

Green Line

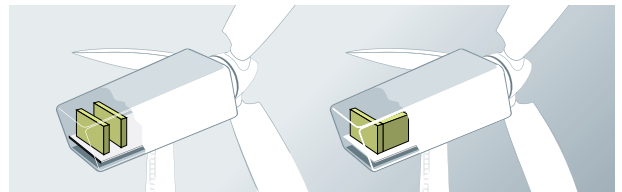
A Fresh Breeze for Wind Energy: The PCS Green Line family sets new standards.

PCS Green Line is the systematic development of our power converters to meet the specific requirements of generating power from wind energy. PCS is the converter specialist for wind turbines.

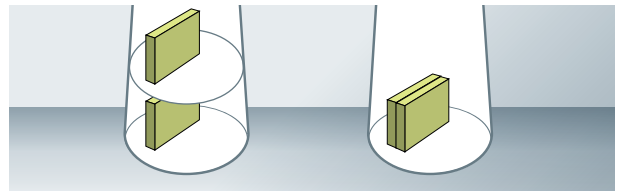
Wind energy has become one of the main pillars of the energy revolution. To ensure reliable power supply using wind energy, wind power systems need reliable and efficient frequency converters. The PCS Green Line family of power converters are the new standard for wind turbines. Whether used for retrofitting or in a system with a generator and transformer: PCS is your converter specialist. High availability, modular product design, and the specific expertise of PCS in the area of grid codes ensure optimal grid integration – and maximum yield.

Exemplary reliability and flexibility

Compact PCS frequency converters have proven themselves under the harsh conditions of railway use and wind energy, as well as for highly dynamic industrial applications. Thanks to the flexible set-up and compact dimensions, these systems are ideal for supplying wind energy to the grid – on land (onshore) and sea conditions (offshore).



Setup in the nacelle: parallel or diagonal



Setup in the tower foot: atop one another or back to back

Properties of the full power converters

Output can be scaled from 1000 kW to 7000 kW

Liquid-cooled

Individual set-up arrangements in tower and nacelle

IGBT-based four-quadrant power converters

Variable grid and generator connection possibilities

EMC-compliant enclosures for minimal occurrence and emission of interference fields

IP 54 protection against environmental influences such as water, dirt and salt

Conforms to technical directives and grid connection requirements

Fault ride-through capability

CE conformity

Customer-oriented service: training, commissioning, spare parts management, customer-specific service agreements

The PCS Green Line Family: More power, less maintenance.

The PCS Green Line family is designed to meet the specific requirements of generating power from wind energy. A modular product line with standardised construction, which sets new standards when it comes to reliability and flexibility.



Production of power converters in Berlin

Advantages of synchronous generators

Full power converters for synchronous generators are currently the fastest-growing technology on the wind market. Synchronous generators offer significant advantages. They are comparatively inexpensive and they can be built so they are compact. Also they require little maintenance. They achieve high energy output and have a

high rotational speed range. Above all synchronous generators meet the grid requirements in connection with the full power converter. And, because synchronous generators are not connected directly to the grid, the drive train is not affected by grid disturbances.

