

## Manual

# HF-Inverter LWS - 300W/500W



Version 0.91 & 1.0  
20/04/2018



**HF-500-230-2050- ab V0.91**



## **Dear customer,**

Congratulations on your purchase of our Flow Turbine Inverter.

This product has been carefully tested and complies with the latest state of national and international requirements in terms of function and safety. Our inverters are especially optimised for the use with LWS systems' unique flow turbines.

This product is intended to be used only with the designated wind turbines and must only be used with the original in order to obtain the best possible results. Compliance with these instructions will ensure the safety of your power plant.

Your LWS Systems GmbH & Co. KG  
Your Team Hybridfabrik

## **Disclaimer:**

We strive to keep this manual and other documents up to date and state-of-the-art. We reserve the right to make technical changes. Therefore, it is possible that there might be differences found between the delivery status of the devices and these documents.

If in doubt, ask your dealer for the latest version.

This manual corresponds to the technical status at the time of printing.

Changes in technology and equipment as well as errors are reserved.

No liability is assumed for damage due to outdated information.

Likewise, LWS or Hybridfabrik shall not be held liable for damage to the device other objects or injury to persons, unless the instructions given in this document are observed.



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### 1 Introduction

#### 1.1 Validity

This manual covers installation, commissioning and troubleshooting when installing the following products:

→ HF-500-230-2050-ab V0.91

#### 1.2 Application

This manual contains important safety instructions and installation instructions that must be followed during the installation and operation of the device.

#### CAUTION:



**The operations described in this manual must only be carried out by a trained electrician. Compliance with the regulations of the responsible network operators (TAB) and the applicable VDE Directives is mandatory!**

### 2 Safety

#### 2.1 Safety instructions



##### Opening the device

**Some parts inside the device may be live.**

Contacting these parts may lead to serious injuries and/or death!

Never attempt to open the device yourself and do not attempt to repair the device yourself.



##### Electrical connection

Some parts inside the device may be live. Contacting these parts may lead to serious injuries and/or death! Never attempt to open the device yourself and do not attempt to repair the device yourself.

### Switching the device on and off



The devices are switched off and on, using the device fuse in the electrical installation.

Make sure the fuse is turned off before removing the power connector.  
Switching on the mains when the power is switched on can trigger the internal device fuse!

### Accessories



! Use only the spare parts and accessories supplied or released by us. The use of unauthorised replacement parts and accessories may affect the function and safety of the device.

### Guarantee



**The following aspects shall make the warranty non and void!**

- \* Connecting the device improperly
- \* Opening the device without prior written approval
- \* In case of damage and destruction of the housing or installed/attached components
- \* Damaging the seal(s)
- \* In case of penetration of water
- \* Overheating due to improper installation
- \* If an installation protocol has not been received 14 days after installation



### 3 Description of the device



### 3 Description of the device

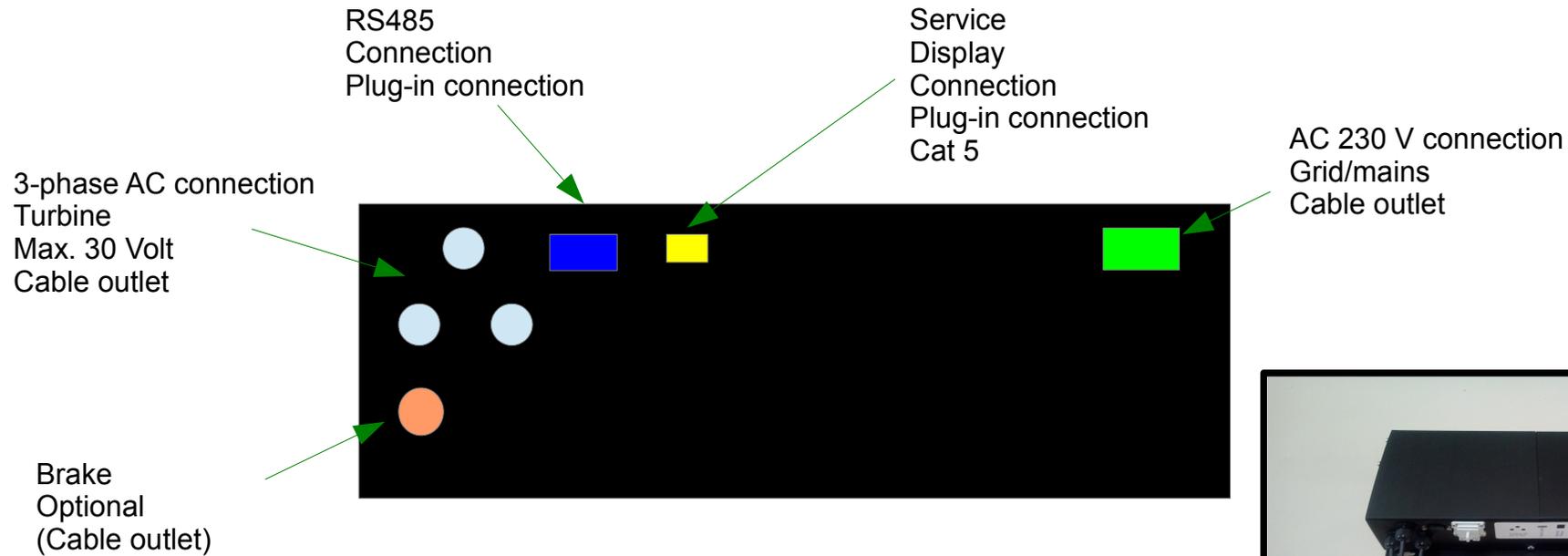
#### 3.1 Scope of delivery

- \* 1 - Inverter
- \* 1 - Quick start guide
  
- \* 3 - AC 28 V connecting cable 2 m long for turbine 4 or 6 mm<sup>2</sup> (integrated)
- \* 1 - AC 230 V connecting cable 2 m long for network connection/grid (integrated)
  
- \* 1 - Service display for programming and checking (optionally only trained specialist personnel)
- \* 1 - Communication connection RS485 integrated

#### Optional accessories and features (starting with version > 1.02)

- \* 1 - Wireless data interface (optional)  
Transmits the data using a wireless network signal to the ACCBox
  
- \* 3 - Turbine connection as MC4 connector (optional)
- \* 1 - AC mains connection as cold device socket (optional)

