



Sustainability enabled by MR Cleantech

reinhausen.com



MR Cleantech optimizes your carbon footprint

Our market-leading cleantech solutions for regulating load flow and power quality help an ever-growing population achieve attractive living conditions without burdening future generations.

MR's carbon footprint is characterized not so much by emissions during production and delivery, but rather by its contribution to sustainable, environmentally friendly operation under the toughest operating conditions.

As "THE POWER BEHIND POWER", we support public and private network operators as well as industrial companies and transformer manufacturers in the transformation toward a sustainable, secure and economical energy supply.

With our products, we contribute to the energy transition and reduce the CO₂ footprint of our customers. In addition to the core component for load flow control – the on-load tap-changer – we also provide a wide range of components and software solutions for optimizing the service life of equipment, among other things.

In the following, we will show you what our products can do in various applications and how you can use them reliably, efficiently and, above all, sustainably.





Benefits at a glance

We develop and market particularly durable products with low maintenance requirements that help minimize the use of resources. This starts in the manufacturing stage, where we focus on high-quality materials that facilitate recycling later on, and we are constantly working on our range of retrofit-capable solutions. Our core competence – sustainable load flow management and voltage regulation during operation – enables the increasing integration of renewable energies. We also help maximize operating life by using intelligent analytics to digitize critical equipment and identify and eliminate the risks of unplanned outages at an early stage. Our new network components also contribute to the energy transition by simplifying energy conversion and helping to distribute large amounts of power more efficiently. In sum, our innovative products reliably enable a more efficient energy supply as well as adaption to changing requirements.

- + **Durable products for less resource use in operation**
- + **Materials and solutions for efficient recycling**
- + **Load flow and voltage management for more renewable energies**
- + **Digitalization and smart analytics for maximum service life and fewer outages**
- + **Innovative products for a more efficient power generation**
- + **Innovative power electronics save costs and accelerate the energy transition**

Durable products for less resource use in operation

The on-load tap-changer (OLTC) is used to dynamically adjust the voltage ratio between the primary and secondary sides of a power transformer under load to the respective operating requirements. Since the tap changer is one of the few mechanically moving components of a transformer, it is considered a critical component. Decades of development work and operating experience enable us to guarantee reliable OLTC operation over the entire service life of the transformer.

Pioneer in vacuum technology

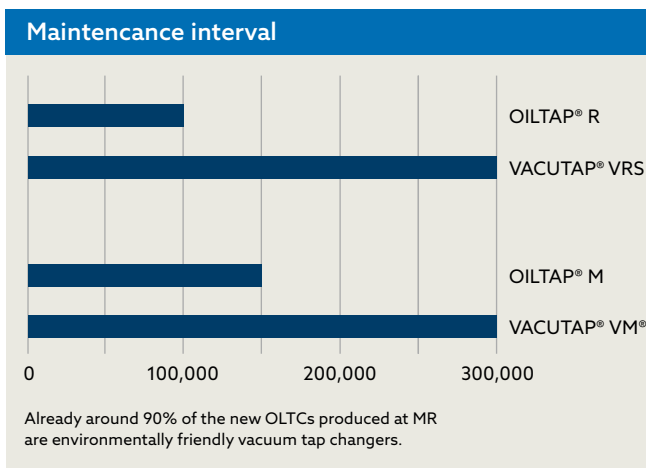
As a technology leader, we set the course early on to switch from oil to vacuum technology. The result is our VACUTAP® family, which offers the longest service life with the lowest maintenance. Since there is no time interval to be observed for on-load tap-changers with vacuum technology in addition to the number of switching operations, maintenance is generally not necessary over the entire service life of 40 years for network applications. At the same time, vacuum technology eliminates the need for an oil filter system or oil replacement. Disposal is also significantly simplified due to the much lower level of contamination.

