WIND ENERGY

INNOVATIVE AND FLEXIBLE
POWER QUALITY SYSTEMS.

WWW.REINHAUSEN.COM
STABILITY, SECURITY AND COST-EFFECTIVENESS FOR WIND FARMS.
The steadily increasing share of wind energy in Germany's electricity supply is presenting growing challenges in terms of grid compatibility.

Wind turbines must function similarly to conventional power plants at the grid connection point. Among other things, this means that they must provide inductive or capacitive reactive power and adjust the voltage statically in order to fulfill the grid operator's requirements. Depending on the type of system used and the electrical grid topology of the wind farm, wind turbines alone are often unable to meet all of these requirements.

The use of power electronics in wind farms results in harmonic emissions. Modern wind turbines function using IGBT frequency inverters that, in a broad frequency range, emit harmonics of up to 9 kHz. Currently, these harmonics are increasingly resulting in limit violations, and can also cause grid faults.

In many cases, long lengths of cable are used to connect wind farms to the grid. An increase in cabling can also be observed in medium- and high-voltage grids. The interplay of the existing grid impedance with the grid topology of the wind farm can lead to significant resonances. This in turn amplifies the harmonics emitted by the wind farm and pre-existing harmonics in the grid. This can result in critical grid situations.

In the event of a grid fault, wind turbines must help maintain grid stability. Modern wind turbines are able to provide the necessary voltage support themselves in order to ensure this stability. Technically obsolete systems are no longer able to meet the latest requirements. This in turn jeopardizes the entire wind farm's certification.

The power supplied by a wind farm fluctuates depending on the wind conditions. The resulting performance peaks can cause the grids to be overloaded, which currently results in costly mandatory shut-downs for grid operators in accordance with the German Renewable Energy Sources Act. On the other hand, wind turbines must provide sufficient power upon request for the purposes of frequency stabilization. The new technical connection guidelines (TBG) include greater feed-in requirements in the event of falling grid frequency.

**GRIDCON® solutions offer comprehensive support for your system:**

- Excess energy
- Controlling power
- Voltage drops
- Reactive power
- Harmonics
- Power peaks
- Voltage fluctuations
- Commutation notches
- Voltage-range violations
- Transient overvoltages
- Frequency fluctuations
- Comprehensive service
SECURE OPERATION OF WIND FARMS.

GRIDCON® solutions ensure secure and guideline-compliant operation of wind farms.

GRIDCON® solutions are tailor made and are ideal both for use in individual systems as well as for entire grid segments. Expanding your system accordingly allows for the optimal provision of the required system services. Specialists from MR can determine your needs and create an individual solution for you.

Compensation systems supply the inductive and capacitive reactive power in wind farms in the event that the wind turbines are unable to meet these requirements on their own. These systems are integrated into the innovative and flexible GRIDCON® STATION systems. GRIDCON® STATCOM is used to meet challenging dynamic requirements.

When it comes to dimensioning filter-circuit systems, a great deal of planning work is required in order to minimize resonances and reduce harmonic emissions. In this area, MR offers full support, from measurement and simulation to dimensioning all the way to supply and commissioning. In particular, the high-frequency filters dimensioned by MR to reduce harmonics of up to 9 kHz are the only filters of their kind currently on the market.

The use of GRIDCON® ESS battery storage devices helps to smooth out feed-in power and provide grid support through the absorption and discharge of active power based on the grid frequency and without involving the wind-turbine controllers. The storage device’s converter enables the provision of additional system services.

The converter’s current limit allows for optimal performance depending on the voltage at the point of transmission. The GRIDCON® transformer can optimally adapt the system’s impedance to the grid at this point, in turn optimizing the feed-in power. Moreover, the voltage at the feed-in point remains within the required limits at all times.

GRIDCON® solutions are based on MR’s proven range of Power Quality systems and are already installed in a large number of onshore and offshore wind farms. High-frequency filters and energy accumulators have been added to the product range specifically for the operation of wind turbines. The resulting increase in performance features provides a comprehensive addition to the wide variety of solutions on offer. A solution tailored to your individual needs, all from a single source, also takes into account all physical interrelationships and avoids any unwanted negative interactions between the individual controllers and systems.
Our solutions

- Support for and performance of grid measurements and grid simulations
- Planning and implementation of measures for guideline-compliant operation on the grid
- Solutions for existing systems, system modernization, and new systems
- Services and solutions for wind-turbine manufacturers, project offices, wind-turbine and grid operators
GRIDCON® SOLUTIONS FOR WIND FARMS.

GRIDCON® STATION high-frequency filter at the Offenbach onshore wind farm

Background
The Offenbach an der Queich II wind farm in southern Rhineland-Palatinate provides around 13,800 households with clean wind energy. However, during the certification process, the system demonstrated high-frequency harmonics emissions that exceeded the grid operator’s upper limits.

Challenge
- Harmonics emissions that exceeded the grid operator’s upper limits
- Faults possible within the wind farm and in the upstream distribution grid
- Necessary certification could not be carried out
- Result: the entire wind farm was threatened with shut-down

Solution
The Power Quality experts started by taking detailed measurements at several points within the wind farm using precise measurement technology. A mathematical simulation in conjunction with the collected real-world measurement data provided the best possible results for the purpose of finding a solution. As a solution, Power Quality developed a world-first filter concept that reduces the harmonic level in the frequency range up to 9 kHz over a broad spectrum. The limit values were complied with, secure grid operation was ensured and the certification could be successfully completed.

Offenbach onshore wind farm

<table>
<thead>
<tr>
<th>System type</th>
<th>GRIDCON® STATION high-frequency filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>2.8 MVA, 3 filter circuits with 189 / 3800 / 5600 Hz</td>
</tr>
</tbody>
</table>
GRIDCON® STATCOM dynamic compensation at an offshore wind farm

**Background**

One of the offshore wind farms off the German North Sea coast produces around 1.3 billion kilowatt hours of power annually. The high connected loads and low short-circuit capacity result in problems that have to be resolved using Power Quality solutions.

**Challenge**

- Changing reactive power requirements due to fluctuating feed-in power
- Transient voltage changes due to switching operations

**Solution**

The only logical solution was to install a compensation system on the offshore platform. In order to provide the necessary reactive power as quickly as needed, these use cases require dynamic systems that ensure balanced reactive power and stabilize the voltage in the wind farm, even in the event of transient operations such as transformer switching.

<table>
<thead>
<tr>
<th>Offshore wind farm in the North Sea</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System type</strong></td>
</tr>
<tr>
<td><strong>Power</strong></td>
</tr>
</tbody>
</table>

GRIDCON® STATION resonance filters at the Nordergründe nearshore wind farm

**Background**

Within a 12-nautical-mile zone northeast of the island of Wangerooge, 18 wind turbines feed a total of 118 MW of power into the transmission grid. The offshore undersea cable caused critical resonances in the upstream transmission grid.

**Challenge**

- Cable resonances at the grid connection point
- High harmonic voltages that exceed the limit values

**Solution**

Resonances in the power grids are eliminated using passive filter circuits. On the basis of comprehensive evaluations, an optimal filter concept was developed that was integrated into the wind farm via the tertiary winding of the high-voltage transformer.

<table>
<thead>
<tr>
<th>Nordergründe nearshore wind farm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System type</strong></td>
</tr>
<tr>
<td><strong>Power</strong></td>
</tr>
</tbody>
</table>
The data in our publications may differ from the data of the devices delivered. We reserve the right to make changes without notice.