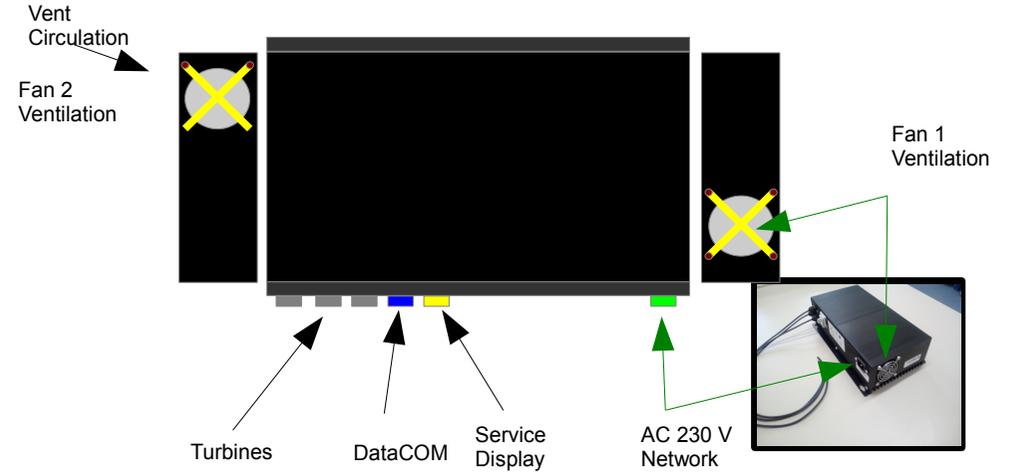
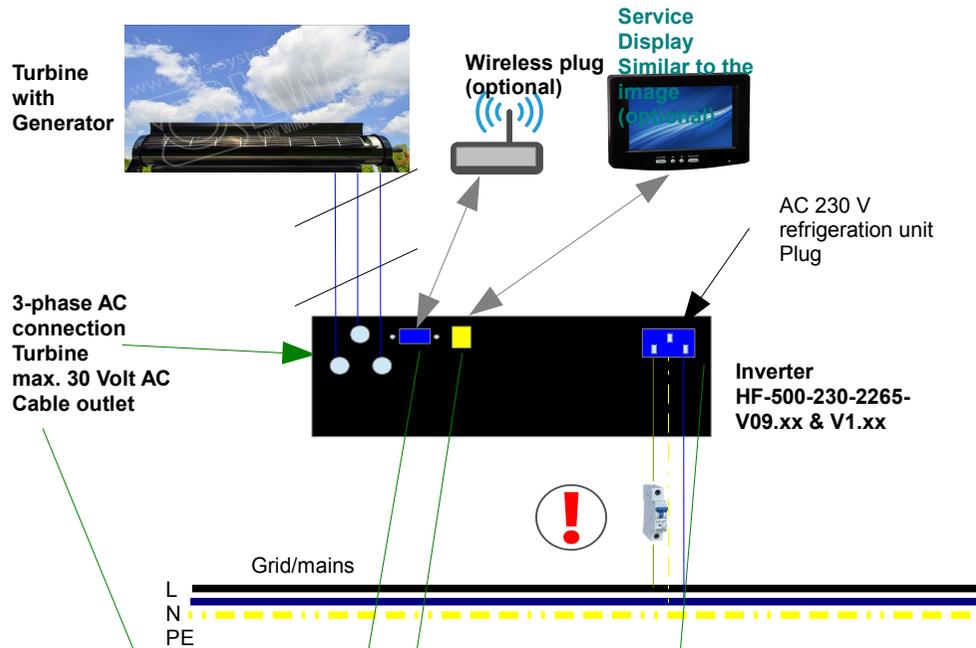
### 3.2 Overview - Connections



**Depending on the version, the connections may differ!**

- DumpLoad (brake)/optional
- Service Display connection/optional
- 3-phase AC optional as MC4 plug connection selectable
- Brake optional

### 3.2.1 Overview - Connections & example



#### Assignment of the AC cable - Mains connection - Grid - 230 V

The maximum conductor cross-section for the AC connection is 2.5 mm. Depending on the cable length, the responsible electrician must calculate the correct dimensioning.

**Compliance with the current regulations is mandatory.**

- L1 → black (phase)
- N → blue (neutral conductor)
- PE → green/yellow (protective conductor)

**It is essential to connect the protective conductor.**



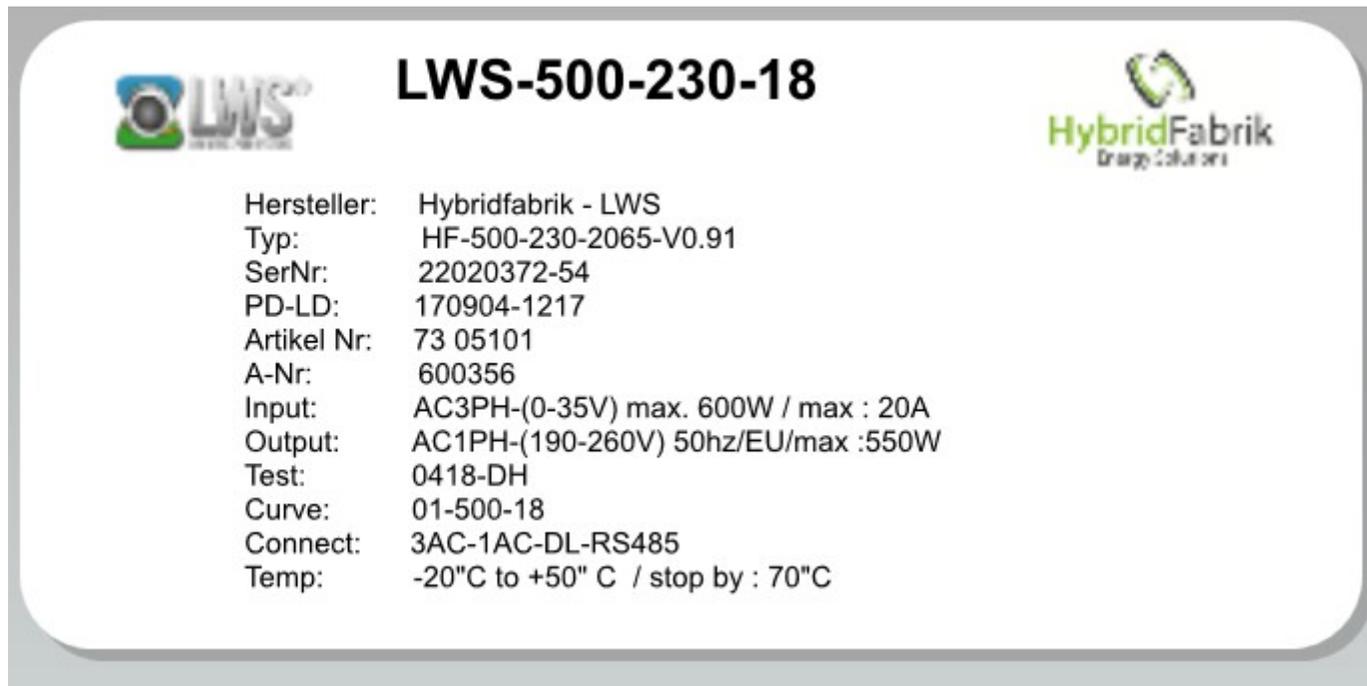
If connecting to the public network, compliance with the regulations and connection conditions of the responsible Distribution Network Operator (DNO) is mandatory. The installer is responsible for providing a flawless connection and be compliant with applicable standards.



**In order to attach the inverters, only use the mounting holes located in the floor of the inverters. Do "NOT" drill new holes for mounting purposes.**

### 3.3 Name plate

The name plate is located on the connection side of the inverter. Here, all technical data relevant for the connection can be found. For the unambiguous identification of the device, the serial number and article number is located on the name plate.





## 3.4 Functional principle



### 3.4 Functional principle

HF-500-230-XXX Wind Inverters include an intelligent control unit as well as an integrated grid and plant protection (German: NA Protection) according to ARN-4105 (German requirement for integration of power production units into the low voltage system) and was specially developed for LWS turbines.

The alternating current produced by the generator AC 0-28 V is first rectified and then output via the integrated control electronics according to the set wind characteristic curve to the AC grid.  
At the same time, the input voltage and frequency of the generator is constantly monitored.

For devices with connection for the “Service Display”, the function of the inverter can be check visually after the connection is completed.

The following is displayed: The mains voltage, the current turbines voltage (after the equal regulation)  
Depending on the version: Date, time, mains frequency output, inverter type

The display can be used by trained service technicians to make settings and adjustments. No PC is required for this.

Depending on the version and type the following settings are possible:

Date, time, starting voltage, max. Voltage, 9-level characteristic curve, overload protection (brake)

In order to automatically limit the speed of the generator, the overload protection is achieved by the special connection of the (adjustable) “braking resistor”. If the wind forces exceed 12 m/s, the brake must be connected.

The connections of the inverter are prepared on the input side and on the output side with the connection cable, and the initial startup of the device does not require accessing the housing.