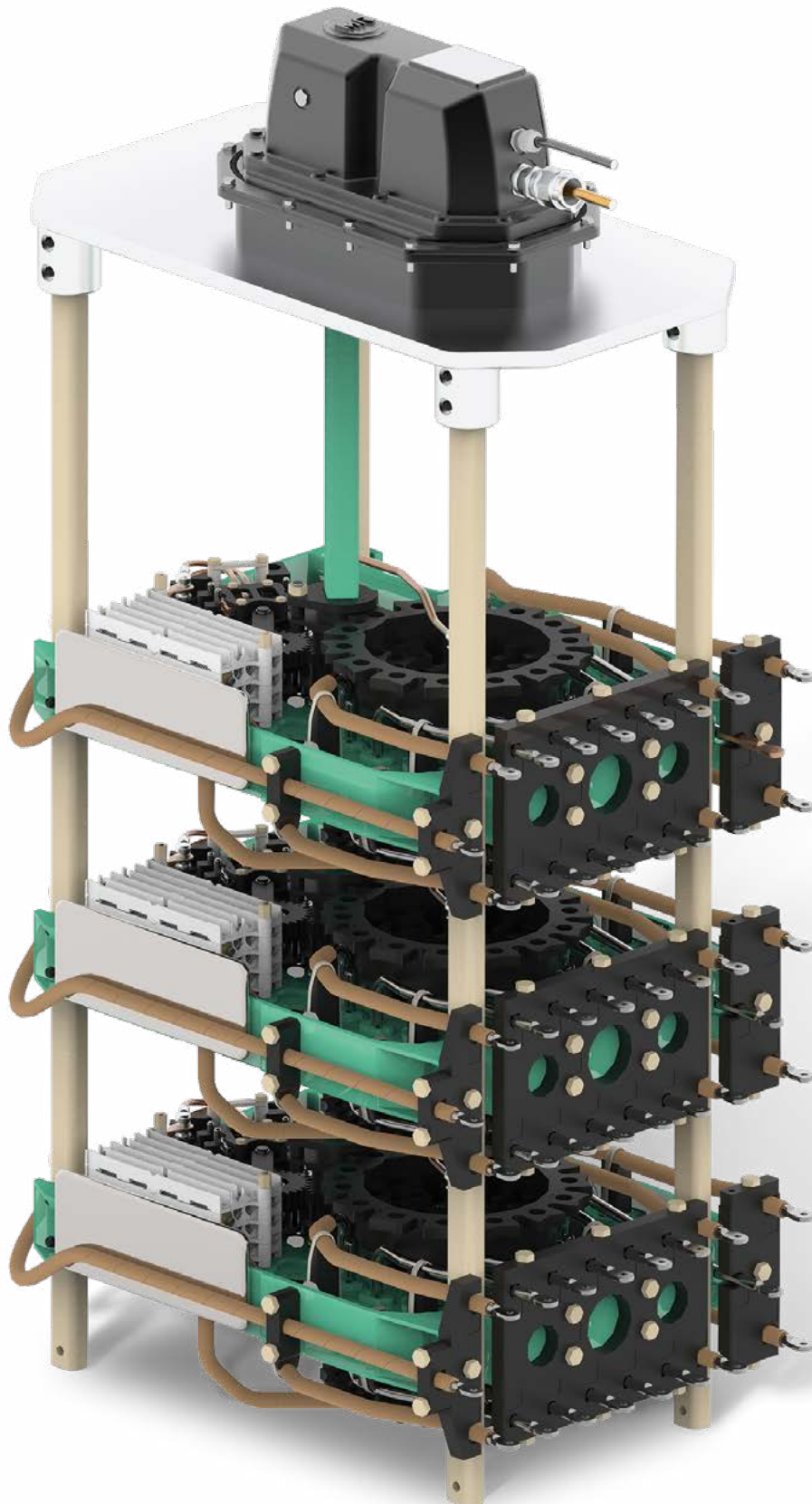
A strong product portfolio

The tap changers in our VACUTAP® and ECOTAP® product families ensure that resources are conserved thanks to their long service life and low maintenance requirements. In normal operation, there is no need to purchase spare parts or replacement tap changers, nor are trips by service technicians necessary. The risk of transformer failure can be further reduced by our portfolio of high-quality accessories and protective devices in the MESSKO® and CEDASPE® product families. This also applies in maritime and desert climates or in earthquake-prone regions.

