

Automated Curtailment of Wind Turbines During Critical Transmission Periods

Maid Delic

Lund University, Lund
adi10mde@student.lu.se

Abstract

Gotland is an island located east of the Swedish mainland in the Baltic Sea. The island power distribution grid is connected to the Swedish mainland by two High Voltage Direct Current (HVDC) cables. The two HVDC cables are intended to be used for power transmission from and to the mainland. During high power consumption the power flow is intended to be directed to Gotland, and during high power production, a HVDC cable can be used to transmit power to the mainland.

Wind power is the main deliverable of electric power on Gotland and there is 170 MW installed wind power on Gotland. If the wind power production exceeds the consumption on Gotland, the power can be transmitted to the mainland. There are periods where service is necessary on one of the two HVDC cable. During these service periods, power flow (20 MW) from the mainland to Gotland is necessary due to grid safety purposes. This is what is called the critical transmission periods.

If the wind power production on Gotland is high and the power flow from the mainland to Gotland reaches 20 MW the wind power is curtailed. This is to bring the wind power production down to increase the power flow from the mainland to Gotland.

Gotland Energi AB (GEAB) is curtailing the wind power during the critical transmission periods in a manual manner from a drift operation station. This leads to waste of wind power energy and a automated process was needed to reduce the wind power waste during these periods [1].

I. System Identification – Curtailment test

To be able to get an understanding of how the existing HVDC cable reacts to changes in the wind power production, a curtailment test was executed. The test was executed during a period where one of the HVDC cables was out of order and a wind power plant was curtailed with 10 MW.

The data was collected and a system identification using Matlab was done. The result of the test and system identification led to a model of the behavior of the HVDC cable during curtailment of wind power production. The derived model was used in simulation purposes and control design in the project.

II. Control – Automated Curtailment

To be able to automate the curtailment during critical transmission periods, a control algorithm had to be designed. During this project two control designs were designed. This was to come up with the optimal control design for the automated curtailment of the wind power. Both of the control designs had an deadband filter due to the natural power flow variation of the HVDC cable. The major reason for the deadband filter was to avoid sending curtailment signals to the wind power plants too often.

The goal of the two control designs were the same, to reduce the waste of wind power production due to the manual curtailment process.

III. Fair Dispatch

The wind power parks on Gotland are not owned by one entity, this leads to a problem when curtailment of wind power is necessary. A fair approach of curtailing the wind power parks had to be presented. The fair dispatch problem was known in other parts of the world and research from United Kingdom was used as a base in the design of the fair dispatch algorithm.

The parameter that was mostly used in the fair dispatch concept in this project was to involve the economical aspect of the wind power production on Gotland. Different approaches such as equal amount of loss in revenue, resource based loss in revenue and contract based dispatch are presented in the project.

IV. Results

The resulting simulations using the model and the two control designs showed that there were no bigger difference between the two designs. Both of the control designs showed that adopting an automated curtailment system would reduce the waste of wind power during the critical transmission periods.

After conducting interviews with GEAB personal it was found that the economical approach of a fair dispatch would not be realizable since GEAB can be seen as the Distribution System Operators on Gotland and they should not be involved in the electricity market. A contract based dispatched approach was found to be realizable since the wind power owners sign a contract for the wind power production and there should not be any legal problems.

References

[1] Delic, M, 2015. *Automated Curtailment of Wind Turbines During Critical Transmission Periods*. M.Sc. Lund University.