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## Pitch System as a Way of Load Reduction

Recent economic and technical developments such as the pressure to reduce the overall cost of electricity generated by wind turbines, the necessity to reduce costs as well as increased emphasis on reliability and predictability of power production make it urgent to find a technical solution to that question.

Load reduction is a key element of the solution. In addition, load reduction gains an increasing importance due to the trend towards larger wind turbines.

Over the relatively long history of the development of wind turbines, blade pitch control is something that has only recently been implemented to improve the availability, reliability and lower the cost of wind energy production. Early wind turbines had fixed blades and no way to "feather" or protect the blades from high winds and extreme weather conditions.

Pitch control means the turning of rotor blades between 0° and 90°. When wind speeds are below rated power, typically below 12 m/s, the rotor blades are turned fully towards the wind which means that the pitch is positioned at 0°.

At increasing wind speeds the pitch of the blades is controlled in order to limit the power output of the turbine to its nominal value. When wind speeds reach a predefined threshold, typically 28 m/s, the turbine stops power production by turning the blades to a 90° position.

Collective pitch control adjusts the pitch of all rotor blades to the same angle at the same time.

During start-up, regular operation (power generation) and shutdown a wind turbine is subject to various forces causing peak loads and fatigue loads. There are also forces on the hub, mainframe and tower structures. These forces have two effects, in particular on the tower: The yaw moment (Myaw) is twisting and the tilt moment (Mtilt) is bending it. When designing strategies to counterbalance the forces discussed above, a first step is an analysis: the Fourier analysis gives what is usually called the 1p, 2p, 3p, components of the loads. Classic IPC, which is most often used, only compensates for the 1p component. Other components can also be addressed by IPC but their compensation requires increased pitch activity and more dynamic control systems. The newest measurement technologies such as LIDAR (Light Detection and Ranging) provide real-time information on wind conditions and forecasts for the next few seconds. Based on this information it becomes possible to prevent peak loads by using IPC to develop preventative load alleviation strategies.

Pitch system by changing the angle of attack reduces the load reduction and thereby extends the life of the wind turbines, increases reliability and reduces maintenance costs.