For transformers with a smaller footprint

A new innovative member of our ECOTAP® series is the ECOTAP® VI, which was designed for use in the lower transmission voltage range. During its development, special focus was placed on sustainability – of the on-load tap-changer as well as of the transformer. Through the principle of shared oil management, tap-changer assemblies and add-on components can be saved which means that less space, material and insulating fluid is required over the entire operating life of the transformer.





The ECOTAP® VI saves 25% CO₂ over its entire life cycle compared to conventional vacuum tap changers.

Materials and solutions for efficient recycling

The sustainable reduction of greenhouse gases and the departure from fossil fuels are among the most urgent tasks of our time. This is particularly true for the energy sector, which is increasingly switching to renewable energy sources and the use of ecologically safe materials. In addition to energy generation, this also affects the plants and components used for energy transmission and distribution.



Natural esters

More and more energy suppliers and transformer manufacturers are turning to alternative insulating fluids such as natural esters which are obtained from renewable raw materials and are significantly more environmentally friendly than mineral oils. At MR, we have been working since the beginning to continuously expand the range of applications of our products for sustainable insulating fluids.

Alternative gases

In addition to liquid-insulated products, there are also gas- or air-insulated tap-changers as well as insulators. Large support insulators for high-voltage equipment and switchgear, for example, are filled with insulating gases to ensure electrical strength over a service life of more than 30 years. Whereas the climate-damaging insulating gas SF₆ was previously used for this purpose, in the future its use may be prohibited or only allowed under strict conditions.

For reasons of sustainability, MR has always refrained from offering products for use with SF₆. A future alternative for modern products will be alternative insulating gases or technical air.



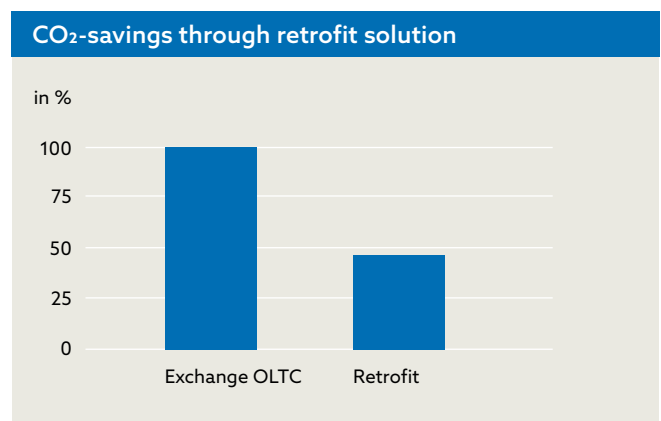
In the manufacture of the necessary components alone, retrofit measures can save around 50% of CO₂ equivalents compared with the production of a completely new OLTC.

Retrofit solutions

Even in the unlikely event of a replacement or upgrade of an on-load tap-changer, we pay particular attention to efficiency and replace only the diverter switch insert with more modern vacuum technology, while parts such as the oil vessel or the selector remain in service until the transformer is scrapped (and in the event of dismantling, possibly even beyond).

The advantages of this process are speed on the one hand and resource conservation on the other. This is due to the continued use of intact components of the existing product and the transformer oil. Since the tank does not have to be opened, the oil can simply be reused. Switching to new technologies also contributes to resource conservation, as the transformer can then be operated more sustainably.

Furthermore, a costly and energy-intensive transport of the transformer to a repair workshop can usually be avoided by using MR transformer services, which we offer worldwide.



Recyclability and local disposal

An essential contribution to the protection of the environment is recycling. Our tap-changers are manufactured with high-quality materials such as silver, copper, steel and magnesium and can be recycled together with the transformer at the end of its service life.

