

innovation in grid & storage

NGC NEXT GENERATION CONVERTER

MSC MULTI-SOURCE CONVERTER

IES ENERGY STORAGE SYSTEMS

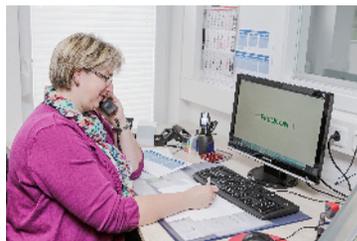
NGC STATCOM

IES SOLAR ENERGY STORAGE

IIGS INTERCONNECTABLE ISLAND GRID SYSTEMS



FREQCON



About Us

German Competence in Engineering

FREQCON GmbH is a German manufacturer of power converters and control systems for renewable energy projects and energy storage applications.

The family-owned company was founded in 1988 and trades as Freqcon GmbH since 2005. Freqcon was one of the pioneering companies providing power electronics and controllers to the wind turbine industry.

FREQCON GmbH is based in Walsrode, Niedersachsen, Northern Germany.

We provide the complete package: installation, commissioning, staff training, remote monitoring and support service.

FREQCON has a strong focus on research & development and co-operates with a number of universities and research institutes from all over the world. We take on the challenges of the future and develop tomorrow's energy solutions.

Products

Tailored Solutions

FREQCON's power converter and control systems allow efficient and reliable grid integration of wind turbines, solar farms and battery storage systems. We provide solutions for grid-connected systems as well as island grid systems.

A special focus is on microgrid systems where different energy sources can be integrated efficiently. Our products cover the whole range from several hundred kW to multi-MW systems.

We provide customer specific solutions tailored to meet the individual requirements of each project.

Our products are deployed world-wide in applications with 36 GW installed capacity.

innovative • effective • reliable



Quality

High-End Components – Highly Qualified Engineers

Our products are „Made in Germany“ and satisfy highest reliability requirements.

We exclusively purchase high-quality components of world-wide availability.

Our products are designed with optimised life cycle costs in mind, based on high-quality manufacturing process and low maintenance design.

FREQCON GmbH is certified according to ISO 9001:2008. Our products are certified according to IEC standards and GL guidelines.

We are a certified „Siemens Solution Partner“ in wind energy.

Based on our long lasting experience in development and manufacturing of power converters and control systems you can feel confident and at ease whenever purchasing a FREQCON product.

References

World-Wide Applications

FREQCON power converters and control systems can be found in applications around the world, especially in Asia and Europe.

A number of the leading wind turbine manufacturers are among our customers, as well as project developers of wind and solar farms along with system integrators of battery storage systems and operators of different manufacturing plants.

Examples:

- Integrated Electrical Systems for wind turbines 1.5 MW – 6.5 MW
- Energy Storage Systems 5 MW/10 MWh
- STATCOM Converter 14 MVA
- Island Grid System (Wind/Solar/Diesel/Battery Storage) 200 kW
- Combined System with wind turbine for RO desalination plant 2 MW

tailored solutions provided
by FREQCON



NGC Next Generation Converter

NGC Next Generation Converter for Wind, Solar and Grid Support

FREQCON NGC Next Generation Converters offer high efficiency, a cost effective solution and come as full size 2-Q or 4-Q converters for all generator designs (synchronous generator, induction generator) for wind, hydro, cogeneration units and diesel generators.

The system is used as solar converter, providing a centralized design with high voltage DC-bus for saving cable costs.

FREQCON NGC as battery to grid converter provides advanced grid support services, e.g. fast frequency response and synthetic inertia.

Reactive power compensation for high dynamic grid voltage control

Harmonic filtering based on ultra-fast IGBT-switching

Grid support applications according to BDEW2008, TC2007, TR8 FGW, DS3



3 MW wind converter



9 MW multi-level, high voltage converter

- Field proven design, with more than 15 GW installed since 1988
- Low EME design by symmetrically grounded DC-link
- Low THD (<2%) certified in many applications
- Fully scalable design (single module size: 500 kW, 1 MW, 1.5 MW, 3 MW)
- High efficiency through optimised pulsing (1.5% AC/DC conversion)
- Variable frequency for noise reduction and optimal inductor efficiency
- Phase shift capability for ripple current reduction
- LVRT and HVRT capability
- Full range reactive power control
- Integrated long term, multi-channel trace function, remote monitoring and software updates, WEB interface
- Designed to meet CE, UL, CSA as well as standards and directives like IEC 62477-1, IEC 60204-1, IEC 60146-1-1, Low Voltage Directive 2014/35/EU, EMC Directive 2014/30/EU and more

MSC Multi-Source Converter for Hybrid Energy Generation Systems

Integration of different energy generation systems like wind, solar and diesel today are commonly connected on the AC grid side, causing extensive installation of DC to AC converters and transformers, high costs and losses.