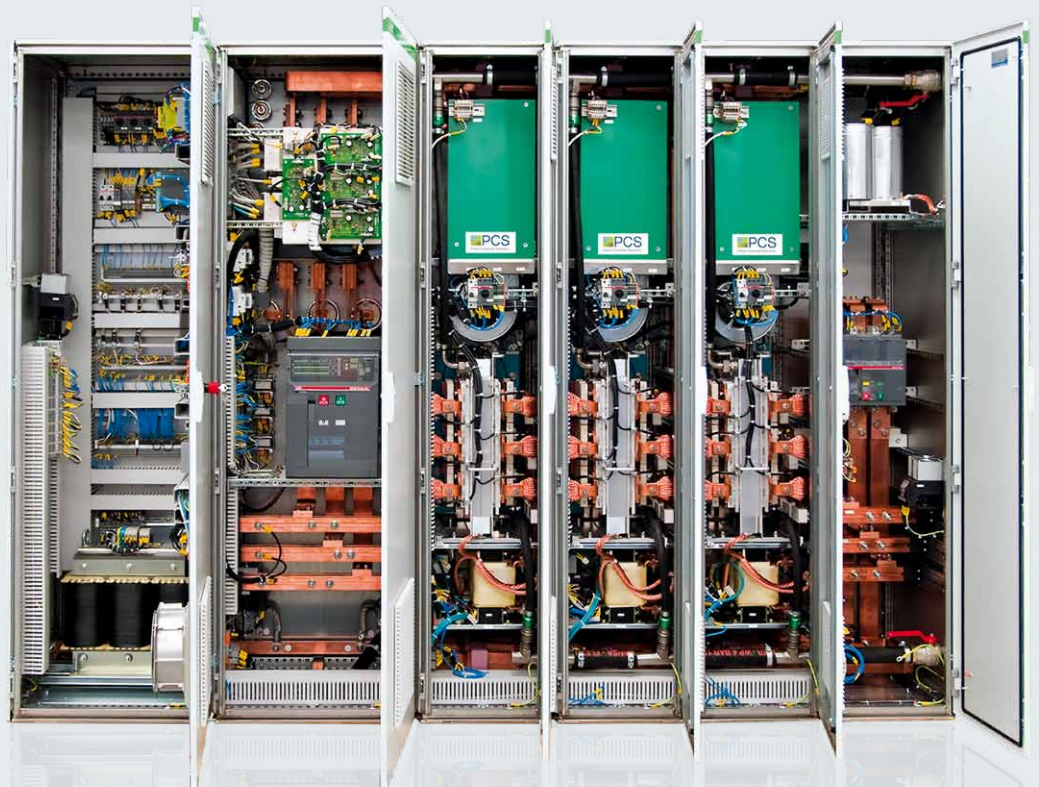
Expandable to a complete system

The modular design, standardised execution and scalability of the output ensure that the PCS Green Line is especially easy to expand – for example by connecting several converters in parallel. PCS Green Line systems offer a perfectly-matched power generation system made up of proven individual components: power converters, generators and transformers form a durable and highly-efficient complete system.

Guarantee of grid compatibility

The PCS Green Line family also includes the LVRT solution PCS Green Line 1000. Designed for use in individual wind turbines, it can be integrated into the power converter system of existing systems as a retrofittable component. In order to satisfy grid operators' requirements, PCS Green Line 1000 supplies reactive current during brief drops in voltage.

Full power converter
PCS Green Line 1522



PCS Green Line Systems: Much more than the sum of its parts.

The better the components of a wind power system fit together, the more efficiently it can generate power. With PCS Green Line systems, you can be sure of this. Together with our partners, we create a perfectly-attuned system with reliable components: power converter plus generator plus transformer for wind turbines – developed by top specialists, put through the paces, and certified by independent authorities.

Short test phases due to pre-configured products

PCS Green Line systems stand for a combination of components that are joined together at the highest technical level to form a perfectly-functioning, efficient system. Because expert knowledge is brought to bear in each product, and is consistently built upon, complete solutions are created that are not just reliable, but also equipped for the future.

Individual combination and quick service

Proven series products are adapted flexibly to the actual requirements of a wind turbine. Test phases are shorter, but also provides an economic advantage. On-site, it is only necessary to install and test whether everything runs perfectly. In case of a malfunction, expert service technicians are on-site as quickly as possible and ensure that the system is running again. With remote control service

for power converters, for example, our team recognises a problem using remote diagnosis – and they can help right away.

