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Flicker mitigation and voltage sag ride through of a wind turbine using an STATCOM

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Abstract summary

Wind farms are becoming more and more important as distributed renewable energy resources, that's why quality issues (such as flicker emission and voltage sag ride through) are being taken into account by grid codes.
Wind farms employing fixed speed induction generators may require the installation of compensation devices (e.g. SVC, STATCOM, DVR,...) to fulfill the network LVRT requirements. Additionally, these devices can contribute to decrease the flicker emission.
In this paper, the installation of a STATCOM device in parallel with wind turbines is examined. Different configurations are analyzed through simulation with the aim of determining the STATCOM size and designing its control. Measurement data obtained in a wind park has been used in order to simulate the real working conditions of wind turbines.

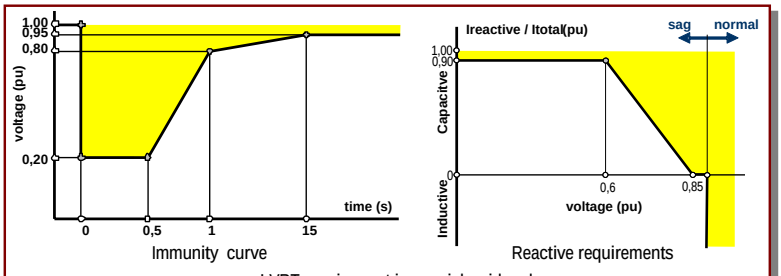
Objectives

The main objective of this work is to analyze the capability of an STATCOM connected to LV side of a fixed speed wind turbine. This device is used to fulfill the grid code requirements related to voltage sag immunity (LVRT) and to reduce flicker emissions.
The steps to achieve the above mentioned objectives are:

- **Modeling. Wind turbine and STATCOM are modeled in PSCAD. The wind turbine simulation results are compared with measurement in a real wind turbine installed in the Sotavento Experimental Wind Farm (www.sotaventogalicia.com).**
- **Simulation. The behavior of STATCOM connected in LV side in a wind turbine is studied.**
- **The result is the STATCOM size and the design of its control to fulfill the grid code requirements.**

Spanish Grid Code

Spanish grid code requirements for voltage sag immunity are summarized in the figures bellow. In left curve, the worst voltage that a wind farm must withstand is shown. During the voltage sag the wind farm must have a capacitive behavior as shown in the right diagram.



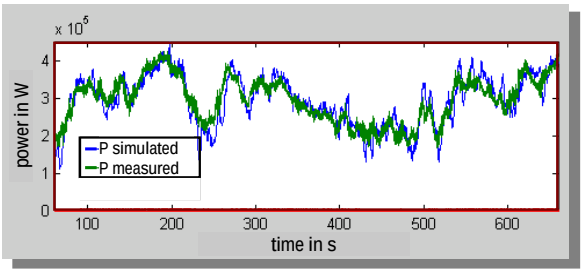
LVRT requirement in spanish grid code

Additionally, the response time to achieve the required reactive behavior is limited to 150 ms at the beginning and at the end of voltage sag. During these transient periods certain amount of active and reactive power consumption is allowed.

Modeling

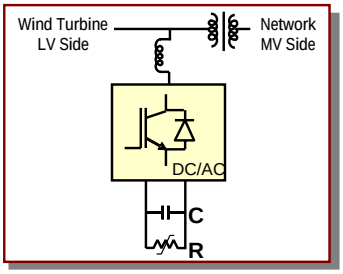
A) Wind turbine and STATCOM are modeled in PSCAD software.

- **Wind turbine simulation results are compared with real measurements as shown bellow.**



B) STATCOM has been modeled with:

- **DC/AC converter, it controls Q and DC voltage.**
- **Capacitor, it is used to maintain DC voltage.**
- **Brake resistor, it is included to dump wind turbine power during sag.**

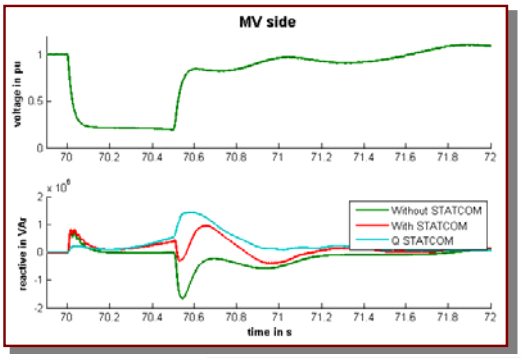


Results

A wind turbine connected to MV network has been simulated. The two scenarios taken into account were:

- **Without STATCOM, compensation is done by means of capacitor banks.**
- **With STATCOM, which is used for LVRT and reactive compensation.**

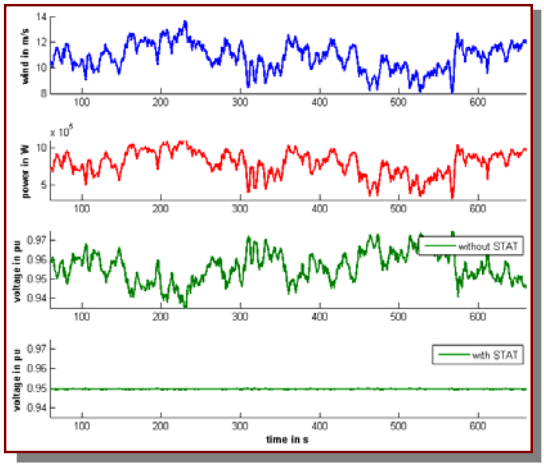
Voltage during sag, reactive power injected at MV side and reactive power injected by STATCOM are shown bellow.



With the proposed STATCOM configuration, the wind turbine fulfills the reactive LVRT requirements.

Flicker emission has been simulated for the two scenarios. Results are shown in the table bellow. Flicker severity level (Pst) has been calculated in the LV and MV side.

	Without STAT	With STAT
Pst MV side	0,1351	0,0063
Pst LV side	0,1425	0,1167



Conclusions

- **A model to evaluate the behavior of an STATCOM connected to the LV side of a wind turbine have been developed.**
- **By mean of simulation the fulfillment of LVRT grid code requirements is analyzed.**
- **Flicker emission is estimated.**

AN STATCOM CONNECTED TO THE LV VOLTAGE SIDE CAN BE USED TO FULFILL THE LVRT REQUIREMENTS. A REDUCTION ON FLICKER EMISSION IS ACHIEVED WITH THIS CONFIGURATION.

References

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