Based on our **Next Generation Converter technology**, we developed the **MSC Multi-Source Converter** that can be tailored to meet the requirements of a wide variety of renewable energy projects, both on-grid and off-grid.

The MSC Converter allows **parallel operation of several energy sources** such as wind turbines, photovoltaics, diesel generators or cogeneration units. At the same time different battery storage technologies such as li-ion, lead-acid or redox-flow batteries can be connected in parallel.

The MSC Converter helps to provide a stable and **uninterruptible island grid supply** with high power quality.

- **Field proven design**, with more than 15 GW installed since 1988
- **Low EME design** by symmetrically grounded DC-link
- **Low THD (<2%)** certified in many applications
- **Fully scalable design** (single module size: 500 kW, 1 MW, 1.5 MW, 3 MW)
- **LVRT and HVRT capability**
- **100 Mbit communication interface** supporting PROFINET, PROFIBUS, MODBUS/TCP, DNP3, OPC, ETHERCAT and Can-Bus
- Designed to meet CE, UL, CSA as well as standards and directives like IEC 62477-1, IEC 60204-1, IEC 60146-1-1, Low Voltage Directive 2014/35/EU, EMC Directive 2014/30/EU



IES Industrial Energy Storage

IES Industrial Energy Storage for Grid Support Services

The integration of high levels of renewable energy requires certain measures regarding **grid stabilisation**. The traditional power network faces complex challenges as wind and solar penetration increases.

Energy Storage Systems will play a vital role in future smart grids to **ensure system stability** of the electrical network. We have specified 3 scalable standard products for the battery storage market:

- IES 500 kW / 500 kWh
- IES 1MW / 1 MWh
- IES 3 MW / 3 MWh

Based on leading edge power converter technology, **FREQCON** provides tailored solutions for grid support applications. Respecting all relevant grid code requirements our products allow the operator to provide a number of ancillary services and harvest multiple value streams:

Voltage Support	High dynamic reactive power control to stabilise voltage
Reactive Power	Providing reactive power to reduce network losses
Firm Frequency Response (FFR)	Providing FFR to stabilise system frequency
Short Term Operating Reserve (STOR)	Providing STOR to balance intermittency of renewables
Peak Shifting	Shifting peak generation to peak demand
Energy Arbitrage	Trading wholesale power to benefit from price fluctuations
Black Start Capability	Providing active power to the system after shutdown
Capacity Provision	Providing peak-time capacity to avoid reinforcement costs



- **Active balancing**
 - Optimizes charging efficiency (4% better than passive balancing)
 - Optimizes battery capacity (8% better than passive balancing)
 - Increases maximum cycle capability (15 % better than passive balancing)
- Low EME design
- Low THD (<2%)
- 100 Mbit communication interface for all major communication standards like IEC 61850, IEC60870-5-10X, Modbus DNP3, IEC 61400-25, PROFINET and others.

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NGC STATCOM Systems for reactive power compensation

The increasing number of renewable energy projects leads to more stringent grid code requirements by local grid operators. In many cases a project specific solution for VAR compensation and voltage control is required.

FREQCON NGC STATCOM is designed to **compensate reactive power** created by long transmission cables, by transformers or by non in phase consumers or power sources.

Our system provides **high dynamic response** to be used in a **voltage control mode** in order to stabilize the grid voltage. The voltage control can be performed in standalone mode, by measuring the medium voltage line or remotely, by using high speed real time communication.

FREQCON NGC STATCOM systems are able to **reduce harmonic distortion** caused by nonlinear consumers. Furthermore, our STATCOM converter can be used to **balance the power flow** of parallel power lines.

Our systems can be equipped with integrated double layer capacitor banks for **active power support** (lifetime up to 1,000,000 charging cycles) and provide **LVRT-support** (Low Voltage Ride Through) to the grid.



- Field proven design, based on **FREQCON Next Generation Converter (NGC) Technology**, with more than 15 GW of installed capacity and 20 years of field experience
- **Low EME design** by symmetrically grounded DC-Link
- **High dynamic response** of active and reactive power
- **Modular, compact and scalable design** (converter capacity can be chosen in steps of 1 or 1.5 MVar. A 20ft ISO container can be equipped with up to 6 MVar of compensation capacity.)
- **100 Mbit communication interface** supporting PROFINET, PROFIBUS, Modbus/TCP, DNP3, OPC, ETHERCAT and CAN-Bus
- In accordance to all important communication standards, like IEC 61850, IEC 60870-5-10X, IEC 61400-25 and others
- **Wide temperature range** (including hot/cold climate), compact, water cooled design



IES Solar Energy Storage

IES Industrial Energy Storage Systems for Large-Scale Solar Applications

For many **large-scale solar farm projects**, grid connection capacity is a limiting factor. In many places the increasing number of renewable energy projects has led to grid congestion and stressed grid assets.

