



**A New Approach to  
Renewable Energy**



## A World Leader in Electrical Solutions

Converteam is an engineered solutions and systems provider, specialist of power conversion: converting power from mechanical to electrical or vice versa, and from electrical to electrical. These solutions are built around three core components: electrical machines, variable speed drives, automation and process controls. Our scope covers system design, manufacturing, system integration, installation, commissioning and a broad range of services. Our worldwide workforce remains fully committed to one overriding goal: to bring you the best in technology, backing this up with a truly effective service in all markets. Our expertise encompasses renewable energy, marine and offshore, process industries, oil & gas, and more.



# Converteam, the Global Partner in Renewable Energy Solutions

The growing need to find sustainable alternatives to carbon based fuels has led to a boom in the renewable markets – a core field for Converteam’s products and systems engineering.

Capitalizing on a century of electrical engineering experience, Converteam has established strong credentials in the renewable sector over the last decade. World leader\* in the wind converters market, it benefits from a track record of more than 15GW (at 2010) of low and medium voltage converters delivered and from recognized expertise in solar and wet renewables, with many firsts in these domains.

## Partnering with our customers

Optimizing the customer’s overall system design and performance while protecting the environment is our major focus and lasting objective. Responsiveness, flexibility and sustainability are key features of Converteam’s approach to engineering and project management of integrated system solutions – from project inception through to final handover and beyond.

## Keeping the technological edge

Research & development is crucial to ensure that Converteam’s range of products for the renewables industry sector is constantly improved to match increasingly demanding market trends and quickly evolving customer expectations. In our R&D plans, we therefore focus on developing and implementing technologies to improve reliability, power density and efficiency as well as to optimize the interfaces between each component of a solution.

## Benefiting from a global reach

Converteam’s competitive approach mixes the strategic resources and vision of a global group with the responsiveness and in-the-field knowledge of a global player. The group has industrial footprints in Europe, America and Asia with four electrical machines factories producing generators and eight converter production facilities worldwide.

In addition, the Converteam service network provides 24/7 support and effective timely responsiveness to customers worldwide.

\*According to “Global Outlook for Electric Drives in the Wind Power Industry” Frost and Sullivan study published in November 2009.



## Converteam Machine Factories

- Nancy (France), Rugby (United Kingdom), Yantai (China), Minneapolis (USA)

## Converteam Converter Factories

- Burlington (Canada), Belo Horizonte (Brazil), Berlin (Germany), Massy (France), Kildgrove, Glasgow (United Kingdom), Pittsburgh (USA), Shanghai (China)

## Converteam Sales & Engineering Offices

- more than 50 offices worldwide

## Collection and connection

The collection and the connection of renewable energy devices into a local transmission and distribution system is often an underestimated challenge.

At Converteam we understand the challenges of connecting many individual systems together avoiding electrical instabilities and optimizing the use of collection equipment.

For wind applications, thanks to the modular nature and compact design of our hardware, the conditioning system can be integrated into the turbine itself or installed in clusters within a central medium voltage station.

### Features:

- low and medium voltage
- power ratings for every application
- based on press pack IGBT technology
- available for individual generation sources (e.g. one wind generator) or clusters (e.g. an entire wind farm).



| Power conditioning system: ProVAr

## Enhancing power quality in evolving grids

The latest international grid connection rules pose numerous challenges to the renewable energy industry.

Converteam provides a full range of power quality systems (STATCOMS), which meet the challenges set by the rigorous grid codes adopted by transmission and distribution system operators worldwide. Our Power Conditioning Systems (PCS) ensure that maximum reactive power is available in milliseconds in response to any voltage dip on the grid.

### Value for customer:

- enhanced reactive current capability compared to other technologies
- small footprint
- reliable, linear response to system changes without mechanically switched devices
- modular system permitting cost effective expansion
- suitable for retrofits into existing installations
- no need for harmonic filters
- fast, dynamic reactive current for optimal grid stability

# ... and Storage: a Common Range for Renewables



Control/monitoring system – wind farm overview

## Controlling and monitoring

Building on its unsurpassed expertise with SCADA and automation systems for power stations and other industrial applications, Converteam offers a fully integrated control system for the management of an individual generator, a substation or entire energy parks.

At its core, this system uses a real-time control and monitoring package with a proven track record. In addition to Converteam drives and other products, data can be collected from a wide range of third party equipment using standard or popular protocols, e.g. IEC61850 and Modbus.