### 3.4.1 Functional principle

The standard factory programmed characteristic curve has been determined from all data of recent years and is designed so that the turbine can work as long as possible in a minimum torque range.

As the wind's force gains magnitude, the torque potential also increases, so that the maximum power of the turbine increases dramatically in the last third of the power curve, and at the same time during the "normal" wind phase the turbine always operates in the medium torque range. (This increases the annual output)

#### Note:



If the characteristic curve is applied too high in the lower and middle range despite the lack of wind power, the build-up of the self-rotation and thus the torque generation is interrupted by the characteristic curve.

This causes the annual output to drop exponentially as the turbine is decelerated.

**(reduced speed = less voltage = less output power)**

Details will be explained during the training.

**Only technically trained personnel shall be permitted to alter the characteristic curves**, since incorrectly entered values can set the work of the system to a complete "zero yield" and the inverter could be destroyed.

An adjustment of the characteristic curve can only be made if there are appropriate wind measurements.

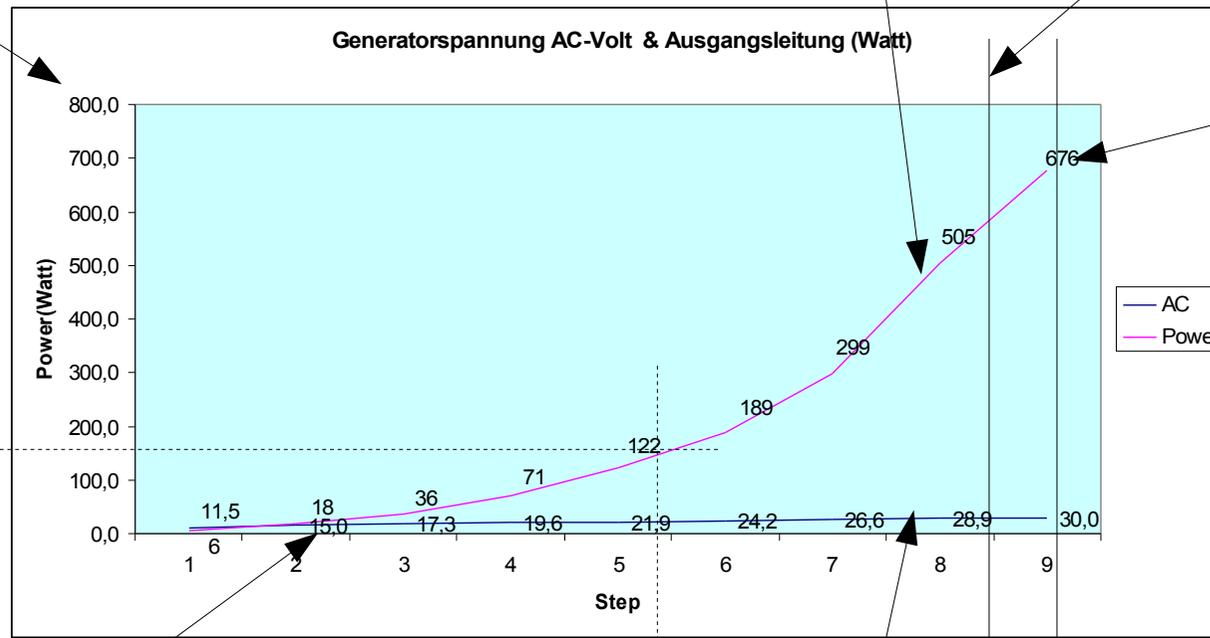
### 3.4.2 Functional principle

Example: 500 W turbine - Basic characteristics curve

Output wattage acc. to the characteristics curve

Output at exit in Watt

Maximum output Step



Fuse output limit without brake resistance

The generator voltage is directly dependent on the speed (RPM) and the speed directly depends on the wind flow

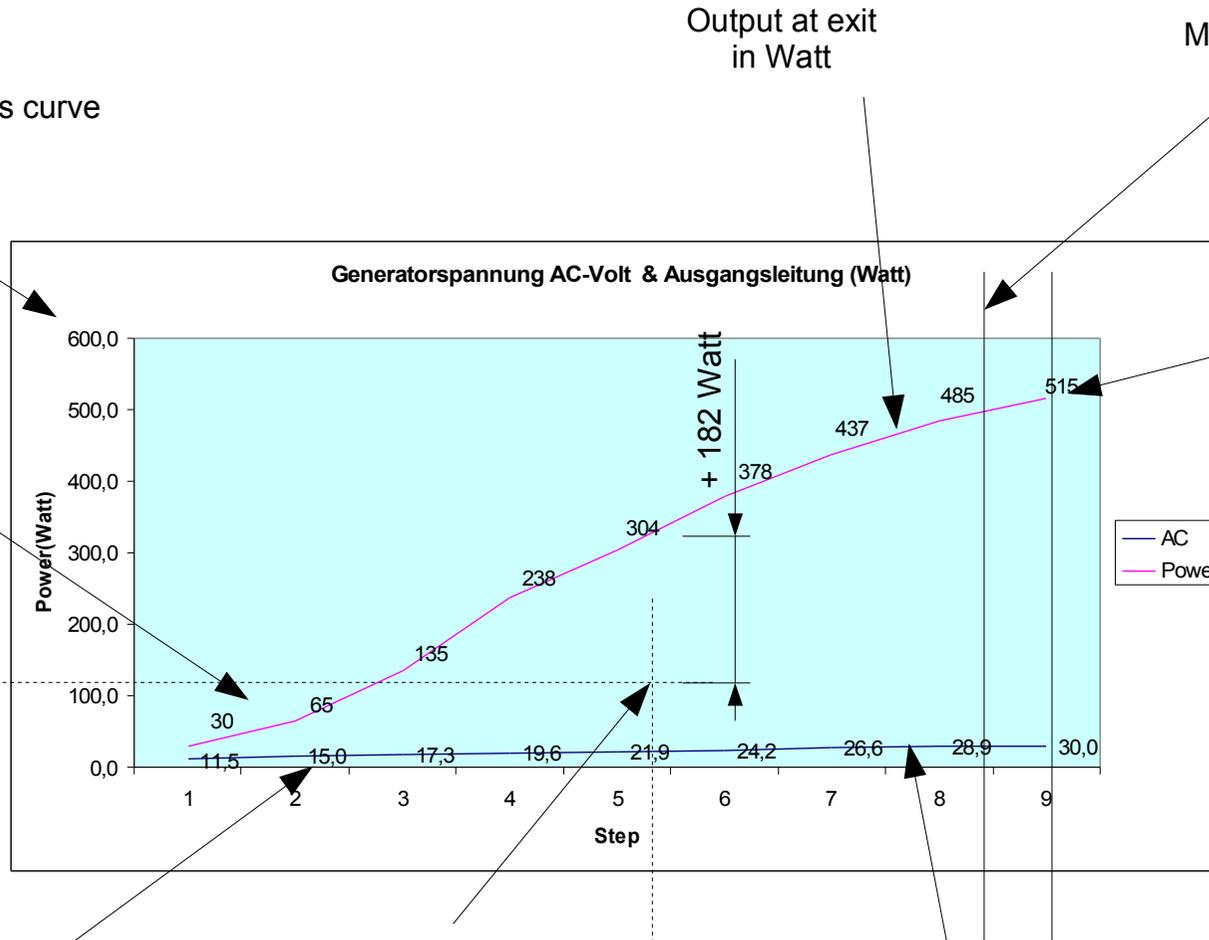
Generator voltage at the same time.