A **FREQCON IES Energy Storage System** is the ideal solution to utilize the allocated connection capacity more efficiently, e.g. a 5 MW solar farm could be connected to a 2 MW grid connection. **Peak time generation** will then be stored in the batteries and fed into the grid later in the day. Additional value streams can be harvested by providing **ancillary services**, such as **voltage and frequency control** to the grid operator.

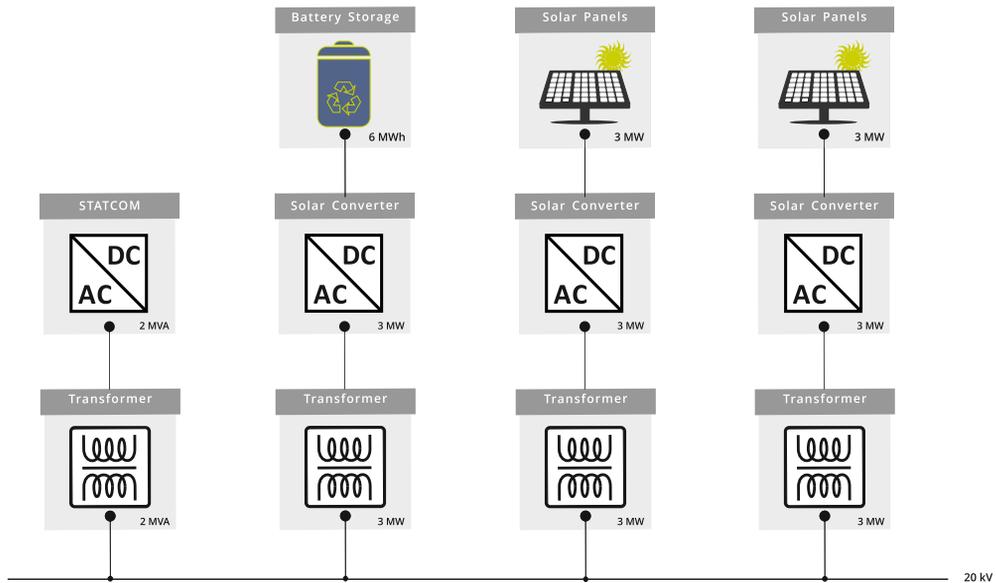
One of the key components of the **FREQCON IES Energy Storage System** is our **MSC Multi-Source Converter**. This advanced power converter takes care of both the charging/discharging of the batteries as well as the grid-compliant DC/AC conversion of the solar power, thus **eliminating costs for the traditional solar inverters**.



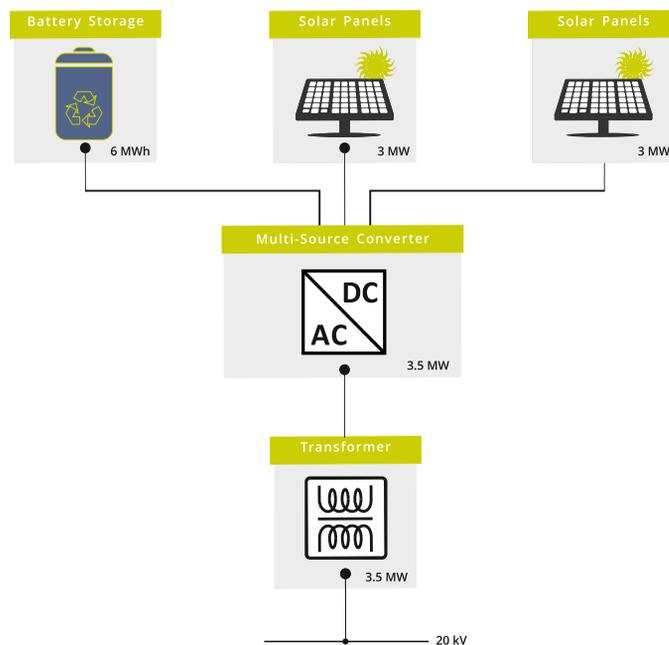
FREQCON IES is based on our field proven **Next Generation Converter (NGC) Technology**. More than 15 GW of installed converter capacity and field experience of more than 20 years have proven the high reliability of our design. NGC's **outstanding power quality** (THD<2%) and **low EME** design is certified for many applications. All components are sourced from well-known industrial brands with world wide availability.