### Features:

- drive/generator monitoring and control
- substation monitoring and control
- energy park monitoring and control
- network-based architecture
- alarm logging and real-time trending
- asset management functions
- remote viewing access via secure web browser
- predictive maintenance

## Enabling component testing

The booming demand for wind power equipment and systems in the higher power ranges has triggered a growing demand for new test benches. Since the wind industry sets the most comprehensive and demanding requirements for gear units and generators, it is vital to simulate dynamic loads and forces for gear units in manufacturing test facilities.

Converteam is a leading provider of high performance test equipment for gears and generators, up to and including complete nacelles with related simulation software from vibration testing through to simulation of wind behavior.



Typical test bench

## Storage

Intermittent renewable energy sources lead to an increased requirement for power storage.

Converteam provides power converters in order to transfer electrical energy efficiently between the AC grid and the energy storage system and vice versa. Converteam can also help you select the best choice of energy storage medium, including flow cells, batteries, flywheels, compressed air or others.

# A Global Leader in Wind Converters and Generators

Every year, Converteam supplies around 5GW of wind converters to the industry, and is recognized as the world leader by external studies. This has been possible only through a distinctive product offering.

The wind converter is a key element of the wind turbine. It allows the optimization of the power output of the turbine by enabling the generator to work at optimum conditions, even with very low wind speeds.

Converteam provides converters for all types of configurations: doubly fed or fully fed generators, low voltage or medium voltage systems.

Our modular and reliable converters are customized to your precise needs.

Converteam is a major systems supplier to the wind industry to which it provides a complete range of converters, generators, SCADA, grid connection and power quality solutions.

The trend towards more powerful wind turbines with maximum energy yield, calls for variable speed generator systems that meet the highest demands in terms of availability, efficiency and grid compliance and stability.



Direct drive PMG



Hybrid PMG



Fully Fed Converter



Doubly fed Converter

| Generator                                       | Features   | Value for customer  |
|---|--|---|
| Direct drive, Permanent Magnet Generator        | <ul style="list-style-type: none"> <li>no gearbox</li> <li>low or medium voltage</li> <li>very low running speed</li> </ul>      | <ul style="list-style-type: none"> <li>reduced overall weight</li> <li>higher efficiency at partial load</li> <li>reduced maintenance</li> <li>grid compliance</li> </ul>                     |
| Hybrid Permanent Magnet Generator               | <ul style="list-style-type: none"> <li>one or two stage gear box</li> <li>low or medium voltage</li> <li>medium speed</li> </ul> | <ul style="list-style-type: none"> <li>reduced component count and weight compared to a fully geared generator</li> <li>intrinsic reliability</li> <li>grid compliance (fully fed)</li> </ul> |
| Standard speed, fully geared PMG                | <ul style="list-style-type: none"> <li>three stage gear box</li> <li>speed of 1500 rpm and higher</li> </ul>                     | <ul style="list-style-type: none"> <li>reliability</li> <li>grid compliance</li> <li>lighter &amp; more robust than a DFIG solution</li> </ul>  |
| Induction generators (fully fed and doubly fed) | <ul style="list-style-type: none"> <li>three stage gear box</li> <li>speed of 1500 rpm and higher</li> </ul>                     | <ul style="list-style-type: none"> <li>compact design for optimized wind turbine nacelle size</li> </ul>  |

| Converter  | Features  | Value for customer  |
|--|---|---|
| Converters for doubly fed generators (low voltage) | <ul style="list-style-type: none"> <li>Power range 0.5 to 5 MW &amp; above</li> <li>Voltage: 690 V</li> <li>Air/water cooling</li> <li>Heating equipment included to meet extreme climate conditions (-40°C)</li> <li>Up to 2 MW power electronics contained in a 600 mm cubicle</li> </ul> | <ul style="list-style-type: none"> <li>High reliability</li> <li>High power density</li> <li>Simple construction thanks to standardized modules</li> <li>Patented technology allowing use in any country</li> <li>Easy service ability – easy replacement of modules without water leakage</li> </ul> |
| Converters for fully fed generators (low voltage)  | <ul style="list-style-type: none"> <li>Power range 0.5 to 5 MW &amp; above</li> <li>Voltage: 690V or 900 V</li> <li>Liquid-cooled</li> <li>Complete isolation of generator from the grid</li> </ul>   | <ul style="list-style-type: none"> <li>Full compliance with the most stringent grid codes, Fault Ride Through functionality</li> <li>Thousands of references including large complex offshore wind farms</li> </ul>   |
| Converters for medium voltage fully fed generators | <ul style="list-style-type: none"> <li>Power range from 5 MW to the maximum turbine size</li> <li>Voltage : 3.3 kV</li> <li>Air/water cooling</li> </ul>  | <ul style="list-style-type: none"> <li>Highly reliable converter</li> <li>High power density</li> <li>Full compliance with the most rigorous grid codes</li> <li>Technology also used in many other MV applications</li> </ul>  |

