CHALMERS

ELKRAFT 2017

GRID CODE TESTING BY VOLTAGE SOURCE CONVERTER

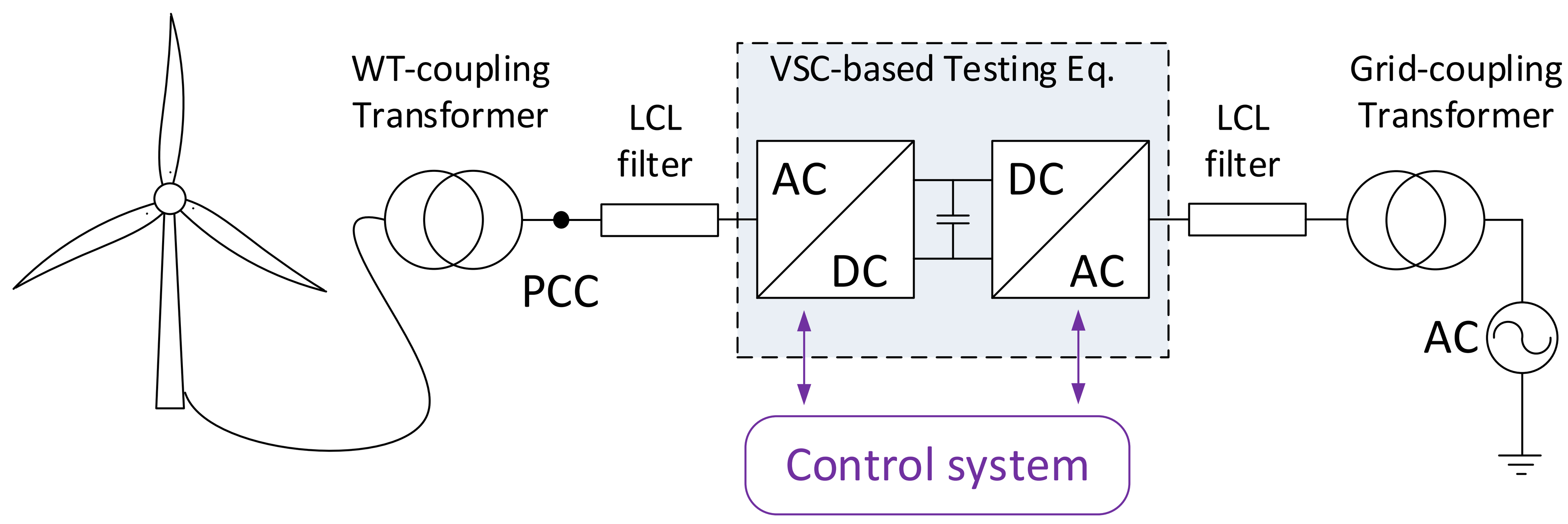
ABSTRACT

- Safe and reliable operation of the wind turbines is important for an efficient operation of the power system.
- One important design criteria for wind turbines is the fulfillment of Grid Codes given by transmission system operators (TSO), they state how wind turbines/farms must behave when connected to the grid in normal and abnormal conditions.
- For this reason, the testing equipment which comprises the use of fully-rated Voltage Source Converter (VSC) in back-to-back configuration is proposed.
- Thanks to the full controllability of the applied voltage in terms of magnitude, phase and frequency, the use of VSC-based testing equipment, provides good flexibility.
- Here, test results of a 4 MW wind turbine and an 8 MW test equipment, located in Gothenburg, Sweden, are shown.

