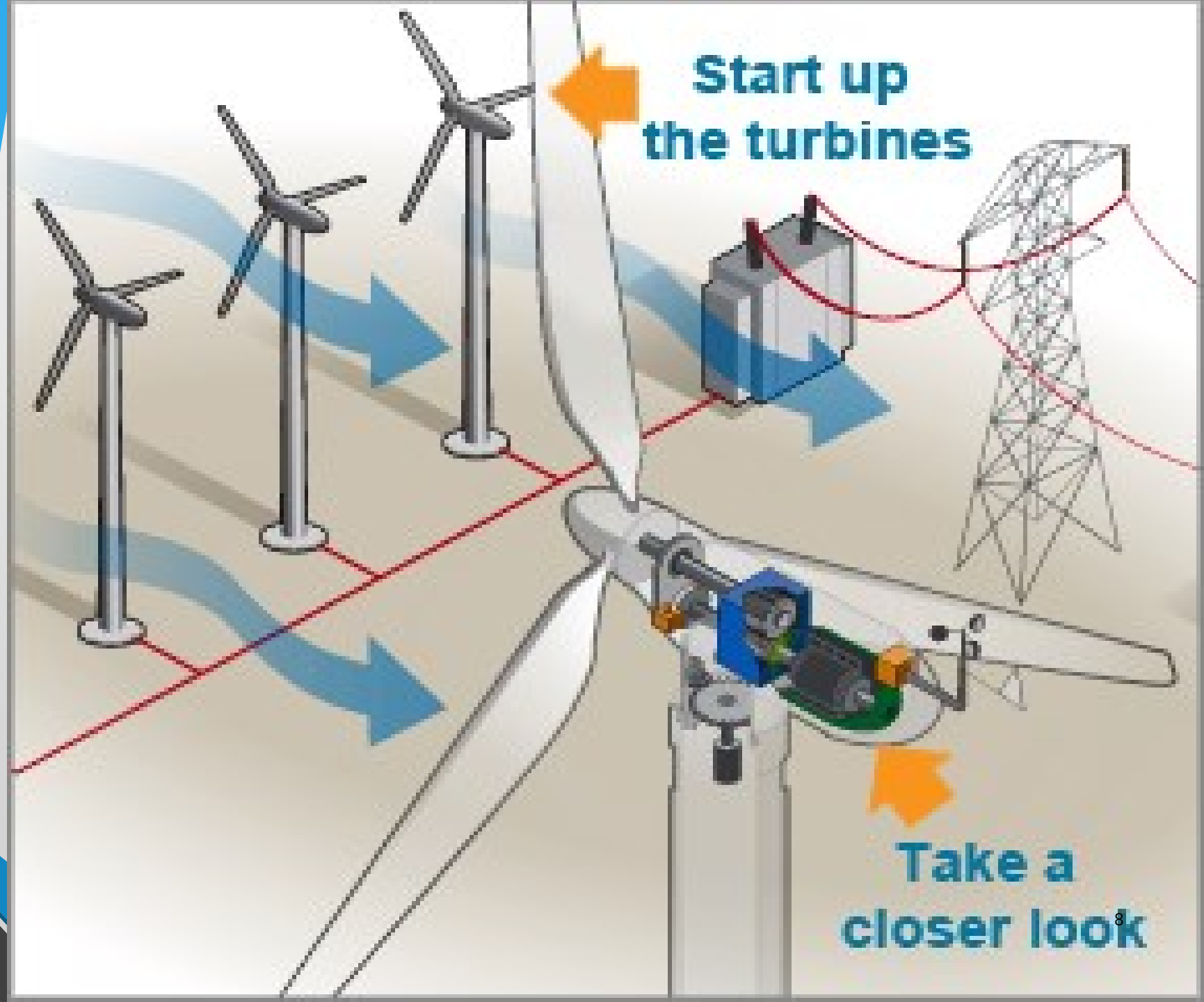
A **wind turbine** is a device that converts kinetic energy from the wind into electrical power. The term appears to have migrated from parallel hydroelectric technology (rotary propeller). The technical description for this type of machine is an **aerofoil-powered generator**.

A wind turbine works on a simple principle. This animation shows how energy in the wind turns two or three propeller-like blades around a rotor. The rotor is connected to the main shaft, which spins a generator to create electricity. Wind turbines are mounted on a tower to capture the most energy. At 100 feet (30 meters) or more above ground, they can take advantage of faster and less turbulent wind. Wind turbines can be used to produce electricity for a single home or building, or they can be connected to an electricity grid

