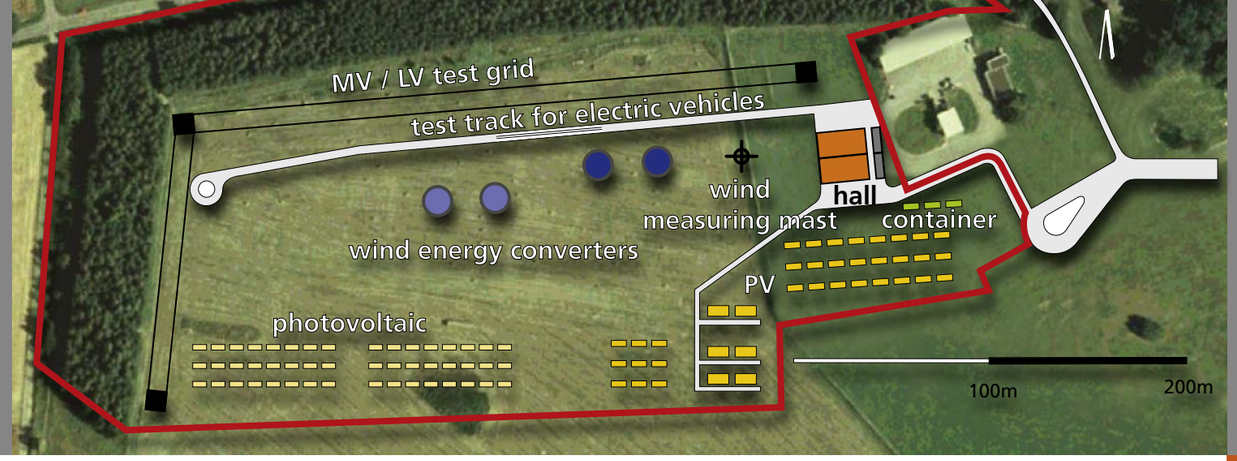

Fraunhofer
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FRAUNHOFER INSTITUTE FOR WIND ENERGY AND ENERGY SYSTEM TECHNOLOGY IWES

IWES-SYSTEC TEST CENTRE

SMART GRIDS AND E-MOBILITY

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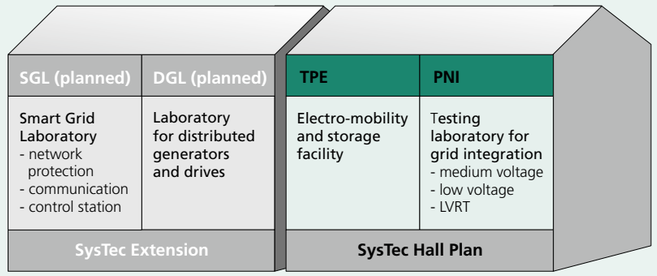
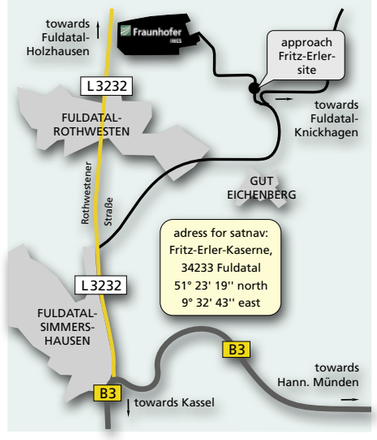


Services (selection)

- Examination of generation plants in accordance with different grid connection guidelines (low voltage, medium voltage)
- Metrological examination of performance (tripping characteristic) of protection devices at distribution grid components
- Measurements of grid quality and analyses of performance
- Determination of energy yields and comprehensive characterisation of photovoltaic modules and systems under realistic operational conditions
- Field and laboratory tests of hybrid systems, small wind power plants and individual components as well as tests with hardware emulations under defined operating profiles
- Complete investigations and examinations in view of the grid integration and the energy management of electric vehicles
- Investigation of electric vehicles in combination with virtual batteries, also when the vehicle is in operation (roller chassis dynamometer, temperature chamber)
- Real time distribution grid simulations to test control centres and the grid integration of distributed generators, electric vehicles and power storage (hardware-in-the-loop)
- Investigation of operating performance strategies for individual plants and hybrid systems (e.g. photovoltaic, storage facilities, heat pumps, combined heat and power)
- Investigation of inductive energy transfer systems

How to reach SysTec:



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HESSEN Hessisches Ministerium für Wissenschaft und Kunst
Federal Ministry of Economics and Technology
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
Federal Ministry of Education and Research

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IWES-SysTec: Test Centre for Smart Grids and Electromobility

In its test centre for smart grids and electromobility, Fraunhofer IWES is developing and testing new equipment and operation strategies for smart low and medium voltage grids. In addition, investigations regarding grid integration and grid connection of electric vehicles and their power generated from renewable energy sources as well as photovoltaic systems, wind energy plants, storage and hybrid systems are carried out under realistic conditions here.