The easy dismantling of our products as well as an achievable recycling rate of up to 95% allow local disposal by the operator without the need for CO₂-generating return transport.

Load flow and voltage management for more renewable energies

As the use of renewable energy expands, the average distance between generation facilities and consumers may increase. For example, offshore wind turbines often generate the electricity needed for large consumer centers inland. The transport of electrical energy over long distances leads to an increased demand for capacity and grid expansion, which is accompanied by cuts in the natural environment as well as increased resource consumption.



Phase Shifting Transformers (PSTs)

Expensive redispatch measures are necessary to compensate for overloads and bottlenecks in the power grid. Phase-shifting transformers (PSTs) can be used to control load flows and thus keep the grids stable despite volatile generators.

The key components of PSTs are on-load tap-changers, which, due to the great importance of PSTs, must meet particularly high demands in terms of reliability and performance with minimal maintenance and low operating costs. Newly developed OLTCs such as our VACUTAP® VRL enable the design of powerful yet sustainable phase-shifting transformers. The high switching capacity of the OLTC eliminates the need for forced current splitting and the winding which would then be necessary. This reduces the volume of the transformer and the amount of material used.

PSTs help to relieve highly loaded lines and shift the load flow to less heavily loaded lines.

High-voltage direct-current transmission

Since climate-friendly electricity is usually generated far from population centers and large industrial consumers, high-voltage direct-current transmission (HVDC) is a key component of the energy transition.

Using direct current technology, energy can be transported over very long distances with low losses, and can also be exchanged between countries that have differing grid frequencies.

The increasing expansion of renewable energy generation requires ever greater transmission power, significantly higher voltages, and larger converter units in the converter stations. The VACUTAP® VRL is also suitable for this type of application.

Variable Shunt Reactors (VSRs)

Another effect of the shutdown of fossil power plants and the increased volatile feed-in from renewables is that the reactive power in the grid cannot be regulated by the generators of the large power plants. However, a balanced reactive power budget is crucial for secure, efficient, and loss-minimized grid management. To reduce the capacitive reactive power demand in the grid, parallel-connected unregulated shunt reactors, which can be connected individually, have been used for a long time.



The circuit breakers used for this purpose are subject to high maintenance requirements and must already be serviced after about 10,000 switching operations.

A technically optimal and economical alternative is the use of a single controlled variable shunt reactor (VSR) regulated by MR OLTCs, which are maintenance-free for up to 300,000 switching operations.

Regulated VSRs offer significant advantages over unregulated shunt reactors, including the conservation of resources and land consumption due to a reduced number of VSRs. In addition, the provision of reactive power and transmission losses can be optimized, which increases the transport capacity of active power over existing lines and reduces the need for grid expansion. VSRs thus offer an economical alternative to significantly more costly SVC or STATCOM solutions, and also prove advantageous through significantly lower power losses in operation.



Voltage regulated distribution transformers (VRDTs)

The changes brought on by the energy transition also do not stop at the distribution network level. On the one hand, decentralized power generation, e.g. through photovoltaic systems, is increasing, while on the other hand, heat pumps and EV charging stations are increasing the load on the grid. Therefore, measures are required to maintain the necessary voltage quality.