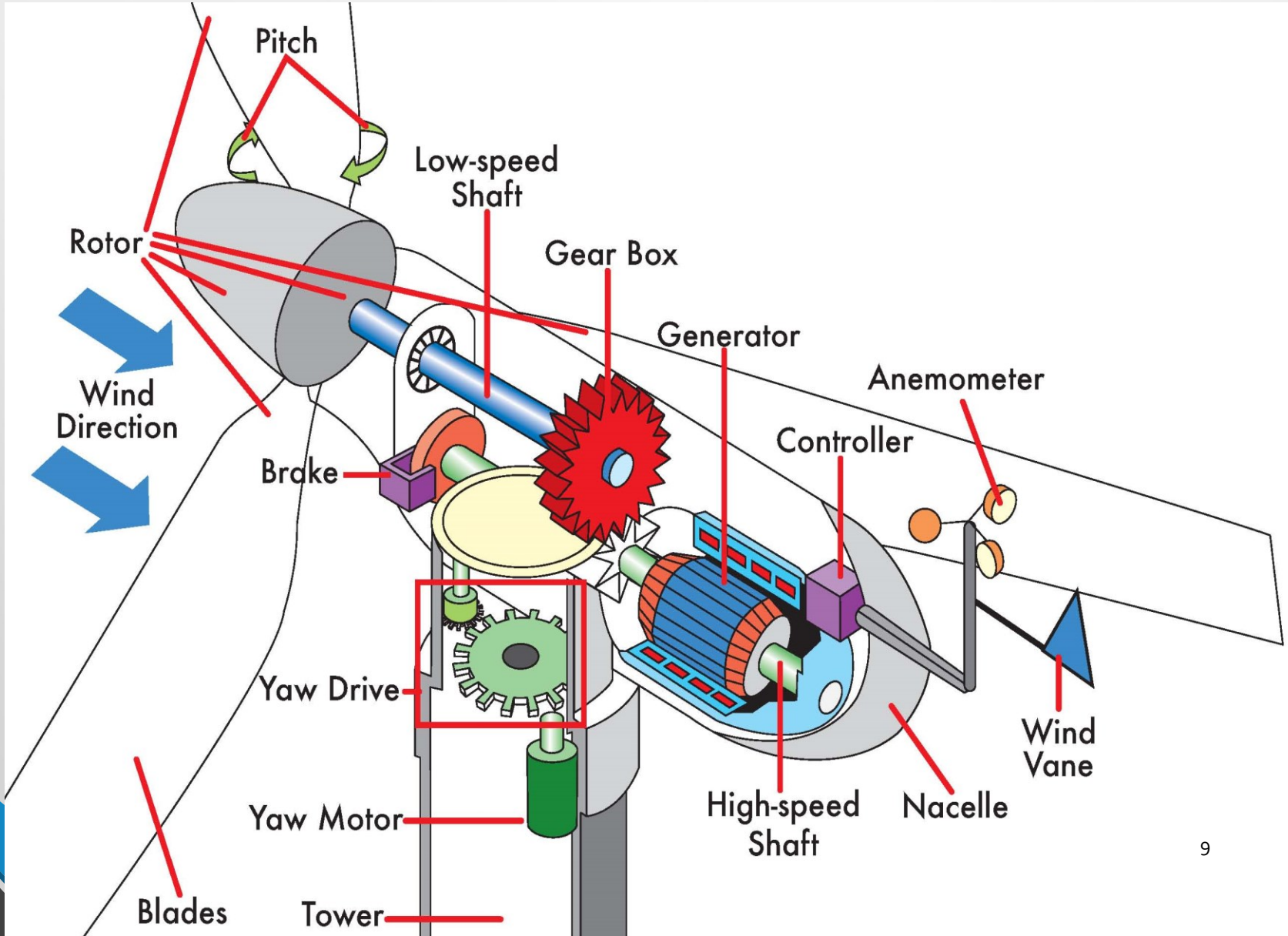

Power in
Wind
Rated Power
Power Captured
Rotor RPM
Power
Wind Speed
Cut-In Speed
Rated Speed
Cut-Out Speed
Region I
Region II
Region III

How do Wind Turbine Work?

- Wind turbines operate on a simple principle. The energy in the wind turns two or three propeller-like blades around a rotor. The rotor is connected to the main shaft, which spins a generator to create electricity.
- Simply stated, a wind turbine works the opposite of a fan. Instead of using electricity to make wind, like a fan, wind turbines use wind to make electricity. The wind turns the blades, which spin a shaft, which connects to a generator and makes electricity. View the wind turbine animation to see how a wind turbine works or take a look inside.