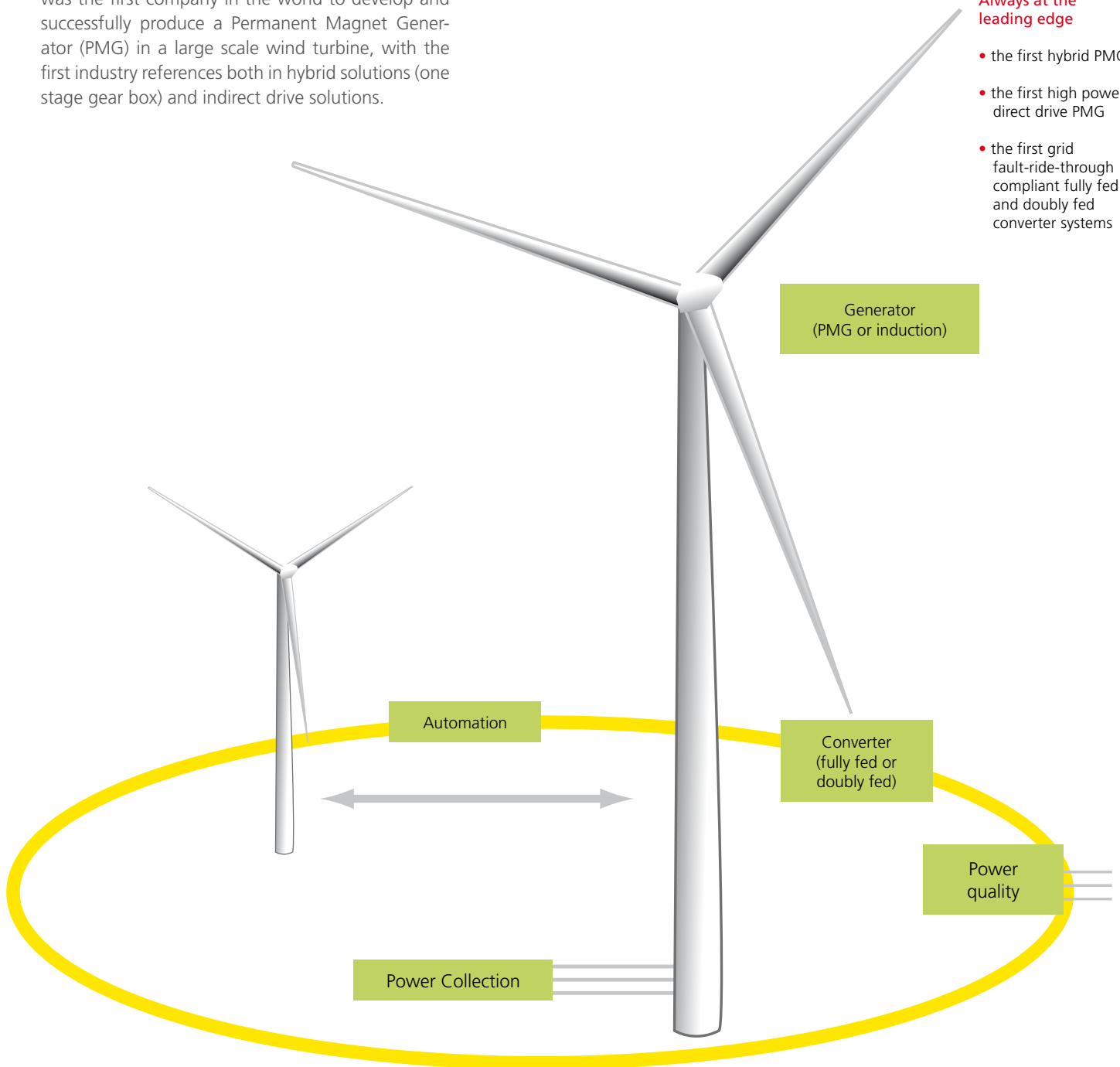
# Proven Expertise and Outstanding References

Capitalizing on its over 100 years of expertise in electrical machines, Converteam offers a full range of generators for every application.