A large open-air ground of approx. 80,000 m² offers sufficient space and very good conditions for solar and wind energy. Furthermore, the open-air ground provides configurable distribution grid sectors (low and medium voltage), as well as a route offering the possibility to test inductive charging systems for electric vehicles.

In the eastern area of the premises there is a hall presently with two laboratory divisions: one of the labs includes a testing area for low and medium voltage converters, electrical machines or grid equipment. There it is possible to develop and test the electrical properties and in particular the ancillary services of remote generators in the power range up to 6 MVA. A mobile test container able to be used to measure the fault-ride-through of generation plants has been integrated into the laboratory. The second lab is equipped with facilities to test grid integration of electric vehicles and power storage. In addition to hardware simulators for batteries, bidirectional charging controllers, charging columns and grid simulators, there is a roller chassis dynamometer for electric vehicles to replicate operational profiles as well as a test facility to analyze inductive energy transfer.

PNI: Testing Laboratory for Grid Integration

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 stabilisation,
- coordinated controller behaviour.

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 realise 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.

TPE: Testing Centre for Electromobility

IWES, together with the Automotive System Engineering Research Association (FAST) of the University of Kassel, conducts research and tests on electric vehicles in the Testing Centre for Electromobility [Test- und Prüfzentrum für Elektromobilität] (TPE). IWES focuses its research on grid integration and supply of renewable energies.

The TPE enables tests of electric vehicles (e-vehicles) and charging devices on the grid. The efficiency of the battery charge on the grid can be determined and charging strategies of e-vehicles can be investigated and evaluated in view of their reliability and influence on the battery. Both, grid disturbance and susceptibility of the e-vehicles can be checked in accordance with the applicable standards.

The concentration of many e-vehicles on a single parking lot offers numerous control options. Consequently, the TPE realistically simulates with devices the charging performance of several e-vehicles. The focus of investigation and development as well as strategies for improved grid integration is primarily set on the energy management of the temporal connection of renewable power generation and the charging of e-vehicles.

The combination of chassis dynamometer and virtual battery makes it possible to run vehicles on the roller chassis dynamometer while they are fed by a virtual battery. In this way it is achievable to quickly test several battery types of different initial states. Obtaining the results, a further development can be obtained quickly. The test hall has been designed in such a way that even prototypes of e-vehicles can be investigated using newly developed testing procedures in a confidential environment. The test track enables the testing of inductive charging systems.

Testing Fields for Photovoltaic and Hybrid Systems

The testing field for photovoltaic and hybrid systems provides extensive metrological investigations on the characterisation of components and complete systems for a renewable electricity generation. During this, properties and performance of the systems are researched under realistic operational and environmental conditions. Due to this cause, an extensive infrastructure is available to investigate all system components in a shared distribution grid.

To carry out free-field measurements of PV modules, both, support systems for a free-standing module assembly, and sample roofs of different inclinations for roof-integrated PV modules are available. It is possible to measure electrical, thermal and mechanical properties in different test set-ups. In particular, a continuous measurement of the IV characteristic of PV modules with high accuracy is possible. In order to evaluate operating performance and yields, all relevant environmental conditions like solar position (intensity and spectral composition), temperature and wind speed are recorded.

To examine the components of hybrid systems as well as their control and operation, test environments are available, offering realistic emulations of characteristic conditions to be found in apartments or offices. For this reason, strategies for an optimal operating control of each component (e.g. block heating station, battery storage, fuel cell with hydrogen storage location, PV system, wind energy plant and diesel generator, heat pump as well as load management) can be developed and tested, for example. In doing so, the interactions of different hybrid systems between each other and with the grid are also considered. Furthermore, it is possible to investigate the operational performance of small wind power plants.

1 *Medium voltage switch gear of IWES SysTec*

2 *Test container for performing LVRT tests*

3 *Electric vehicle on the test track of the TPE*

4 *View on the open area test side for photovoltaic and hybrid systems*