

Variable Pitch Wind Turbine Design

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# Purpose

This document records the design and implementation of a small scale variable pitch wind turbine design.

CONTENTS

[Purpose i](#_Toc29156104)

[Introduction 1](#_Toc29156105)

[Requirements 1](#_Toc29156106)

[Design Proposal 1](#_Toc29156107)

# Introduction

This project is set out to design and develop a variable pitch wind turbine that can be built using a combination of 3D printed assemblies, material that can be machined using simple and common workshop tools, that can drive an off the shelf hobby brushless DC motor as a generator using a rectifier.

One of the issues affecting fixed pitch wind turbines, is that of high winds causing the turbine to spin at excessive speeds. This can cause a number of failure modes including wearing out the bearings, or causing the generator windings to get too hot and break.

A variable pitch wind turbine can feather its blades during high wind speeds mitigating this. It can optimise the angle of attack to maximise safe energy harvesting across a range of wind speeds.

# Project Breakdown

The project will be broken down into several different major design tasks. These consist of the following:

1. Determine initial operating conditions:
   * Deployment location average wind speed
   * Target rotor rotational velocity to design for
   * Selection of Brushless DC Motor and planetary gearbox with Torque Speed Curve to match
2. 3D printed Turbine Blade using an appropriate wind turbine airfoil and varied angle of attack to match location wind speed
3. Design of a linear screw actuated swashplate assembly to vary blade pitch
4. Design of Control and Rectification Printed Circuit Board with following features:
   * Rotational speed sensor
   * Motor temperature sensor
   * Anemometer
5. Design test assembly to mount on vehicle roof racks

# Operating Conditions

The deployment location is in Southern Tasmania, Australia. At this time I lack weather data for the deployment location, so using Weather Spark, the average wind speed at the deployment location is between 17 and 21km/h, disregarding local topography. This means the turbine will be designed with an ideal wind speed of 19km/h in mind.

# Air-Foil Selection

During the Carter administration the Solar Energy Research Institute (SERI) was established, which went on to become the National Renewable Energy Laboratory (NREL), one of the national laboratories under the US Department of Energy. Originally wind turbines were designed using the NACA 4 digit and 5 digit series airfoils, which were developed in the 30s to 50s for aircraft. These airfoil designs when applied to turbine rotors suffered from poor power to thrust ratios. SERI and then NREL initiated research into developing optimal airfoil and blade designs utilising these air-foils for wind turbines.