At wind farm level, we are able to optimize the topology of the wind farm in order to maximize the economic benefits to the end-user. Converteam was the first company in the world to develop and successfully produce a Permanent Magnet Generator (PMG) in a large scale wind turbine, with the first industry references both in hybrid solutions (one stage gear box) and indirect drive solutions.

Always at the leading edge

- the first hybrid PMG
- the first high power direct drive PMG
- the first grid fault-ride-through compliant fully fed and doubly fed converter systems



Photovoltaic technology is taking a growing share of the power supply market and requires electrical systems which are able to offer the highest level of cost effectiveness, availability and grid compatibility.

Converteam offers innovative PV plant electrical solutions to feed the unlimited solar power into the public grid. With a solution based on high performance inverters, low or medium voltage switchgear and powerful visualization and control, Converteam combines all elements of a successful integrated system, targeting maximum energy yield, reliability and ease of installation.

Capabilities range from inverter supply to complete electrical power stations, and from electrical system design, through start-up and follow-up services.

### **Modular inverter architecture tailored for your installation**

The inverter system covers a range of power ratings from some hundreds of watts up to several megawatts and can be perfectly adapted to different power configurations of medium and utility scale

photovoltaic plants. The inverters not only convert the direct current generated in the solar modules into an alternating current for feeding into the grid, but are also actively involved in grid safety management.

To complete our offering, we also include sophisticated control, monitoring, data logging and remote access systems which further maximize efficiency and productivity.

- reduced investment costs (such as cable and buildings) and increased energy yield thanks to input voltages up to 1.5 kV
- substantial increases in the overall efficiency of the PV power station with the selection of the optimum DC bus operating point combined with teaming and multi-MPPT capabilities
- inductive and capacitive reactive power management in order to respond to any given grid connection requirements
- reduction of power supply on demand of grid operators



| The technologically innovative solar inverter



# Powering the Future with Wet Renewable Energy

Marine or wet renewables are reaching the prototype and pre-commercial demonstrator stage both for tidal and wave power. Converteam has been involved in the wet renewable market for over a decade and has been selected by many leading players in the implementation of a variety of concepts and technologies.

Converteam has all the necessary technical and marine systems knowledge combined with its electrical systems and modeling skills. Building on the experience developed from wind and other businesses, we have proven control algorithms ensuring that we can deliver power from wave and tidal devices that will always be fully compliant with any of the international grid code requirements.

In the development of wave and tidal power, the devices which extract the natural energy pose unique challenges. A device will convert natural energy into a mechanical form, often rotational, and in some cases linear; Converteam's experience in the design of robust generators for unusual physical locations provides solutions to produce the electrical energy output.

We can build on our proven and volume series production of converters for the wind industry.

The electrical systems also utilize generators, power conditioning and control systems as applied by Converteam in various other markets.

Reliability is particularly critical in wet renewables. Maintenance offshore is both complex and expensive and Converteam is able to offer equipment that has been designed to maximize availability with only essential marine approved subsea components. Thanks to the advanced 4-quadrant power conversion and control system, the reliability and availability of each and every device has been increased significantly while having reduced the operating envelope.

## Value for customer:

- capacity to optimize the whole system architecture, including converter, generator, connection and connection to the shore
- proven components in marine conditions, due to Converteam's very strong expertise in marine, offshore and subsea business

- very reliable components, with redundancy to enable as little offshore maintenance as possible
- most efficient components
- leverage of Converteam's unique technologies and expertise in wind

## EDF: subsea generator project

Converteam is working with Electricité de France (EDF) within the framework of their subsea generator project which will be installed at a site in Paimpol-Bréhat, France.

The project features several electrical generators installed 40m below sea level. The turbines enable water energy to be converted into mechanical energy which will be transformed into electrical power by a generator.

Converteam's scope of supply includes:

- a subsea container housing a conversion system that controls the generators, connects and converts the energy produced and transmits it through a 15km-long MVDC type link to an onshore station
- underwater connections between the generators and the conversion system located several hundreds meters away
- an onshore power station that shapes the electrical signal to feed it to the existing power grid.

This station also accommodates a system to monitor the subsea plant and a communication link to a remote EDF central station where all collected data is dispatched.



Oceanlinx MK3 wave energy converter

# A Clean and Sustainable Energy for the Future: Small Hydro Power

Variable speed systems enabling higher flexibility and efficiency have been in use in large hydro plants for decades. Converteam has a long history in large hydro power projects, manufacturing and supplying power electronics. Those same skills are now being applied to small hydro power.

