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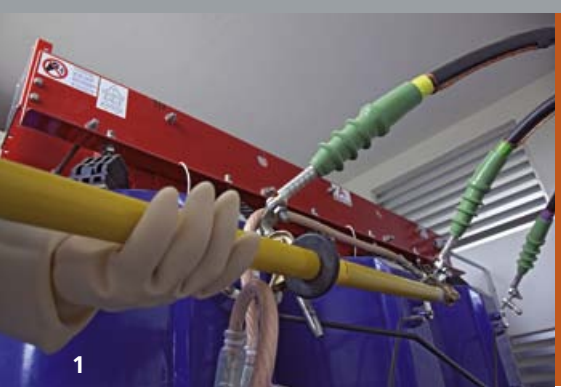
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PNI: TESTING LABORATORY FOR GRID INTEGRATION

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With the establishment of the research and testing laboratory for grid integration [Forschungs- und Prüflabor zur Netzintegration] (PNI), a reference lab was created providing the possibility to realistically develop and test grid components and grid equipment in view of new system functions. Focus of the PNI is to investigate and test the grid interface of storage facilities, generators based on renewable energies, combined heat and power generation plants, adjustable load appliances, electric vehicles and controllable transformers. The infrastructure permits investigations of low and medium voltage grids in the power range up to 6 MVA.

In particular, the laboratory enables to proof the performance of devices and equipment at different grid conditions, especially regarding the aspects of:

- static voltage support, voltage stability,
- dynamic voltage support,
- active power management, load management, frequency stabilization,
- coordinated controller behavior.

In addition to the test procedures in accordance with current standards and application requirements, the investigations serve to further develop the grid connection rules.

It is possible to test individual components as well as realize investigations covering entire grid sections including components connected to them in order to research the control performance of connected components and grid equipment in view of their interaction.

Federal Ministry of Economics and Technology

Overview

The PNI is part of the Fraunhofer IWES SysTec test centre for smart grids and electro-mobility. Currently devices connected to the low voltage grid with rated power up to 1.25 MVA and those with connection to medium voltage networks up to 6 MVA may be tested. For the testing of the static and dynamic response of generators and network assets different test setups are available.

Control room

The test sequence as well as the control of the test facility is controlled from a central control room. As part of the control all relevant electrical data, in particular power quality data, can be acquired, recorded and analyzed centrally. Matlab® / Simulink® applications may be integrated into the control.

Low voltage test bay

For investigations of devices connected to low voltage networks a tap transformer (1.25 MVA) with a wide, finely adjustable voltage range from 254 V_{AC} to 690 V_{AC} as well as an electronic AC grid simulator (100 V_{AC} – 900 V_{AC}, 45 – 65 Hz, max. 1 MVA) is available. For investigations of generators with inverters, e.g. photovoltaic inverters, fast controllable DC sources (5 units, each 150 kVA @ 1000 V_{DC}) can be utilized. Programmable loads with 3 x 200 kW resistive load, 3 x 200 kvar inductive load and 3 x 200 kvar capacitive load, which may be adjusted in 1 kW and 1 kvar steps respectively, are available as well. The low voltage test bus bar is divided into 2 bus bar sections to allow an easy investigation of line regulators, e.g. voltage stabilizers. A voltage stabilizer (rated power 200 kVA, voltage control range +/-10%) is available for system tests. To research interactions between different components operating on the same grid part configurable low voltage networks can be connected to the test bus bar.

Medium voltage test bay

By utilizing digital test signal generators the secondary control technique (protection relays and controls) of generating units and network assets can be tested. For testing the transient behavior a mobile test container (LVRT test facility) is available which is integrated into the central lab control as well. Since the test setup is inside a container even on-site measurements and tests of complete power plants are possible. In this case the test facility is connected to the medium voltage network between the equipment under test and the network connection point of the grid operator. It produces voltage dips on the medium voltage side of the equipment under test without disturbing the public power grid. With the LVRT test facility 3-phase as well as 2-phase faults can be generated.

Services (selection)

- Examination of generating plants in accordance with various grid connection guidelines (low voltage, medium voltage)
- Investigations on novel network assets, e.g. voltage stabilizers, controllable MV/LV substations, charging stations for electric vehicles
- Generation of defined network conditions in low voltage networks (coupling to low voltage test networks)
- Test of devices and components in a system context (in combination with power hardware in the loop systems)
- Metrological examination of performance (tripping characteristic) of protection devices for distribution grid components
- Measurements of grid quality and analyses of performance

1 *Installation of a protective grounding assembly on a transformer (Photo: F. Hellwig)*
2 *Circuit breaker and bus bars inside the AC grid simulator*
3 *PNI laboratory*
4 *Control room*
(Photo 2,3,4: V. Beushausen)