PROPOSED VSC-based TESTING EQUIPMENT

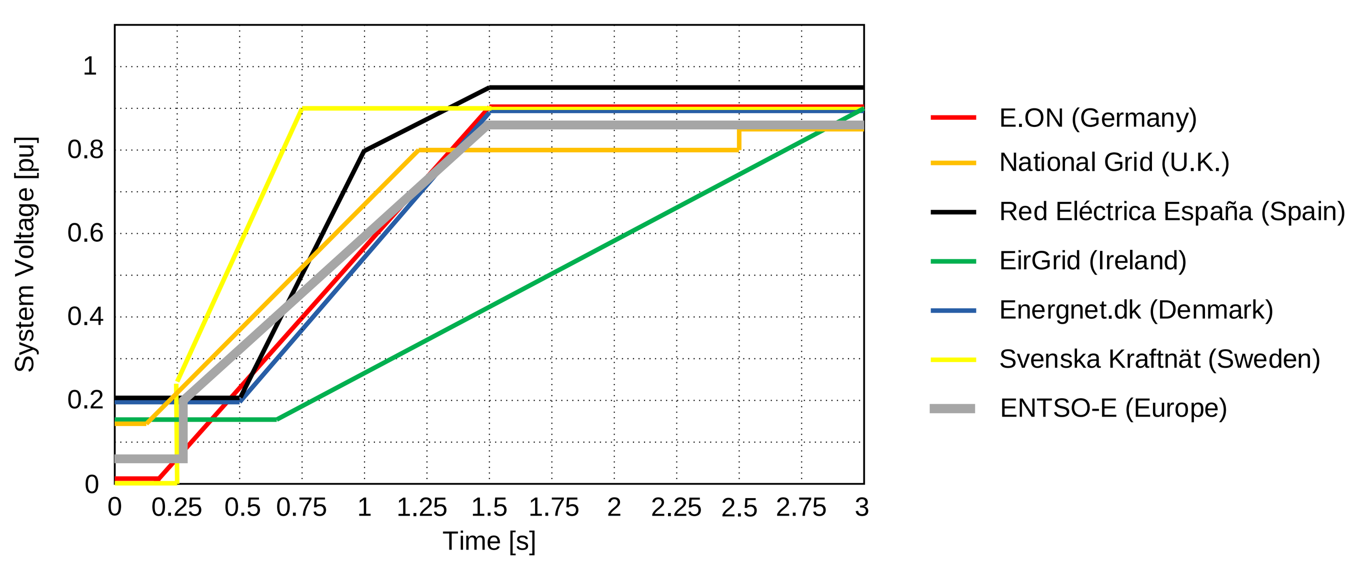
The test equipment is rated at 8 MVA, 10.5 kV, and the wind turbine is rated at 4 MW.

- The turbine-side VSC controls the applied voltage,
- The grid-side VSC delivers the wind turbine power to the grid.
- The tested system and its dynamic are decoupled from the AC grid.