Start up
the turbines
Take a
closer look

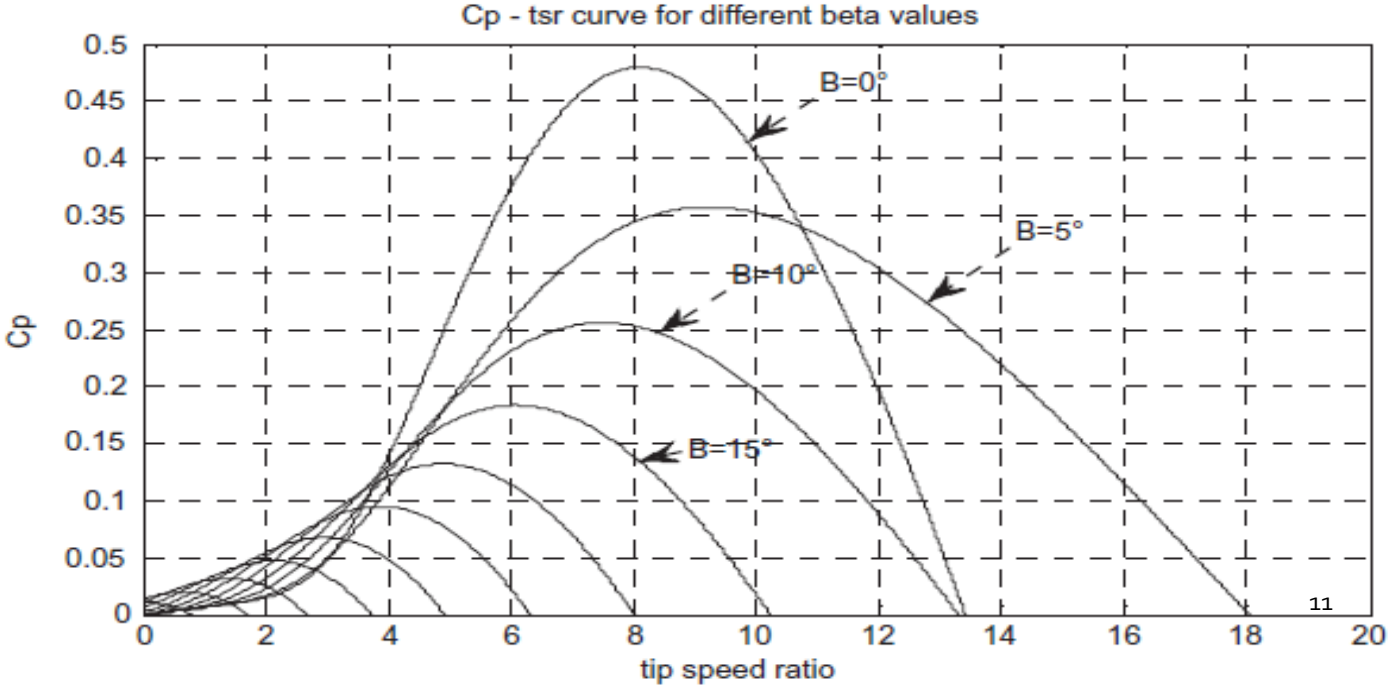
Component wind turbine



What's The Pitch Control?

- Pitch control gearboxes serve the essential purpose of setting wind turbine blades at the best angle to the wind to turn the rotor. Advanced technical features, extremely robust design and high torque capacity make these.
- pitch control system can change incidence of rotor blades in a wind power generation system based on real-time wind speed for the purpose of adjusting output power, achieving higher utilization efficiency of wind power and providing protection for rotor blades.

- When wind speed is not higher than the rated speed, the blade incidence stay near the angle o° (highest power point), which is similar to that of a generator with constant pitch, generating an output power that changes along with wind speed. When wind speed is higher than the rated speed, the pitch control mechanism changes blade incidence so that the output power of generator is within the allowed range.



Control methods for pitch control system

You can use different control methods to either optimize or limit power output. You can control a turbine by controlling the generator speed, blade angle adjustment, and rotation of the entire wind turbine. Blade angle adjustment and turbine rotation are also known as pitch and yaw control respectively.

The proposed control method (Sliding Mode Control)

Sliding mode control (SMC) is a nonlinear control technique featuring remarkable properties of accuracy, robustness, and easy tuning and implementation
The most typical choice for the sliding manifold is a linear combination of the following type.

$$\sigma = \dot{e} + c_0 e$$

$$\sigma = \ddot{e} + c_1 \dot{e} + c_0 e$$

$$\sigma = e^{(k)} + \sum_{i=0}^{k-1} c_i e^{(i)}$$

A typical form for the sliding surface is the following, which depends on just a single scalar parameter, p.

$$\sigma = [\frac{d}{dt} + p]\, k_e$$

K=1 $\sigma = e^{\cdot} + pe$

K=2 $\sigma = e^{\cdot\cdot} + 2pe^{\cdot} + p^2 e$

The control is discontinuous across the manifold $\sigma = 0$.

$u = -U \operatorname{sgn}(\sigma)$

That is

$$u = \begin{cases} -U & \sigma > 0 \\ U & \sigma < 0 \end{cases}$$

Proposed System

- I want to make a control system design for wind turbine.
- We will use sliding mode control for this system because sliding mode control have some advantages in control system
- Pitch angle system have a nonlinear dynamics, and sliding mode controller is popular in control of nonlinear systems.

References

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Thank You