

# Variable Speed Wind Turbine Power Maximization (Onshore or Offshore)



Sector: Renewables

Why chose **ORTO** for this application?

Power generated by a wind turbine is a function of wind speed and air density. Wind speed, in particular, can vary significantly over a short period of time. As wind speed and air density varies, the optimum settings for tip speed ratio and pitch angle, i.e., settings which maximize the power generated, also vary.

Traditional model-based RTO technologies are not suited to such applications as wind turbine dynamics are difficult to model.

ORTO however is model free, continually adapting as conditions change. Wind speed and air density measurements are used to provide feedforward action, allowing ORTO to track changes in the optimum operating point.

## Business Objective

To maximize power generated by the turbine, between the cut-in and rated wind speeds and for any given air density. Prolonging the operating life may also be a key aim.

## Typical Optimization Objective Function

Maximize power generated.

By manipulating, within a permitted range:

- Tip speed ratio (ratio of the turbine blades tip speed to wind speed)
- Blade pitch (blade angle of attack)

Subject to suitable constraint limits on:

- Power output
- Mechanical integrity measurements e.g., stress, strain, vibration.

## Solution

Two agents are required, to adjust tip speed ratio and blade pitch. Yaw angle (angle of turbine to wind direction) can remain under regulatory control, to keep blades at  $90^\circ$  to wind, unless yaw angle is used for wake steering optimization (see wind farm use case).

## Benefits

Typical a 2-3% increase in power generated, between the cut-in and rated wind speeds.