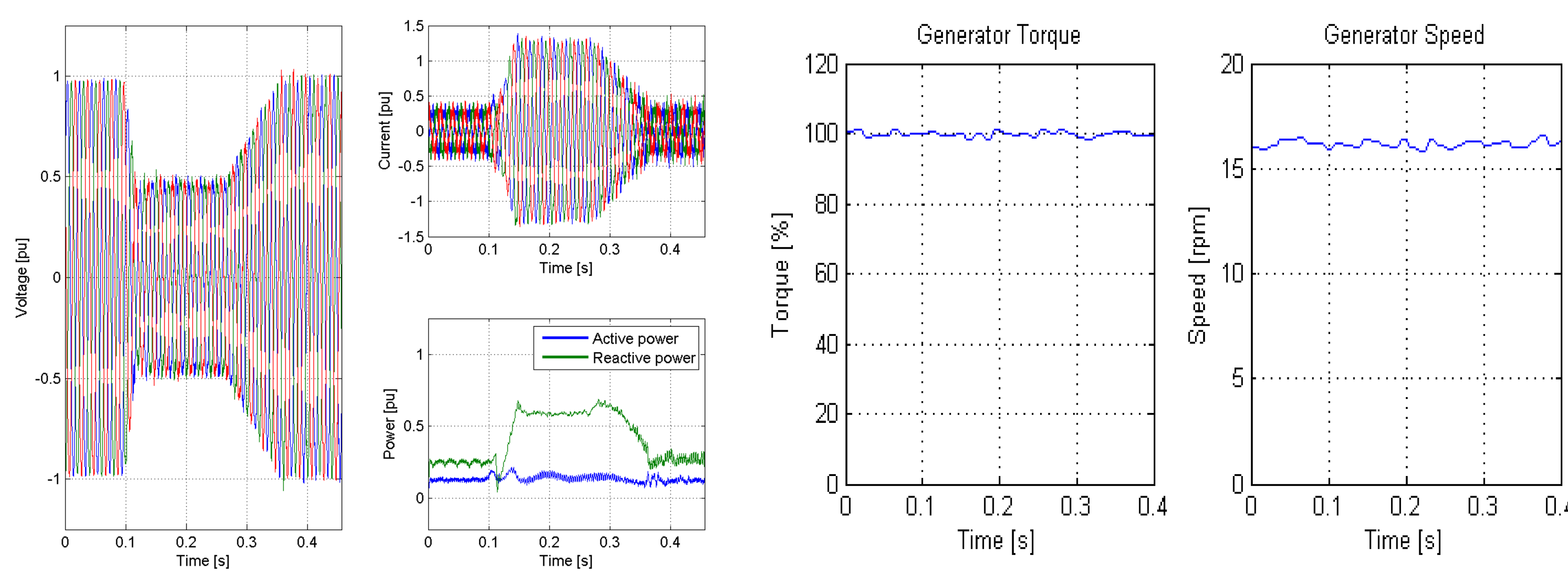


REQUIREMENT for LOW VOLTAGE RIDE THROUGH (LVRT) and TESTING

In every Grid Code it is specified a voltage dip profile that the wind turbine should ride through without tripping. In some cases, reactive current must be injected at the point of common coupling (PCC) in order to support the grid voltage when a voltage dip is detected.

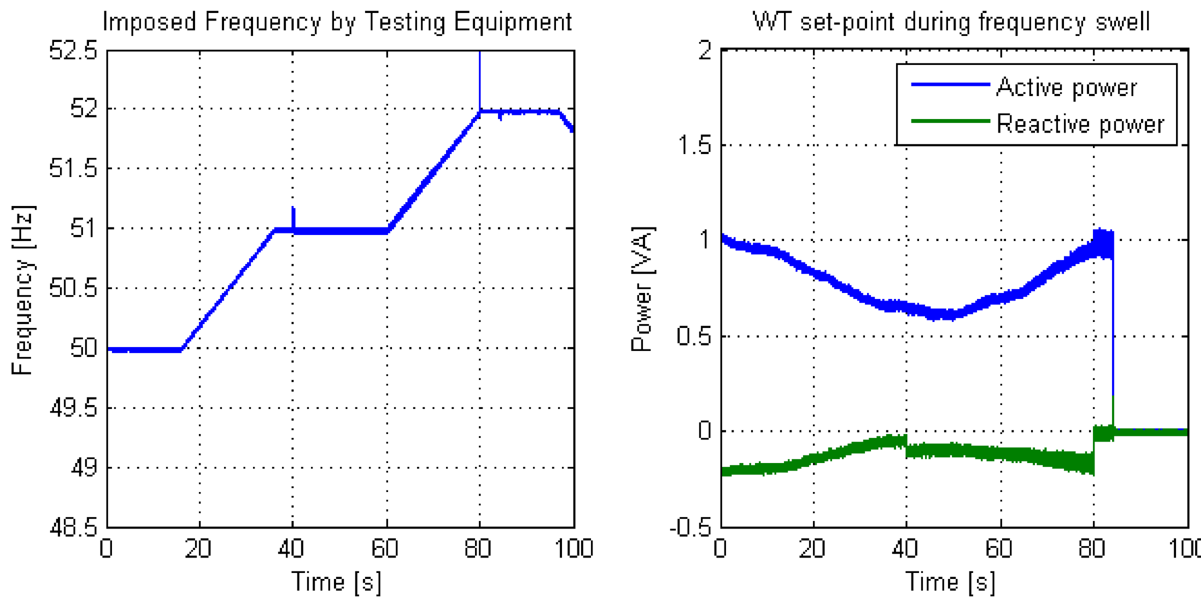


In this example, the testing device is used to reproduce a voltage dip at the wind turbine terminals. The wind turbine reacts by injecting reactive power into the grid in order to support voltage restoration. It can also seen that the wind turbine generator is unaffected by the voltage dip and that the wind turbine keeps on running in a proper way.