### 3.4.3 Functional principle

## Example: 500 W Turbine - Wrong characteristics curve for normal operation & conditions

Output wattage acc. to the characteristics curve

Power demand in the lower power range too steep



**Fuse output limit without brake resistance missing since the last step does not pass the rated power value**

**The system produces only little annual yield!**

**In weak wind conditions, this can drop to "0" because the turbine decelerates during startup.**

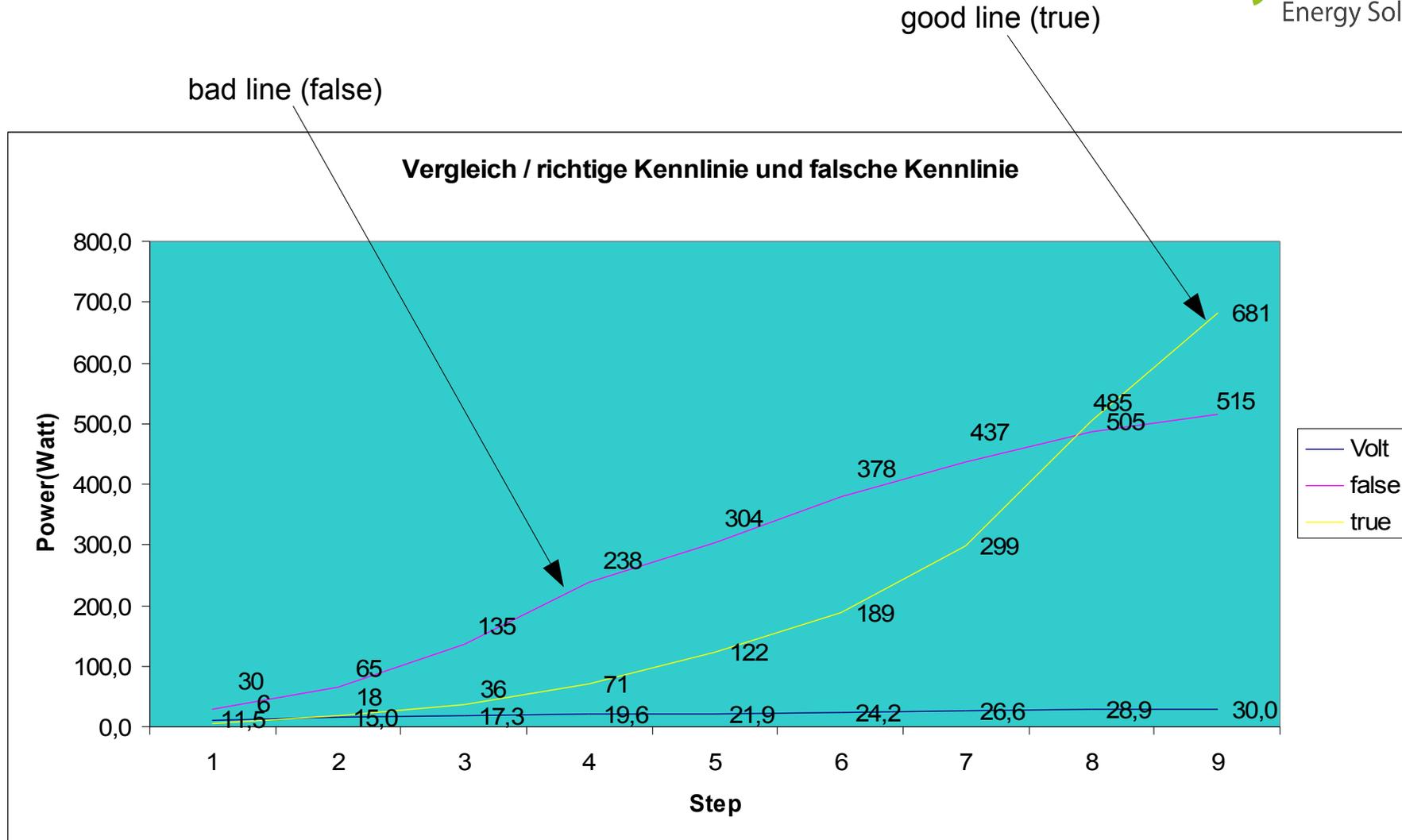
The generator voltage is directly dependent on the speed (RPM) and this directly dependent from the wind flow

optimum work point

Generator voltage at the same time.

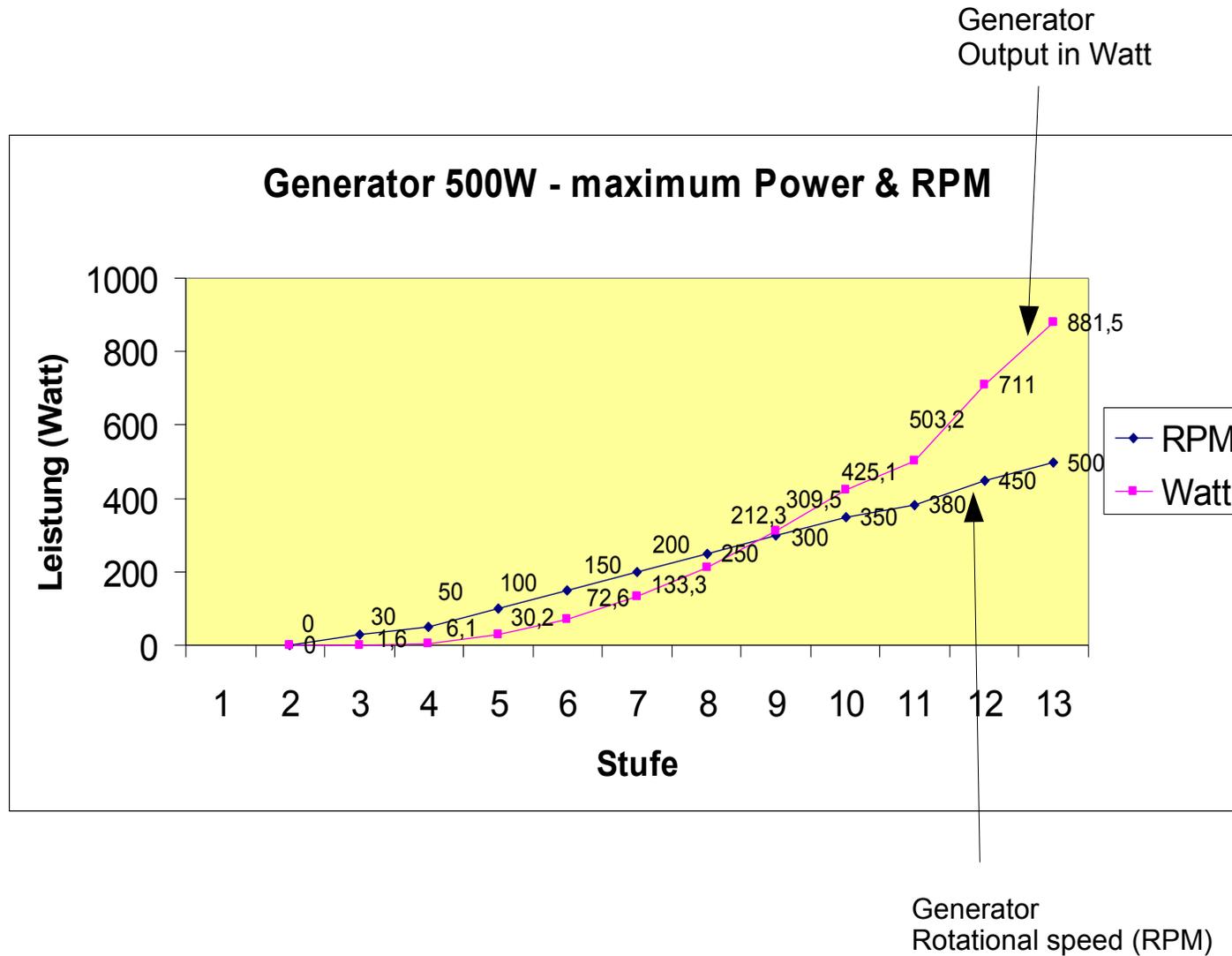
### 3.4.4 Functional principle

#### Comparison characteristic curve / true / false



### 3.4.5 Functional principle

#### 500 W Generator characteristics curve





### 3.5 Intended use



### 3.5 Intended use

The HF-500-230 inverters are mains-powered feeders, designed specifically for the use with LWS flow turbines. The optimum performance curve for these turbines is already integrated into the inverter at the factory.

