

Chapter 1

1.1 Introduction

Wind energy is one of the biggest renewable energy sources used nowadays. Windmills are the primary devices used to obtain this energy. Being a fairly new technology (developed in 1970's), there are still several concerns regarding the optimal performance of this generators.

1.2 Problem Statement

The current approach used by **KK** company is based on two independent controllers. One controller for the pitch performance of the blades, and the other for the shaft's torque. The usage of these two control strategies is determined by the speed of the wind. Depending on the wind's speed there are three working regions for the windmill.

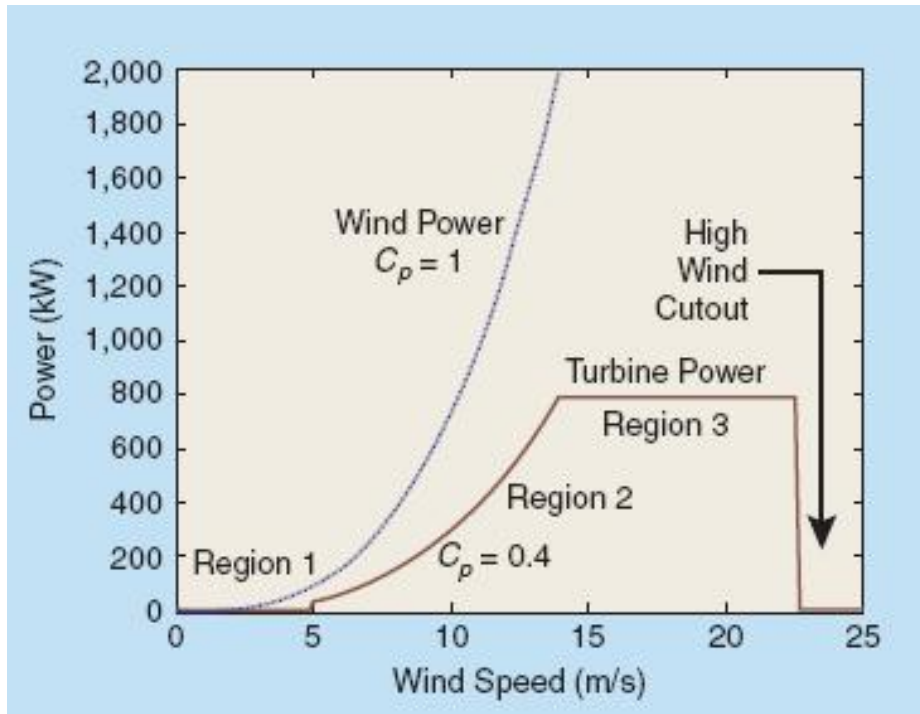


Figure 1.1: Windmill Operational Regions Power [kW] vs Wind Speed [m/s]

- Region 1: Stopped or just starting turbine.
- Region 2: Operational region with the objective of maximize energy capture.
- Region 3: High speed winds. Turbine must limit the captured wind power in order for the electrical and mechanical components not to be damaged.

After region 3, if the winds are strong, the windmill must be stopped completely.

The current control strategies are determined by a coefficients table provided by the blade manufacturer. The reliability of these coefficients is doubted. This coefficients can change due to blades wearing out and varying climatic conditions such as air density, humidity, and temperature.

Another important issue is the wind speed. Due to the size of the windmills, the wind conditions are not homogeneous for the area covered by the blades.

Our project proposal would be to analyze a new control strategy involving the collaboration of these two variables, pitch and torque. As a first approach, we will assume that we have an accurate measure of the wind speed. The coefficients used will be the ones provided by the blade fabricators. With these elements and state of the art models, we will generate a Matlab Simulink model. The second step will be to develop a MIMO controller for our model. The last steps will be to simulate and analyze our results. All these with the main focus of providing assistance to **KK**'s search for a more suitable control option.

The motivation for this analysis is the increase on the energy obtained. This energy is currently being wasted because the windmill can not adapt to the shifting wind conditions. This amount of wasted energy (about 3%) can be reflected on millions of Euros, which are enough motivation to take this project into account. In case this is not enough motivation, the necessity to obtain an environmentally friendly energy source desired.