TESTING for FREQUENCY DEVIATION

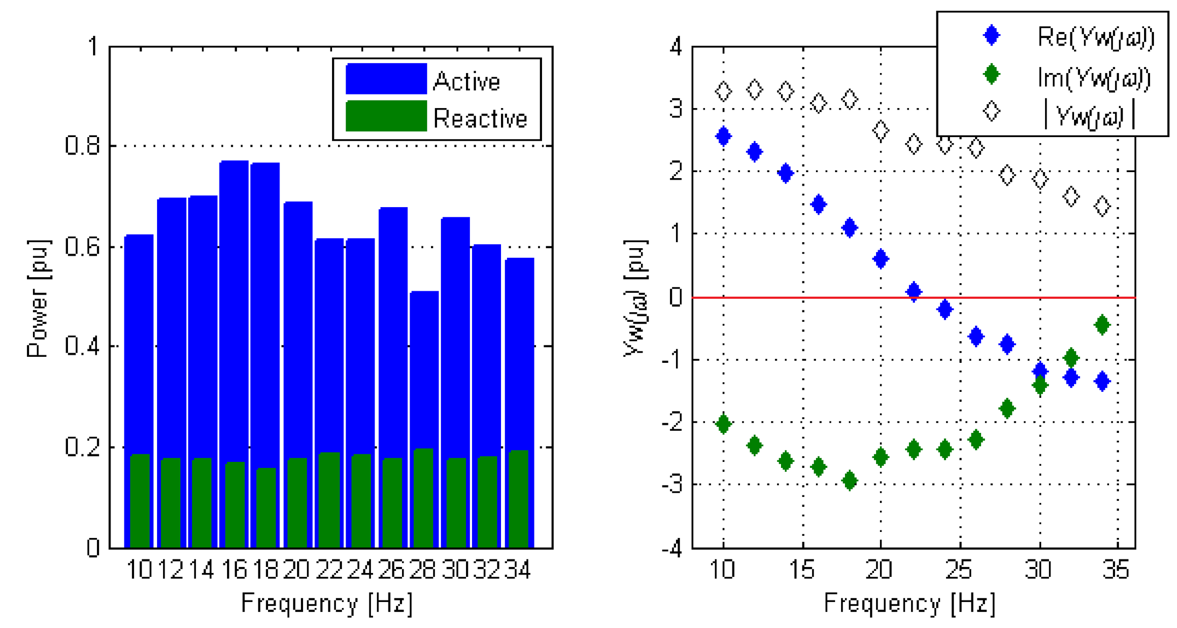
In this test, the applied frequency is varied upward emulating a frequency swell. The wind turbine reacts by disconnecting 5 seconds after the frequency reaches 52 Hz.



Big Glenn 4 MW wind turbine and the 8 MW HVDC-VSC station with filters and surge arresters

IMPEDANCE CHARACTERIZATION of THE WIND TURBINE

Finally, the testing device can also be used to characterize the input admittance of the wind turbine system $Y_W(j\omega)$, allowing the identification of frequency ranges in which the wind turbine can act passively (behaving as a resistor and dissipating the oscillation) or actively (injecting power at specific frequencies), evaluating the risk of interaction with other elements of the gird.



CONCLUSIONS

- VSC-based testing equipment is flexible and allows for full characterization of the WT.
- It allows for testing not only Grid Codes but also future requirements.
- Input impedance of wind turbine system can also be measured by the testing device.
- Methodology validated by field test experiments.

ACKNOWLEDGMENTS

Göteborg Energi

Energimyndigheten

Region Västra Götaland

SWPTC
SWEDISH WIND POWER TECHNOLOGY CENTRE

Protrol AB
PROTECTION & CONTROL

Chalmers University of Technology
Department of Electrical Engineering
Division of Electric Power Engineering

Ola Carlson, Nicolás Espinoza R.
ola.carlson@chalmers.se
nicolas.espinoza@chalmers.se