**The devices are not approved for use with turbines built by other manufacturers.**

The inverters convert the electricity generated by the generator and feed the energy with 230 V AC into the home network or into the public power grid.

Compliance with the general rules and regulations of the distributor network operators is mandatory.

If the mains voltage is lost, the devices switch off automatically.

The devices are suitable for vertical or horizontal installation indoors.

Please observe the following installation instructions.

## 3.6 - System diagrams



The following systems diagrams are intended to serve as presentations only.

The use and implementation must be carried out in accordance with the applicable guidelines in the respective country and according to local rules.

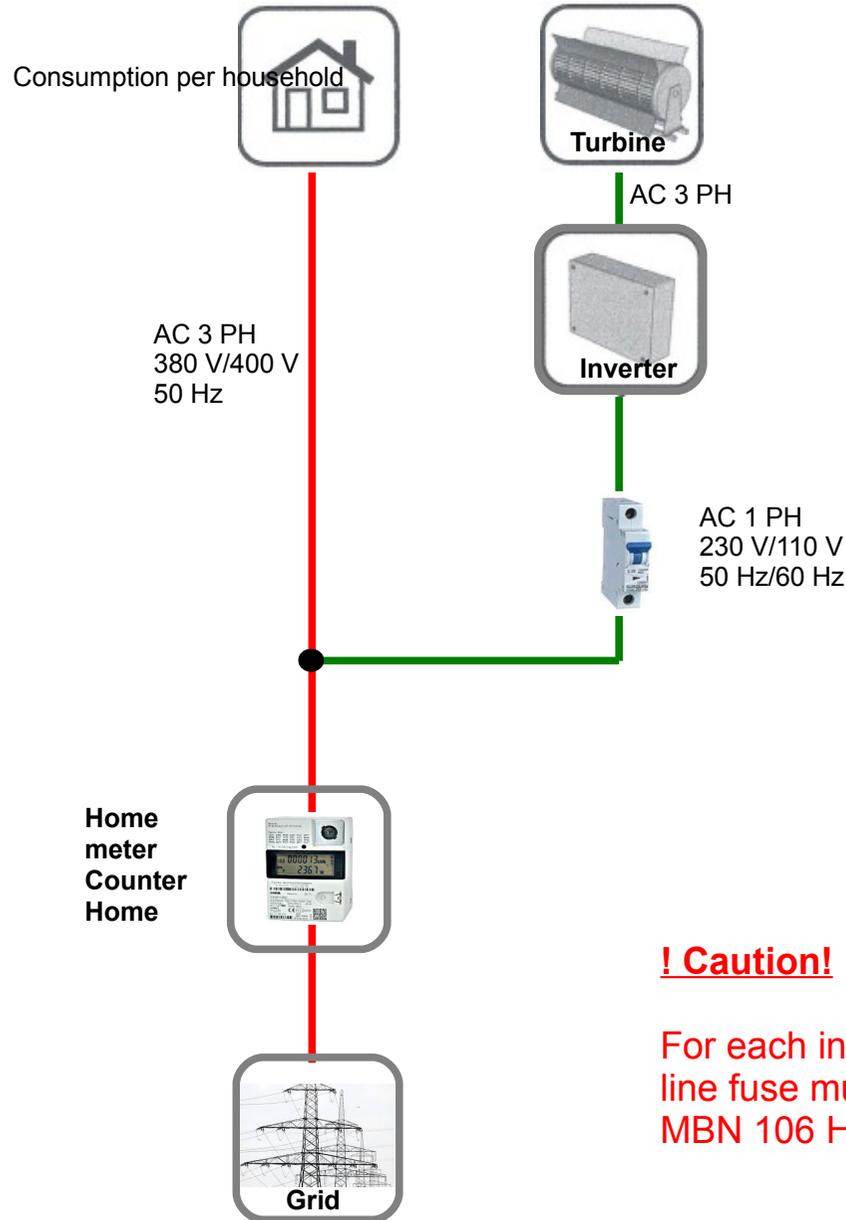
Compliance with the installation regulations and valid standards is mandatory.

All generating installations must be registered in advance with the relevant system operator (DE), irrespective of approval or implementation instructions.

Details are integrated into the technical training!

### 3.6 - Systems diagram 1 turbine

**!! Official meters may be necessary for the production measurement!**



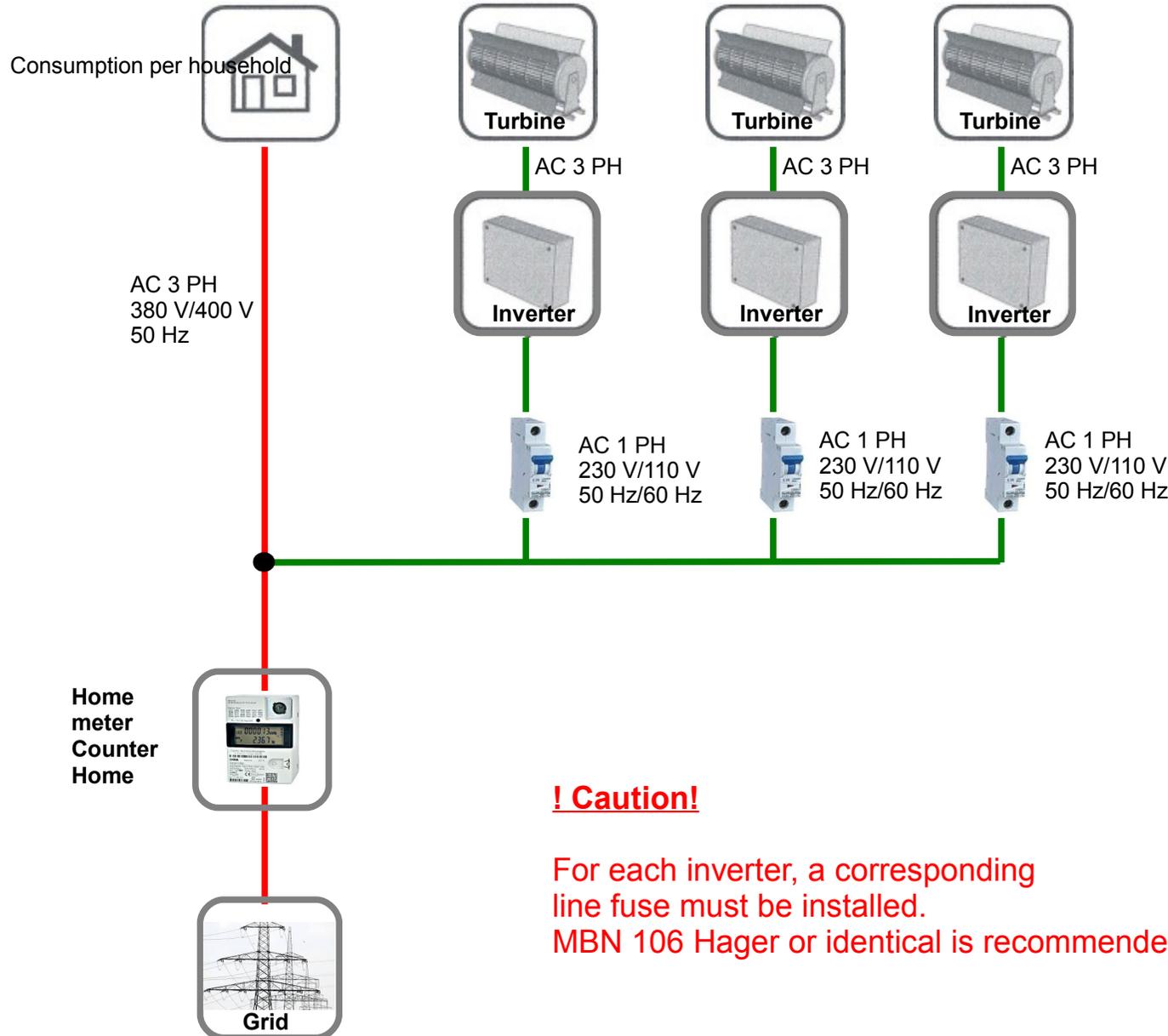
**! Caution!**

For each inverter, a corresponding line fuse must be installed.  
MBN 106 Hager or identical is recommended.