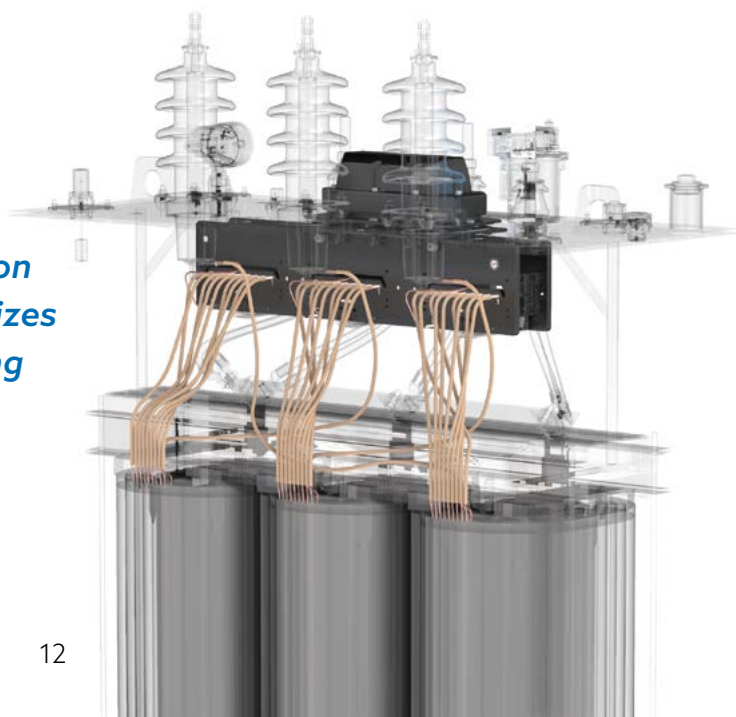
In addition to classic grid expansion, there is also the alternative of using voltage regulated distribution transformers (VRDTs) which enable the absorption capacity for additional loads and feeders to be increased by a factor of two to four without having to lay new lines or install additional transformers. If they are used over a large area, the absorption capacity of the existing medium-voltage networks can also be increased.

The heart of the VRDT is our ECOTAP® VPD® on-load tap-changer, which is equipped with a very compact, intelligent control system. This enables self-sufficient, on-site control that does not rely on communication infrastructure.

Using voltage regulated distribution transformers optimizes topologies in existing networks.

In addition to increasing the absorption capacity for loads and generators, the extension of the electrical supply radii of low-voltage networks is another benefit that the use of a VRDT with ECOTAP® VPD® can bring. This reduces the number of stations, the modernization effort of the affected network and the need for land. In addition, maintenance and servicing of the saved stations are no longer required. Due to the space-saving geometry of the ECOTAP® VPD®, the regulated transformer is compatible with existing local substations, which avoids the construction of new or larger concrete substations.

In addition, as in the high-voltage grid, VRDTs allow transmission efficiency to be increased, since the distribution grid can be operated at the optimum operating voltage by means of active voltage regulation, thus reducing currents and line losses.





The standardized and modular system architecture for customer-specific and application-specific solutions avoids the unnecessary use of materials and resources.

GRIDCON® STATCOM – for dynamic, load-flow correcting measures at all network levels

Where volatile load flows prevail in the grid, dynamic load-flow-optimization measures are essential. Our GRIDCON® STATCOM systems are made for this purpose and convince with modular design for powers up to 50 Mvar, compact construction for high installation diversity, and adaptability to all medium voltage levels.

The use of GRIDCON® STATCOM in the distribution grid improves grid stability through the dynamic provision of both inductive and capacitive control power, as well as voltage stability through innovative voltage control algorithms. In addition, operating costs can be reduced thanks to high control dynamics and dynamic improvement of the power factor at the grid connection point. Harmonic currents are also reduced by active self-compensation. In many cases, this is the first solution for enabling compliance with contractually regulated connection conditions.

Digitalization and smart analytics for maximum service life and fewer outages

With our products, we aim to maximize the service life and minimize the maintenance requirements of transformers and components. This conserves resources, prevents unnecessary replacements, and saves CO₂. With the help of digitalization, this potential can be further leveraged not only for the benefit of our environment, but also economically.





Monitoring systems – anomalies quickly detected

Our monitoring systems from the MSENSE® and ETOS® product series optimize the use of operating resources and detect and evaluate anomalies in operation as early as possible. This can prevent failures or damages and reduce downtimes.

Sensors and measuring systems – precise results correctly interpreted

If measurement data of the entire transformer system needs to be collected, we offer practical solutions with our sensors and measurement systems. Our intelligent, real-time, online monitoring system interprets data on the basis of statistical models and supports service life optimization as well as decisions as to whether a transformer can continue to be operated or must be taken off the grid for maintenance.