- Equipped with a wide range of battery types (LiFePO4, lead-acid, LiS, sodium-nickel) or optional with double layer capacitors
- **Active balancing**
 - Optimizes charging efficiency (4% better than passive balancing)
 - Optimizes battery capacity (8% better than passive balancing)
 - Increases maximum cycle capability (15 % better than passive balancing)
- High **dynamic response** of active and reactive power, harmonic compensation
- **PID-resistant design** by grounding of negative terminal of DC-Link with leakage current measurement
- Industrial high speed communication device monitors more than **32,000 single battery cells**, life time data of cells recorded for more than **20 years**
- **100 Mbit** data interface supporting **PROFINET, PROFIBUS, MODBUS/TCP, DNP3, OPC, ETHERCAT** and **CAN-Bus**.
- In accordance to communication standards like **IEC 61850, IEC 60870-5-10X, IEC 61400-25** and others
- Designed to meet CE, UL, CSA as well as standards and directives like IEC 62477-1, IEC 60204-1, IEC 60146-1-1, Low Voltage Directive 2014/35/EU, EMC Directive 2014/30/EU and more
- **Modular and compact** design, module sizes from 0.5 up to 3MW

OLD APPROACH



FREQCON APPROACH



IIGS Interconnectable Island Grid Systems for

Worldwide, more than 1.2 billion people live in rural or urban off-grid areas. The supply with electricity can contribute to the alleviation of poverty and become the foundation for development and progress.

In collaboration with selected partners, **FREQCON** offers **Interconnectable Island Grid Systems (IIGS)** based on our MSC-Technology which can provide a reliable and competitive electricity supply for rural communities and commercial operations.

The **MSC Multi Source Converter** allows parallel operation of several energy sources (wind turbine, photovoltaics, diesel generator), while the integrated battery storage system reduces diesel consumption to a minimum.

The system provides a very stable, local electricity supply, also called a micro grid. The optional interconnection with other micro grids via AC or DC connection helps to balance intermittency of supply and demand. The connection to a public grid or a railway powerline is also possible.

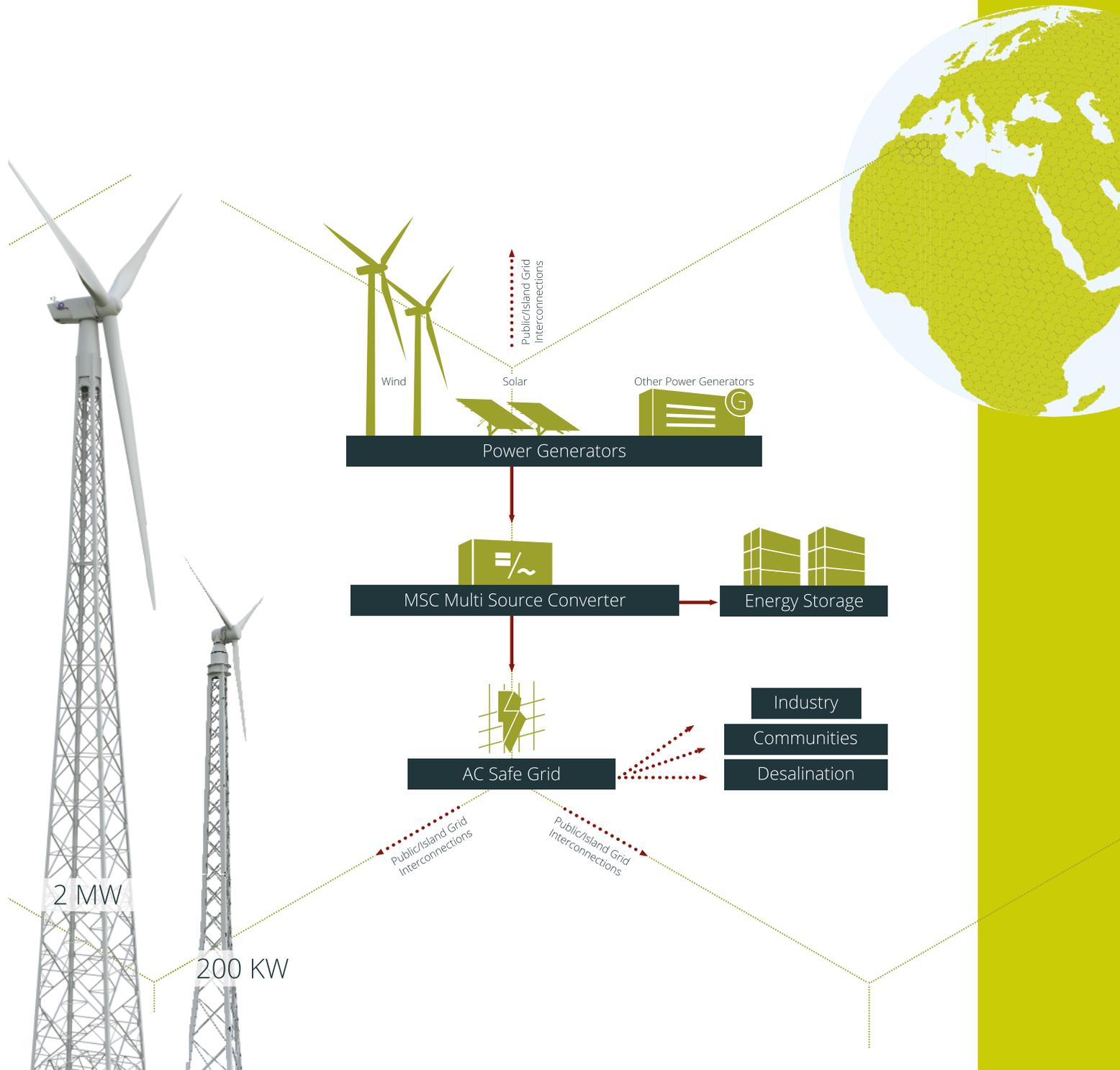
The IIGS can also be operated in connection with RO desalination plants. Intermittency of renewable generation can be compensated by water storage tanks, and the electrical pumps can be connected to a highly efficient DC-grid.