### 3.6.1 - Systems diagram 3 turbines

**!! Official meters may be necessary for the production measurement!**



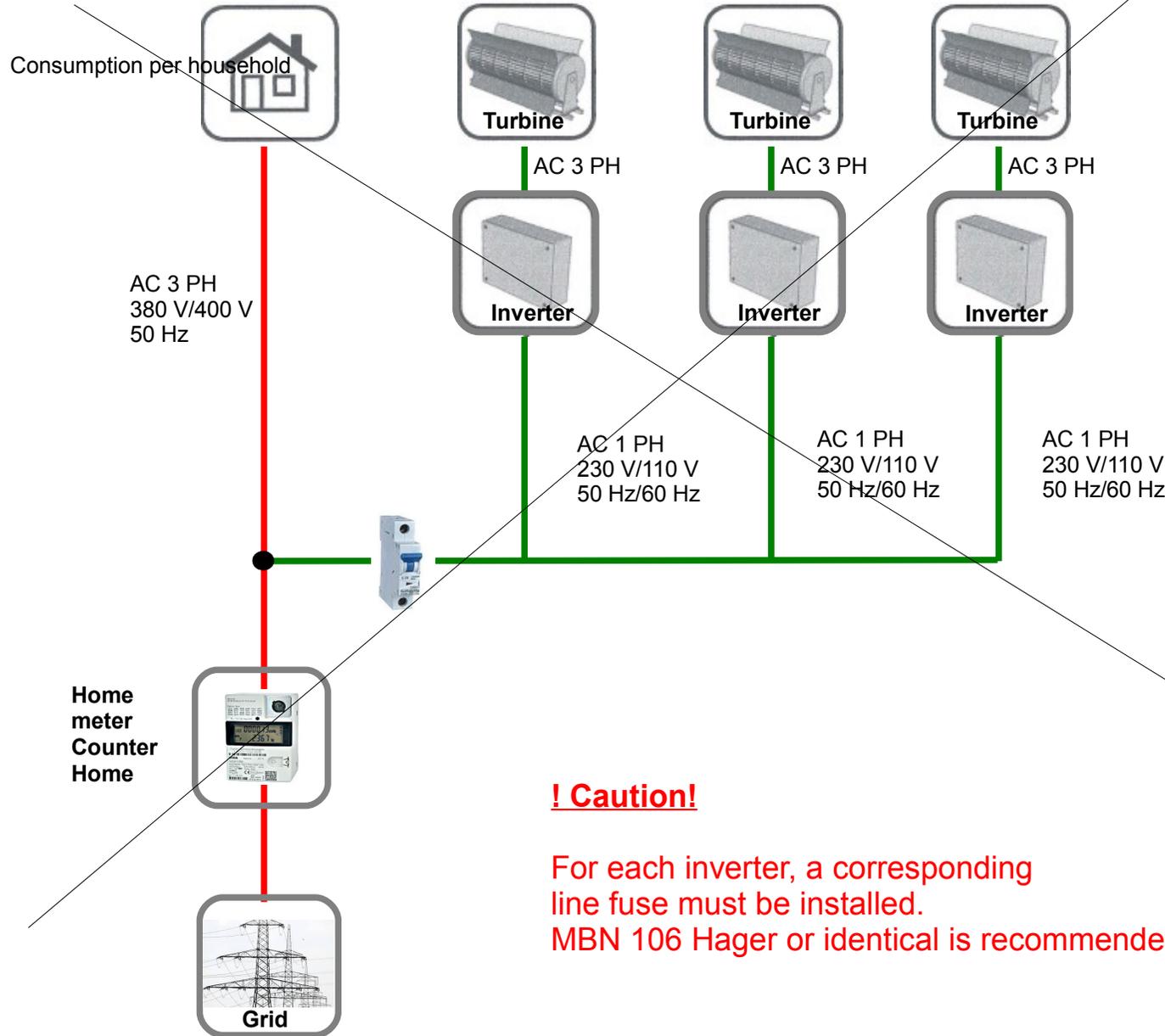
**! Caution!**

For each inverter, a corresponding line fuse must be installed.  
MBN 106 Hager or identical is recommended.