Highlights

Cutting-edge technology in all parts

Matched components, plug & play

Concentrated expertise

Customisation

One contact person for everything

Full service

The variants at a glance

PCS Green Line Induction

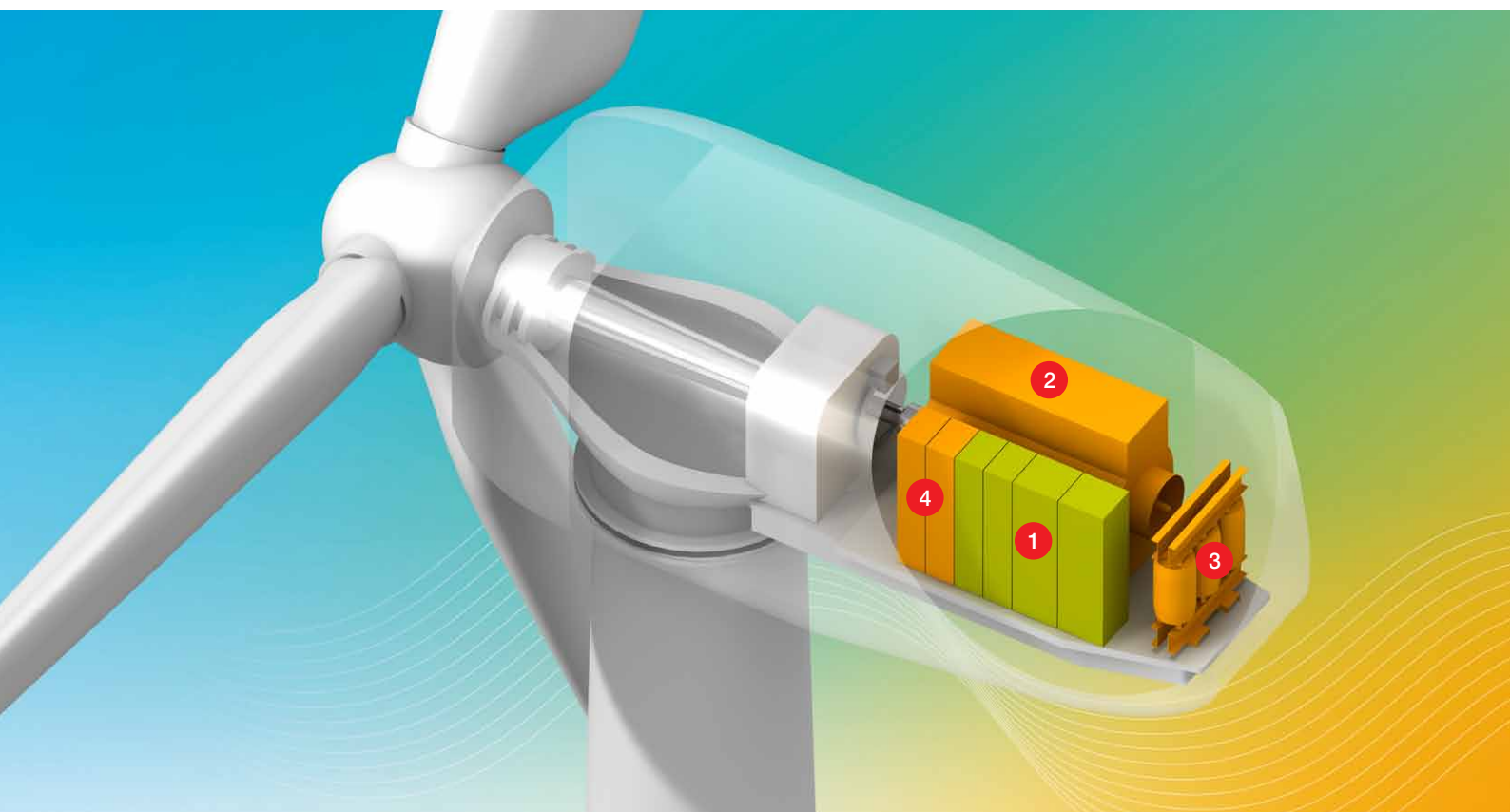
① Power converter, ② Generator

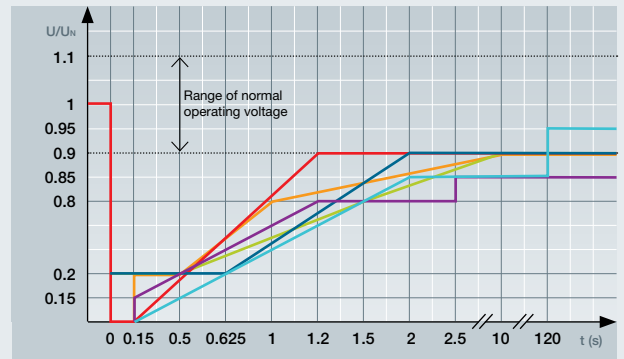
PCS Green Line Grid

① Power converter, ③ Transformer

PCS Green Line Complete

① Power converter, ② Generator,
③ Transformer, ④ Turbine control





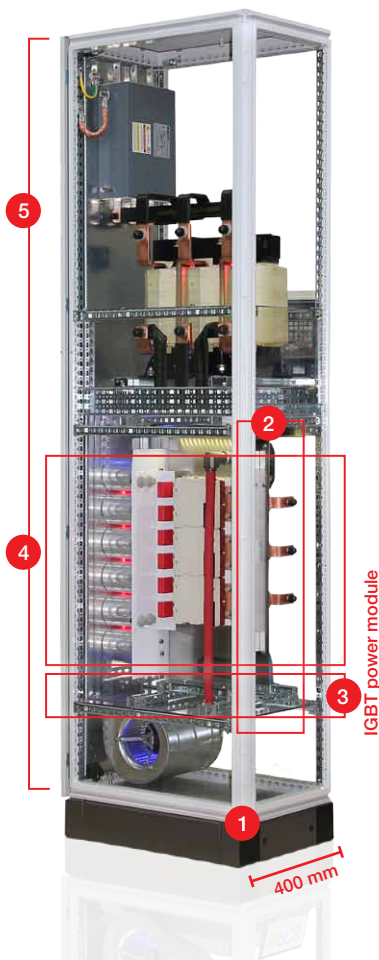
LVRT profiles of the national supply guidelines: ■ Germany ■ Spain ■ Portugal ■ China ■ Great Britain ■ Republic of South Africa

Compact, reliable and efficient: IGBT power module and DCU control unit.

Full power converter with 3-phase power module

The PCS Green Line relies on IGBT-based 4-quadrant converters. The 3-phase power module with integrated IGBTs at the core of the converters ensures maximum performance. The line-side and generator-side power converters are connected using an indirect voltage link. The spatially dense layout of the three phases on only one liquid cooled heat sink reduces the leakage inductance in the voltage link.

Durable, long-lasting film capacitors are used as intermediate circuit capacitors. A power module produces 500 kW (620 kVA). The inductor-type parallel circuits make the converters of the PCS Green Line family scalable in 500 kW increments.



Properties of the power module

- 1 Compact size creates more space
- 2 Improved cooling produces a high power density
- 3 Quick maintenance thanks to optimised design and easy-to-service mount
- 4 Perfect arrangement of all components ensures optimal energy flow
- 5 The modular design allows for partial-load operation to ensure that the system is always ready for operation and to guarantee even loading of the components

DCU control ensures grid connectivity

The DCU (Drive Control Unit) developed by PCS provides the power converter's intelligence. This microprocessor-controlled electronic unit is responsible for the control, protection and supply within the power converter, among other things. It is compact, modular and EMC-compliant. It demonstrates a high level of integration and was developed based on maintenance-free components.