The following table shows 2 exemplary versions with different capacities. Systems are configured on a project specific basis, considering the requirements of the local consumers and the available energy sources.

Interconnectable Island Grid System 300 kW	Interconnectable Island Grid System 1.0 MW
Wind Turbine 200 kW	Wind Turbine 2.0 MW
Photovoltaics 300 kWp	Photovoltaics 1.0 MWp
Diesel Generator 100 kW	Diesel Generator 500 kW
Battery Storage (Li-ion) 600 kWh	Battery Storage (Li-ion) 2.0 MWh
MSC-Converter 300 kW DC-AC Output	MSC-Converter 1.0 MW DC-AC Output
RO Desalination Plant 50 m ³ /day	RO Desalination Plant 275 m ³ /day
Electricity Production: 1.000.000 kWh/year	Electricity Production: 6.000.000 kWh/year
Savings Diesel Consumption: 320.000 l/year	Savings Diesel Consumption: 1.800.000 l/year
Fresh Water Supply: 18.000 m ³ /year	Fresh Water Supply: 100.000 m ³ /year

stable local Grid Supply

Energize the world!



Today, renewable energy systems are in use all over the world and continue to provide clean and reliable energy to the end user. **FREQCON**'s technology provides the perfect solutions for renewable energy systems that are applicable in all environments - no matter whether it is dry, hot and sandy (like the Taklamaka Desert) or humid and salty (like the East China Sea) or cold and icy (like in parts of Canada or at the South Pole).

Countries in which we operate:



Contact:

FREQCON GmbH HQ
Vethem 24
29664 Walsrode
Germany
Phone: +49 (0) 5166 – 930 59 - 0
Email: info@freqcon.com

FREQCON Office Ireland & UK
Boyle Enterprise Centre
Quarry Lane
Boyle, Co. Roscommon
Ireland
Phone: +353 (0) 71 – 966 30 30
Email: k.harder@freqcon.com

FREQCON Office Southern Europe
AXU S.r.l.
Via Postumia 12
20153 Milan
Italy
Phone: +39 (0) 248 202 437
Email: mario@axu.it

Pitch Distributors Germany:

Atech Antriebstechnik GmbH
Fuggerstraße 30
84561 Mehring
Germany
Phone +49 (0) 8677 - 98 09 0
Email: info@atech-antriebstechnik.de

Pitch Distributors China:

P&R Energy Equipment Co., Ltd.
RM 804, Sino Centre, 582 – 592 Nathan Rd., Kln
Hong Kong
Phone +852 - 238 403 32
Email: info@pengruienergy.com

Module Distributors China:

Shanghai Skoden Equipment & Parts Ltd.
No.5 Building 4F, No.166, Mindong Rd,
Pudong, Shanghai, 201209
P.R. China
Phone +86 (0) 21 - 616 205 28
Email: sales@skoden.com