### 3.6.1 - Systems diagram 3 turbines / WRONG

**Each inverter requires its own fuse!**

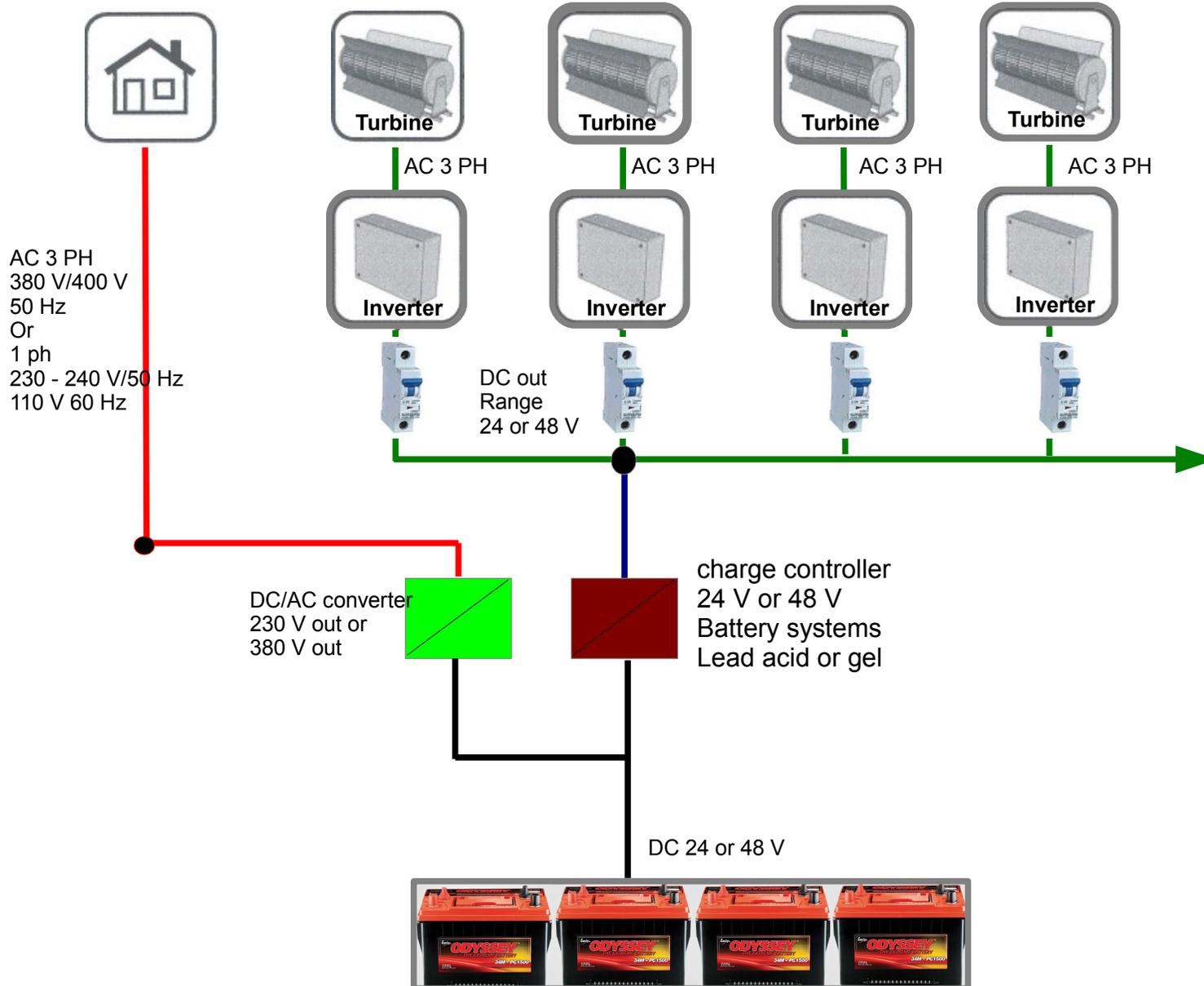


**! Caution!**

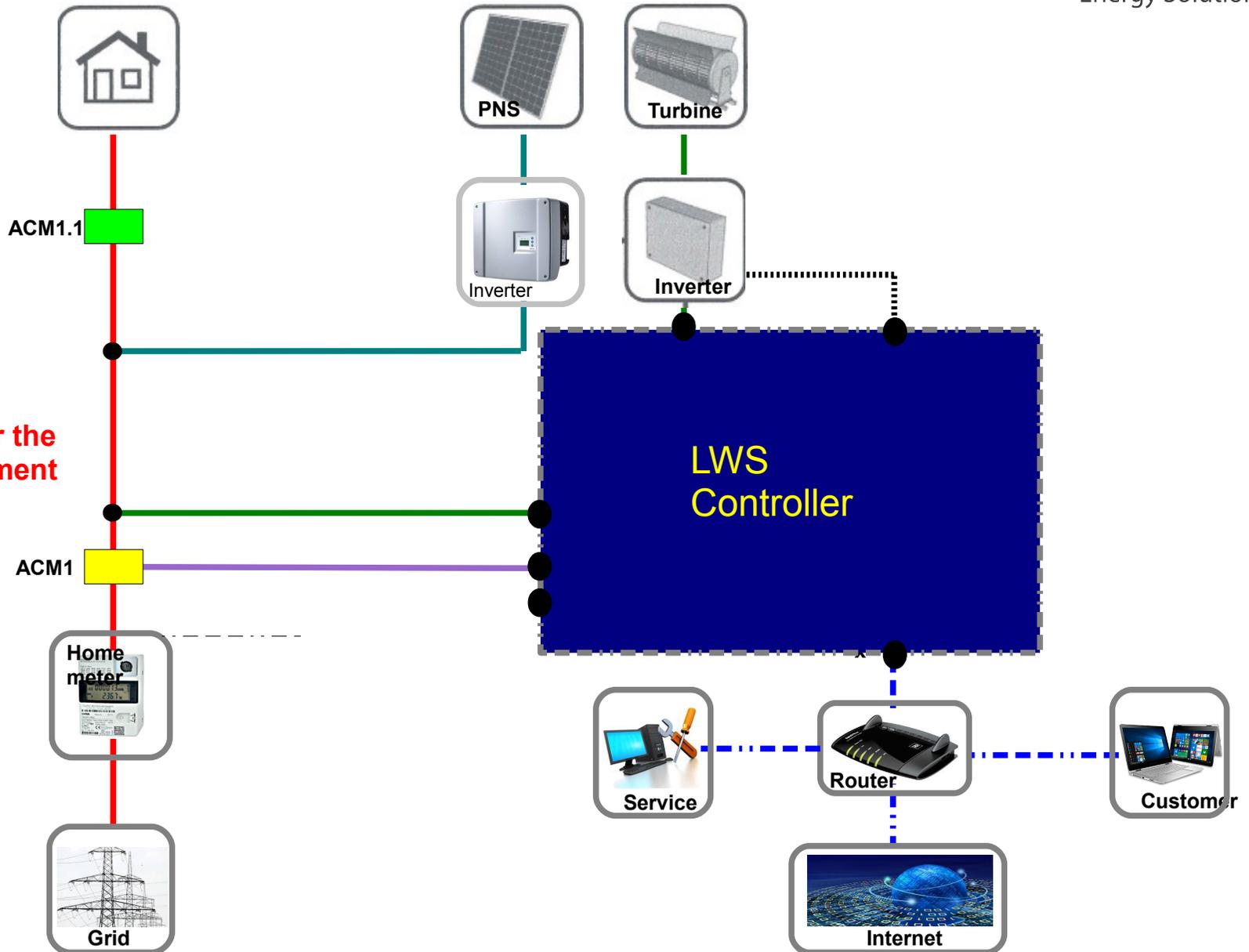
For each inverter, a corresponding line fuse must be installed.  
MBN 106 Hager or identical is recommended.