ETOS® function integration also enables a reduction in the number of devices required to control and monitor the transformer components. All information is collected centrally, evaluated, and made available via a control system interface. This saves material and commissioning efforts for cables, housings, and electronic components.

Intelligent, data-driven utilization concepts – efficient use of existing infrastructure

Infrastructures are currently facing several challenges: They were designed many decades ago for requirements that were common at the time, but must now suddenly transport electricity in a different way. In addition, power grids are often outdated, and the maintenance strategies that have been in place up to now are increasingly in need of renewal, which entails further costs. One solution to this challenge lies in intelligent, data-based utilization concepts that make it possible to use existing infrastructure more optimally and extend its service life. ETOS® enables more efficient use of power transformers and thus the optimization of network management by combining algorithms, analytics, artificial intelligence, and network-control and resource information. With new self-learning algorithms, the ETOS® system also enables prediction of the dynamic overload capability of a power transformer for the next 24 hours.

ETOS® enables more efficient use of power transformers.



RECOTEC® – increased security

You can also rely on our MR solutions for bushings: We support the digitalization of substations, for example, with RECOTEC® data transmission through the insulator. The integrated fiber optic cables can be used for measurement transformers, support isolators and bushings for the transmission of measurement and optical signals. The new, integrated solution simplifies assembly and increases security.



Condition-based maintenance – demand-oriented work and costs

In addition to the seamless recording of measured values, our portfolio includes a wide range of analysis and diagnostic methods that allow statements to be made about equipment condition and the classification of conspicuous measured values. This helps to switch from a time-based maintenance strategy to condition-based maintenance and thereby avoid unnecessary work and costs.

TESSA® FLEETSCAN 2D

TESSA® FLEETSCAN 2D is our intelligent fleet management and assessment system that enables asset and service managers to continuously keep an eye on the condition of transformers. Maintenance, modernization, and investments can be planned more easily, and the longer use of the equipment helps to reduce the carbon footprint.

Remote Service

If maintenance of a piece of equipment is required, expert knowledge is a key factor for successful implementation. Our remote service supports service technicians on site with the aid of data goggles, tablet, or smartphone. This bidirectional audio and video connection enables our specialist to find quick and targeted solutions together with the service technician. A long journey on the part of our specialist is no longer necessary, saving resources and avoiding emissions.



Innovative products for a more efficient power generation

In the course of the energy transition, the share of large-scale power plants in the electricity grids will decrease in favor of emission-free energy generation plants. New ideas and pioneering technologies are the key to ensuring that the adaptation of existing networks to changing requirements is technically successful and remains affordable.

Resolve inverter limitations and avoid losses

Solar farms require inverters to convert the generated direct current into alternating current for grid feed-in during the day. However, the limitations of the inverters prevent the full potential of the solar generator from being utilized. This refers on the one hand to the minimum DC input voltage limit as a cause of DC losses, and on the other hand to the maximum AC output current limit as a cause of power peaks that cannot be fed into the grid.

The remedy is to use the ECOTAP® VI or ECOTAP® VPD in the medium-voltage transformers directly at the inverters, with our VACUTAP® tap changer as the established standard for the central high-voltage transformer of the plant.

Using tap changers to increase the efficiency of solar parks and wind turbines

By their very nature, PV systems do not generate any electricity at night. In order to avoid no-load losses of the system components, they are therefore often switched off via circuit breakers. In contrast to on-load tap-changers, however, these are designed for much lower switching rates. The better alternative to switching the PV park on and off daily is a regulated transformer that sets the busbar voltage to zero.



By using tap changers, the efficiency of solar farms can be increased both during the day by optimizing the inverter operating points and at night by reducing the no-load loss. Similar to solar farms, the inverter performance of wind farms can also be optimized and generation stability during wind gusts increased. This comprises the entire cycle from the wind turbine to the grid connection.