Properties of the DCU

Yield optimisation thanks to field-oriented control

Matched, intelligent control of the generator

Sensorless control for increased reliability – the generator power converter can also be controlled using PCS software without speed sensor

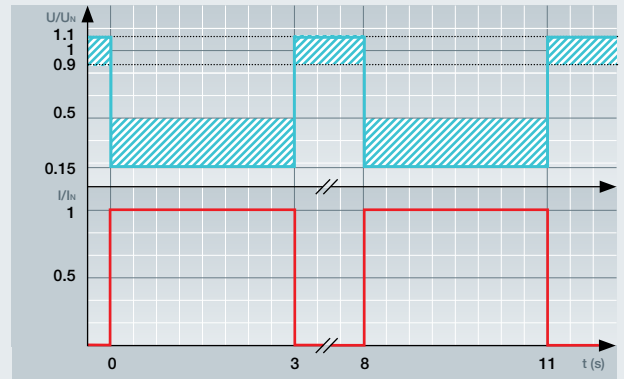
Minimal downtime thanks to remote control – the internet-based monitoring of the system offers quick help when service is required

Temperature-dependent fan control for inductive components

Interfaces for controlling the wind turbine: e.g. CAN, Profibus, Ethercat, Modbus



PCS Green Line 1000 is available in two performance classes and is already installed in various manufacturers' systems for a total of 130 MW. Here on the left: PCS Green Line 1000/2500



PCS Green Line 1000 in operation: ■ Reactive current ■ Voltage

Grid support is our specialty: All grid codes are fulfilled.

In the current era of changing grid codes, the grid compatibility of a wind turbine is becoming increasingly important. PCS Green Line fulfills the national and international requirements – today and in the future. Our experts are very well-acquainted with grid conditions worldwide.

Outstanding expertise for grid support

PCS simulates and tests grid breakdowns in-house

Active harmonic compensation for best-possible grid quality

Flicker compensation integrated into the power converter prevents negative feedback from the wind turbine into the grid

Adjustable $\cos \varphi$ controls the reactive power management for the entire system

Containment of symmetrical break-downs up to 15% of grid voltage

Containment of asymmetrical break-downs up to 0% of grid voltage

Fault Ride-Through (FRT) and grid support

Power converters need to facilitate reliable wind turbine operation even if the grids are exposed to strongly fluctuating frequencies or voltages. By supplying reactive power to the grid and additional grid-supporting measures, the PCS Green Line achieves this without a problem. Thus the wind turbine remains connected to the grid in order to support it, even if the grid voltage falls due to a short-circuit. Grid support and grid compatibility functions are integrated into all PCS full power converters, and with the PCS Green Line 1000 as a retrofittable solution, these characteristics are also available for other manufacturers' systems.

Highly-effective protective measures

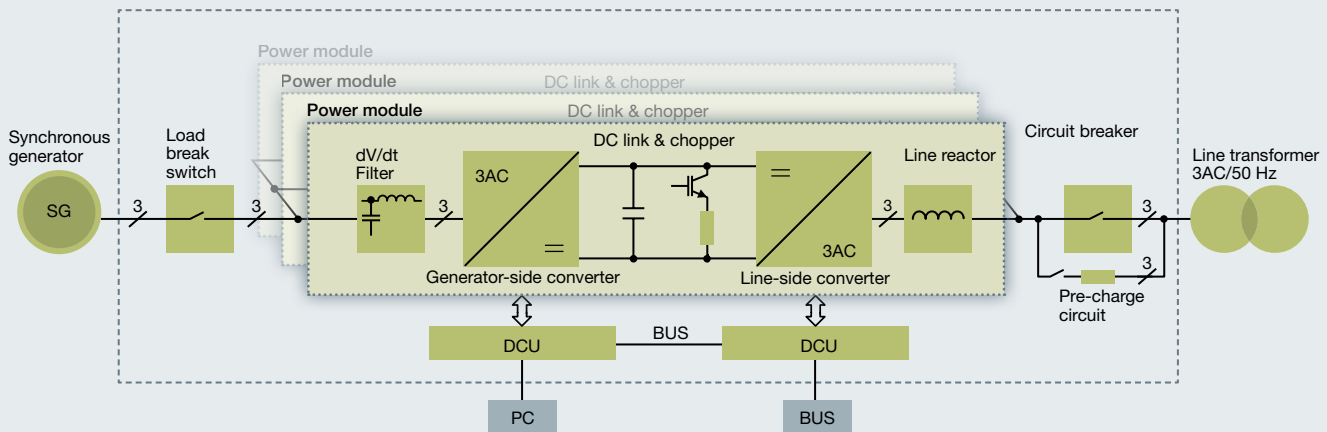
PCS Green Line frequency converters actively compensate for a part of the harmonics. Required reactive current is provided within less than 10 ms. In each power cabinet there is a chopper, which significantly increases operational security during grid faults. The power provided by the generator is transformed into heat in the chopper resistor until the pitch control has turned the rotor blades away from the wind and the system comes to a standstill.