Employing a variable speed solution with IGBT based power converters on appropriate small hydro power systems can significantly contribute to maximizing power throughput and can simultaneously help to protect turbines overspeed, cavitations and oscillation effects.

Our new generator technology and variable speed solutions offer a leap forward in maximizing the converted energy from existing small hydro stations.

## Value for customer:

- reduction of CAPEX of turbine due to use of propeller instead of more expensive and complex turbine (thanks to the use of the variable speed)
- higher life expectancy of the turbine due to absence of overspeed, cavitation and oscillation effects
- additional efficiency (due to ability to optimize working range of the turbine)
- storage flexibility (with ability to arbitrate on prices of electricity)
- ability to compensate for reactive power
- ability to optimize the whole system architecture including both the converter and the generator.



| Hirschaid run-of-river power station

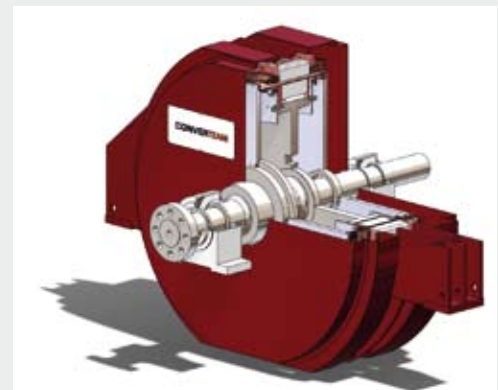
## HYDROGENIE: HTS generator for small hydro projects

Built in the 1920's, the Hirschaid power plant, located on the river Regnitz approximately 10km south of Bamberg in Germany, satisfies the electrical power requirement for around 2,000 households.

In the course of the HYDROGENIE project, part funded by the European Union FP6 program, E.ON, as owners and operators of the plant have elected to replace one of the three existing generators with a machine based on Converteam's HTS technology.

The new generator unit is of an upgraded power rating of 1.7MW compared to the existing 1.25MW. Crucially, the HTS machine is accommodated within the footprint of the original generator and has required no significant infrastructure modifications.

The new generator is designated as the plant's base load generator and as such, it is anticipated that base load generation will increase by more than 30% when compared to the original generator configuration.



| HYDROGENIE

# A Lasting Commitment to Service and Support

The Converteam service organization is dedicated to comprehensive customer support during all product lifecycle phases including spares and repairs, training, routine service contracts, 24/7 breakdown support, upgrade and enhancement projects.

Converteam is a world leader in the development and application of advanced High Temperature Superconducting (HTS) generators for renewable applications.

An HTS machine is of much reduced size and weight, and of increased efficiency, when compared to a conventional generator.

HTS technology is changing the face of offshore wind farm construction and can be the deciding factor in permitting the construction of 6MW turbines and beyond. In wind turbines, the advantages of HTS translate into either significant reduction in the nacelle weight, which in turn reduces the capital cost of the complete turbine, or into enhanced output.

In the hydro and wave power sectors, similar benefits may be accrued. The dramatic improvements in power density and efficiency mean that existing installations can be upgraded to enhanced output capacity without necessitating major changes in the civil infrastructure. New plants can be smaller and simpler than originally envisaged.

The inherent ability of an HTS generator to tolerate regular significant overloads means that in wave power applications the machine can be rated for average conditions rather than for peak conditions as is the case with a conventional generator.



| HYDROGENIE HTS generator

In addition to supporting customers through its engineers in the field, Converteam has a global network of thirty eight Regional Business Centers (RBCs). These RBCs, backed by expert engineering and development resources from our engineering centers, and by service excellence centers, offer a combination of expertise, proximity and effective responsiveness to customers around the globe.

## Remote Support (ViSoR)

Downtime represents financial losses and risk to reputations for our customers. Therefore, bringing the appropriate expertise to bear on the problem in the most efficient way possible is crucial.

ViSoR, the Converteam service formed around an internet based connection, permits our specialists to access and inspect equipment and systems from anywhere in the world and to offer expert advice and solutions. This system utilizes robust security techniques to prevent unauthorized or inappropriate access.

## Training

Using and maintaining systems and equipment safely and efficiently is a vital part of any successful project implementation.

Converteam provides comprehensive training facilities for the equipment and systems that it supplies. Content, duration and location are flexible to suit the specific needs of the customer.

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