Optimizing energy conversion in H₂ electrolysis through intelligent regulation

This advantage can also be seen in regard to H₂ electrolysis, which is the cornerstone of the energy transition. Here, converters must also be installed in the plants and, together with dynamic control concepts, the energy conversion can be implemented more efficiently and thus more sustainably.



Innovative power electronics save costs and accelerate the energy transition

For DC systems such as PV systems, battery storage and e-charging stations, but also for electronic consumers such as servers or frequency converters, direct current grids offer many advantages over classic supply with alternating voltage. DC grids eliminate one step of energy conversion and allow high power levels to be distributed more efficiently – both in industry and in the IT and residential sectors.





GRIDCON® products: Reliable and efficient converters for DC systems and AC networks.

GRIDCON® Power Conversion System – the multi-talent for low voltage

The expansion of grids within the energy transition requires the connection of DC systems to the AC grid. Our modular GRIDCON® Power Conversion System (PCS) for DC and AC supply in the low-voltage range makes it possible to consume electricity where it is generated. GRIDCON® PCS is versatile and can be used in combination with an energy storage system for self-supply and for stabilizing the power grid in combination with PV systems.

For a more sustainable energy supply, grid operation can be realized by an energy storage system instead of a diesel generator. In addition, the storage of solar energy and the connection of charging stations for electric vehicles result in an increased consumer share of the power supply. The decentralized supply structure also reduces losses and relieves the power grids during the expansion of renewable generators.

GRIDCON® DC Transformer – isolated converter for bi-directional operation

The GRIDCON® DC Transformer is the first isolated DC/DC converter that can behave like a regulated AC power transformer. It converts different DC voltages and offers efficiency, flexibility, scalability, and a compact design. Applications can be found in the fields of energy storage and charging technology, as well as in highly automated factories.

GRIDCON® High Power Charger – for more e-mobility

We are also contributing to e-mobility with our efficient and bidirectional charging system which can be connected directly to DC networks and enable fast charging of electric vehicles with up to 450 kW. Thanks to its modular design, the system can be scaled in terms of power, and enables higher power in parallel operation. The GRIDCON® High Power Charger can be connected to grids (e.g. GRIDCON® PCS) using bidirectional inverters, while the connection to battery storage systems can be made via DC or AC. As a bidirectional system, it enables the operation of battery-powered vehicles as mobile, bidirectional storage units in a future SmartGrid.



Composite pylon - compact and aesthetic power poles

The Composite Pylon provides a compact and aesthetic alternative to conventional power poles, with the aim of minimizing the impact on nature and the landscape.

The main innovation of the Composite Pylon is its support arms made of high-performance plastic, which are electrically insulating. This feature makes it easy to attach conductor bundles and ground cables, thus saving on the construction height normally required for electrical insulation.

We can achieve energy transition – together with you!

The energy transition poses enormous challenges for the energy industry worldwide. As a reliable partner, we are doing everything we can to support you in achieving the climate targets. Our own sustainability targets are herefore closely aligned with these requirements.

In dialog with you, we qualify new materials such as natural insulating media, develop technical solutions for optimized operation and a long service life of transformer components, and at the same time help to save costs through condition-based maintenance.

In order to ensure that grid quality can be kept resilient and stable in the future, it will be necessary to make the power grids smarter in the future and to introduce new operating resources at all levels.

Together with research institutes and universities, we are working on groundbreaking concepts and testing these in field trials.

Our projects include:

- **FlexNet-EkO**
Local grid with increased supply security and solar storage in the interconnected grid
- **HPC Prime**
Compact and efficient DC charging stations up to 450 kW
- **AC2DC**
Cost savings through replacement of 110 kV AC distribution networks by ± 55 kV DC distribution networks
- **ENSURE**
Building blocks and concepts for accelerating the energy transition
- **DC Industry**
Standardization for DC networks
- **LEM power electronic mesh current controller**
More power in the local network through load balancing

***We are and remain THE POWER BEHIND POWER
– more than ever a reliable partner for mastering
future challenges – on the way to a more sustainable
future.***

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