Reliability proven thousands of times over

With PCS, experience acquired from many thousands of power converters for railways pays off: for railways, the converters are mounted externally and subjected constantly to strong vibrations and harsh climatic conditions. Furthermore, the current collectors regularly break down. From this extensive expertise our specialists supply unique grid breakdown competence, which you are welcome to take advantage of.

Technical data PCS Green Line 1000

PCS Green Line 1000	/2500	/850
Line voltage	3 AC 690 V	
Line frequency	50 Hz/60 Hz	
Maximum current	2500 A	850 A
Maximum duration of the current	2 x 3 s	
Cooling	Convection	
Dimensions L/D/H mm	1400/600/2100	1400/600/1400
Weight approx.	950 kg	750 kg



Full Power for the Grid: PCS Green Line for synchronous generators.

The current industry trend is towards low-maintenance synchronous generators with high power efficiency. There are various configurations of such a wind turbine type: with, and without gearbox and with permanent, or external excitation, of the generator. PCS Green Line power converters are optimally attuned to all requirements – and extremely powerful: as full power converters, feed the entire generator output into the grid and they can reliably satisfy the grid requirements.

High performance with small dimensions

The PCS Green Line power converters for liquid-cooled synchronous generators offer high performance with small dimensions – and they can be connected in parallel to increase output up to 7.0 MW. The inlet temperature of the liquid can be up to + 45° C at nominal output.

PCS offers everything that modern, future-proof power converters need today: from user-friendly design to optimised monitoring and control technology – tested in simulated and real test runs. Reap the benefits of PCS's superior technology, service and project management expertise.

Types and performance classes

PCS Green Line	1022	1522	2022	2522	3022	3522
Nominal output (kW)	1000	1500	2000	2500	3000	3500
Input current (A)	1040	1550	2070	2590	3100	3620
Input voltage (V/Hz)	690/50	690/50	690/50	690/50	690/50	690/50
Output current (A)	1040	1550	2070	2590	3100	3620
Dimensions without control cabinet*	L	1800	2200	2800	1800	2400
	H	2000	2000	2000	2000	2000
	D	600	600	600	1200	1200
	in a row (D)			back to back (D)		

* Dimensions of control cabinet 600/2000/600 mm (L/H/D)

Technical data

Line voltage	690 V
Line frequency	50 Hz/60 Hz
Performance classes	1000 kW to 7000 kW
Power efficiency	> 96 %
Pulse frequency	1.5 kHz/3 kHz ¹
Power factor at the grid connection point	0.9 capacitive to 0.9 inductive
Ambient temp. during operation	-25 °C / -13 °F to +50 °C / +122 °F
Protection rating	IP 54
Installation location	Nacelle, tower
Configuration	Flexible configuration of the power converter enclosures ² , e.g. in a row, back to back, diagonally, parallel, atop one another
Connections for cables	Left and right
Connections for coolant	Left and right

¹ depending on the frequency of the fundamental mode

² possible with removable control cabinet