Generator **Co**nverter **Lab**

Institute for Drive Systems and Power Electronics

Leibniz Universität Hannover

Motivation

GeCoLab stands for Generator-Convertor Laboratory and is a universal generator test bench which enables a deep investigation of wind turbines and hydrogenerators in the megawatt class including converter-generator interactions. The study of megawatt generators is an ongoing important topic due to the very different phenomena and uncertainties of large electrical machines. Although calculation methods for Megawatt generators have already been developed for many years, there are still many problems and effects to be studied. There is no prototyping of big generators for investigation reasons. Considering the hydrogenerators of giant hydropower plants, each generator represents a unique electromechanical device which is designed and constructed for the specifics requirements of a power plant. Due to the large geometry and high currents of the machine, there are occasionally unknown phenomena which have to be studied. Moreover, the increasing complexity of electrical grids and rapid emerging of frequency converter-based generators encourage a much deeper study of the converter-generator interactions. GeCoLab has been created to deal with these challenges.

Our expertise

With a long tradition reaching back to the 20ies, the Institute for Drive Systems and Power Electronics is an excellent research institute in the field of electrical machines and power electronics. IAL has an established research network with different electrical and mechanical engineering institutes as well as the automotive, mechatronic, wind and European center of power electronics. In the field of power electronics, our research focuses on multi-level power electronics, novel semiconductors and optimized control algorithms. In the field of generators, we are focusing on developing analytical models of electrical machines, fault diagnostic, calculation of mechanical stress and vibrations and analytical estimation of circulating bearing currents in the generator. We are developing a variety of different commercial software programs for the calculation of different types of electrical machines. Beyond that, we are also developing FEM software and combined analytical-numerical methods. All these help us to carry out research work on analytical and numerical methods for the calculation of synchronous (permanent magnet and separately excited) and asynchronous (also DFIG) generators. Profiting from the facilities of GeCoLab, we can test your motor or generator prototype with different types of converters for fault diagnostics, performance validation, and analytical modelling und design method development. We can carry out investigations on our generators (PMSM and DFIG) or your components using our sensor types, such as torque, position, speed, voltage, current, flux, vibration, temperature, etc.

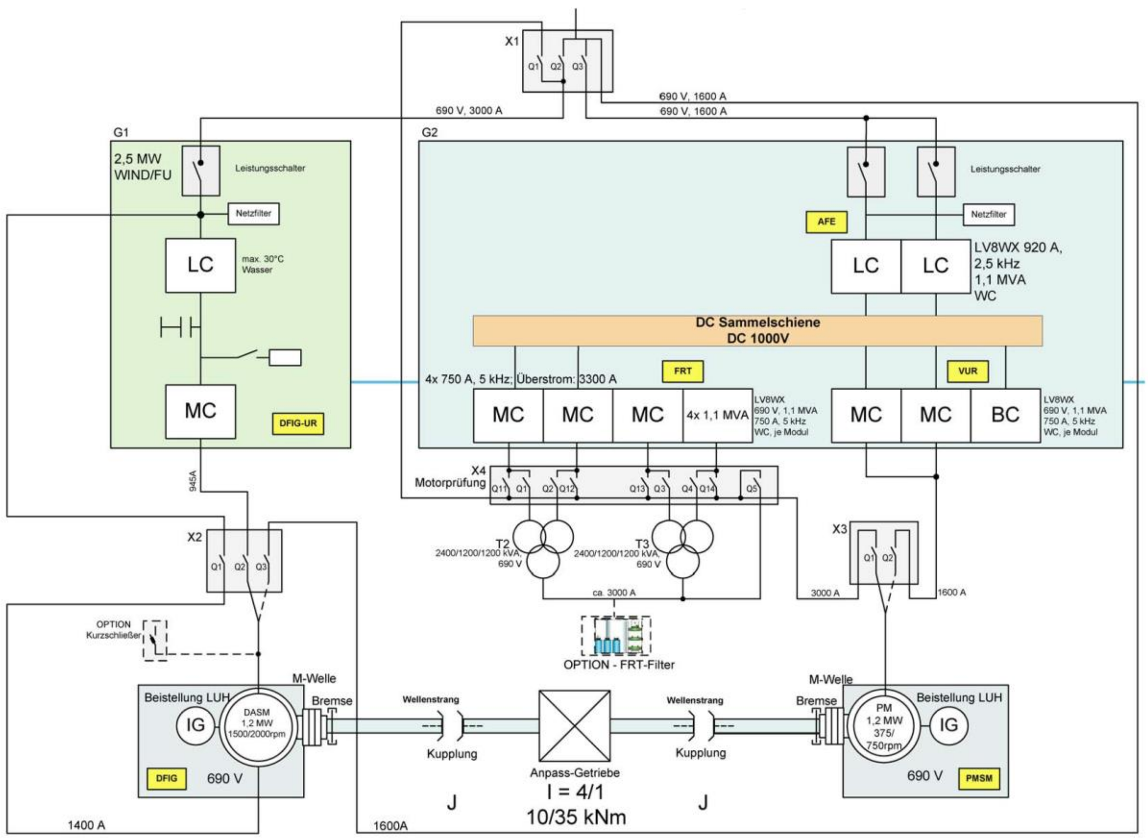
What we offer

GeCoLab facilitates a detailed investigation on both conventional and innovative converter and generator concepts including control and filter design methods. This includes investigations into dynamics and system stability, stationary and transient thermal loading, various methods of grid injection and control and the behaviour of grid faults, such as voltage dips, symmetrical and asymmetrical short circuits. It is also possible to research on the converter-generator interactions and their influence on other system components, such as bearings and gearboxes. These could be, for example, the influence of current harmonics on the generator, local saturation effects as well as bearing stresses and bearing currents.

GeCoLab offers an optimal solution for research on the electrical drive train of wind turbines and hydrogenerators. However, it is worth mentioning that the investigation is not limited to these two types of generators, and principally any kind of generator and converter can be installed on the test bench. The universal test bench is currently equipped with a doubly-fed asynchronous and a permanent magnetic synchronous machine, each with its own 690V inverters as well as a converter-based grid emulator with 4.4 MVA. The machines are equipped with extensive additional measuring technology in the stators and rotors. A modular coil circuit, adjustable eccentricity and the current measuring very different parts of the machine are just some examples of the machine facilities. The two generators, the inverters and the gearbox are water-cooled, each of which can be operated with different setpoints for flow temperature and flow rate.

Span area	10 m x 4.3 m
Max. components weight	20 t
Permanent magnet synchronous machine	P= 1.2 MW N= 375 rpm
Doubly-fed asynchronous machine	P= 2.08 MW N= 1780 rpm
Converter-based grid emulator	S= 4.4 MW

The two- and three-pole short circuits, an unbalanced grid or harmonics in the main voltage can be generated and investigated using the fault-ride-through network. A specific time-dependent grid voltage fault can be individually realized for each phase. It is worth mentioning that very different components can be substituted in the test bench and studied. These can be, for example, a doubly-fed asynchronous machine (DFIG), a rotor converter of DFIG, synchronous generators and the converter of synchronous generators. A quick change of components is made possible by a tensioning field and an on-site 20t crane. The machine foundation is decoupled from the building by means of pneumatic spring elements. In addition, a readily accessible terminal box is installed to replace the inverter with a test object. Researches on the mentioned topics result in an improved validation of analytical modellings, diagnostic procedures and advanced simulation models for electrical and mechanical components for a better design of generator and converter.



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