### 3.6.2 - Systems diagram island mode

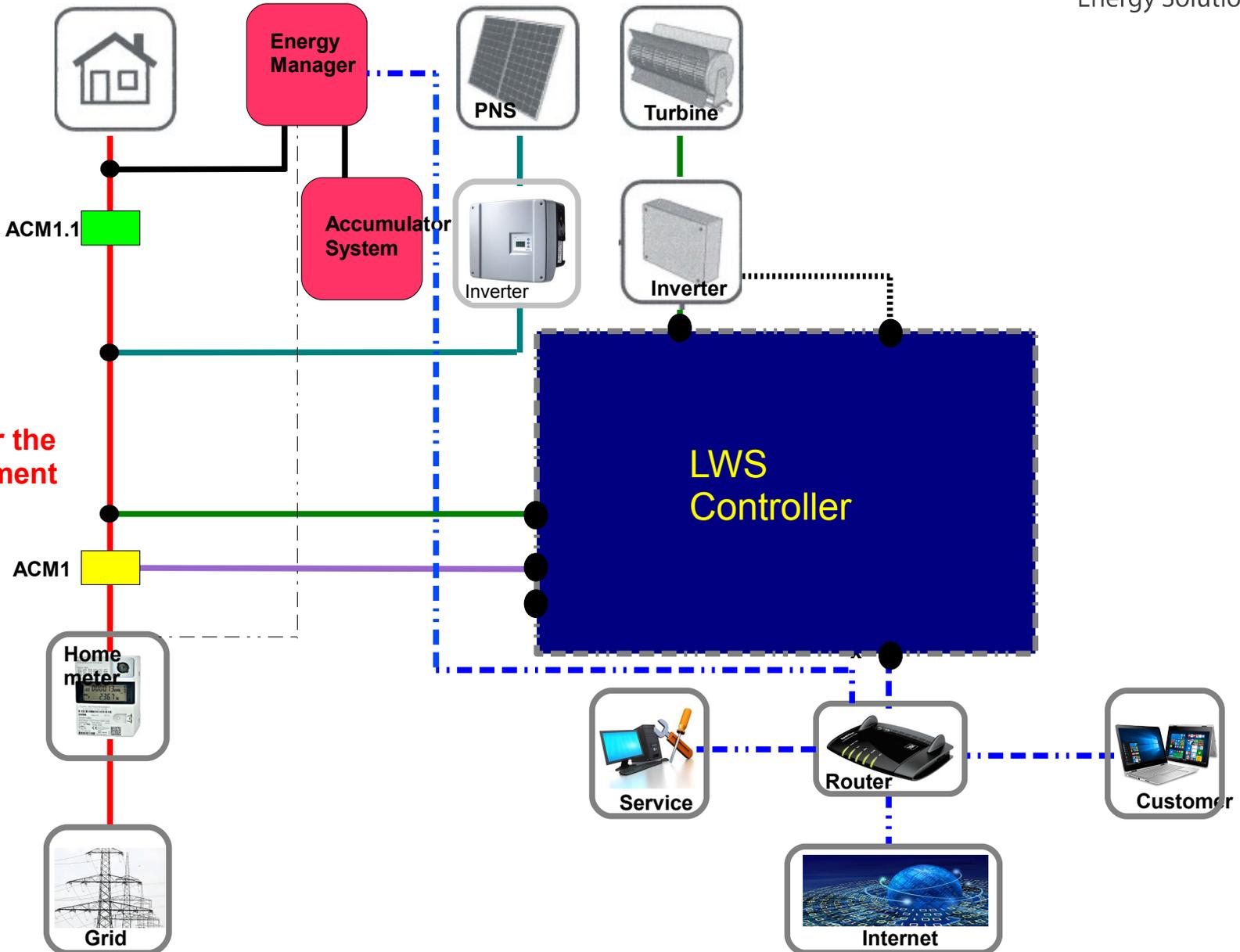


### 3.6.3 - Systems diagram mixed operation photovoltaics & wind



**!! Official meters may be necessary for the production measurement !**

### 3.6.4 - Systems diagram mixed operation photovoltaics & wind & accumulator



**!! Official meters may be necessary for the production measurement !**

### 4.1 Safety instructions



If an accident occurs, the weight of the inverter can cause injuries. Therefore, protective measures must be taken and wearing safety gloves and safety boots are mandatory.

Furthermore, only proceed with the installation if your health allows you to do so!

### 4.2 Assembly information:

The mounting location and type of attachment must be suitable for the inverter. LWS inverters are usually delivered together with the wind turbine.

**The inverter is “NOT” suitable for outdoor use.**

**However, if using an additional external enclosure, the inverter may also be mounted outside.**

Please ensure that the additional enclosure has the appropriate ventilation, as the inverter has an automatic ventilation system. A heat buildup will destroy the inverter.

### Particular attention to the following instructions is strongly advised:

- \* Sufficient load capacity of the mounting surface and fasteners must be ensured.
- \* Do not expose the inverter to direct sunlight in order to avoid a power reduction due to overheating.
- \* Do not expose the inverter to stagnant water, include cable drip loops along the wiring/cabling.
- \* Avoid permanently high humidity and condensation.
- \* If the inverter is installed in a residential area, pay attention to vibration-damping underground, because the inverter develops noises during operation which can be annoying.
- \* During the installation, maintain the minimum clearances and keep other objects away from the units in order to allow sufficient convection cooling.



## 4.2.1 Installation

Before starting work...



### **Tools and materials on-site/Installer/Technician**

The following tools and materials must be provided by the technician:

#### **Turbines & Inverter Connection:**

1. 6 - Butt connectors 6 mm<sup>2</sup>
2. 6 - Butt connectors 4 mm<sup>2</sup>
3. suitable crimping pliers for butt connectors
4. Alternatively: 6 - MC4 sockets, MC4 plugs with corresponding tool, each
5. Cable from the inverter to the turbine according to the calculation (4mm<sup>2</sup> / 6mm<sup>2</sup> / 10mm<sup>2</sup>), depending on the length
6. M6 dowel with matching screws for the substrate
7. Cable duct, recommended size 60 x 40; if using MC4 system, a larger size may be required
8. Automatic circuit breaker B6A, based on the number of inverters used (alternatively B16A)
9. If necessary, use a RCD switch 0.003 for the entire inverter circuit (observe regulations!)
10. 1 x 10mm<sup>2</sup> wiring material for meter cabinet or UV
11. Micro fuses 10 A/250 V AC

#### **Measuring, testing & labelling:**

1. Multimeter AC 230 V/380 V + AC 10 A + DC 0 - 200 V + DC 10 A
2. Current clamp AC/DC
3. possibly a second multimeter for AC measurement 0 - 230 V (for turbine testing)
4. Labelling device
5. Shrink tubing, different varieties 12.7 mm/9.5 mm/6.4 mm
6. Dryer
7. Electrical tape
8. Cable ties, different varieties
9. Compass
10. Anemometer



## 4.2.2 Installation log Sample



Installation date : \_\_\_\_\_

Technician: \_\_\_\_\_

Order No.: \_\_\_\_\_

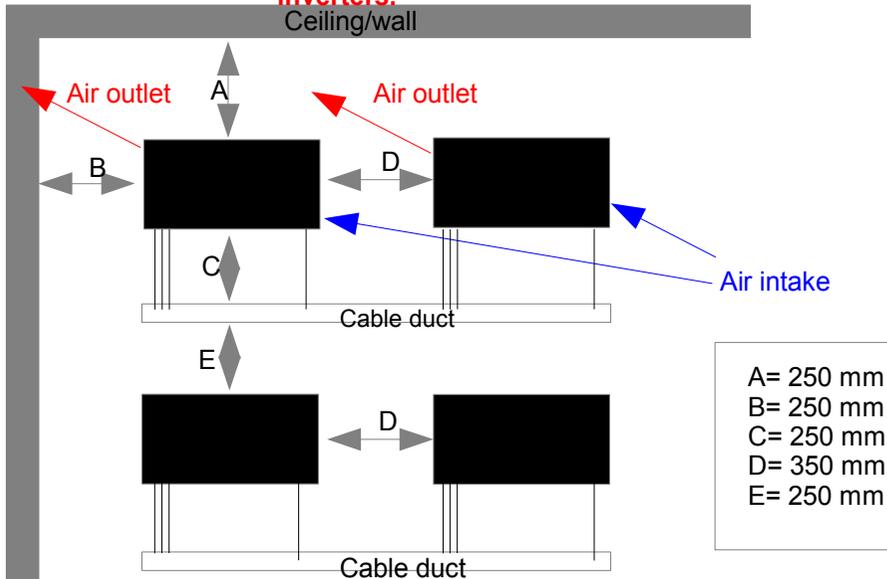
<b>Customer:</b> _____ Postcode, city ____/_____ Street: _____ Telephone: _____ Mail: _____	<b>Number of wind turbines:</b> _____ Type 300 W ____ Type 500 W ____ <b>Number of inverters:</b> _____ Type 300 W: ____ Type 500 W ____ <b>Photovoltaic (PV) module available:</b> _____ kW/P: ____ <b>Accumulator available</b> _____ kW: ____ <b>WP available:</b> _____ Type ____
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Wind speed measurement was done before installation? Yes No: \_\_\_\_\_ Running time of measurement?: \_\_\_\_\_ days  
 Used measuring instrument(s): \_\_\_\_\_ Measurement protocol available?: \_\_\_\_\_ yes/no

	Name plate	Inverter name plate				Service display or measurement			
Pos	Turbine type	Inverter type	Series No	Software	Characteristics curve:	Grid: (V)	Volt (IN)	Power(OUT)	OK? - Remark
001									
002									
003									
004									
005									
006									

Date: \_\_\_\_\_ Technician \_\_\_\_\_ Place: \_\_\_\_\_ Customer: \_\_\_\_\_

**In order to attach the inverters, only use the mounting holes located in the floor of the inverters.**



Always mount and operate the device so that the connections point downward!



Avoid installations near water pipes.

Avoid heat sources in the immediate vicinity of the inverter

### Installation instructions

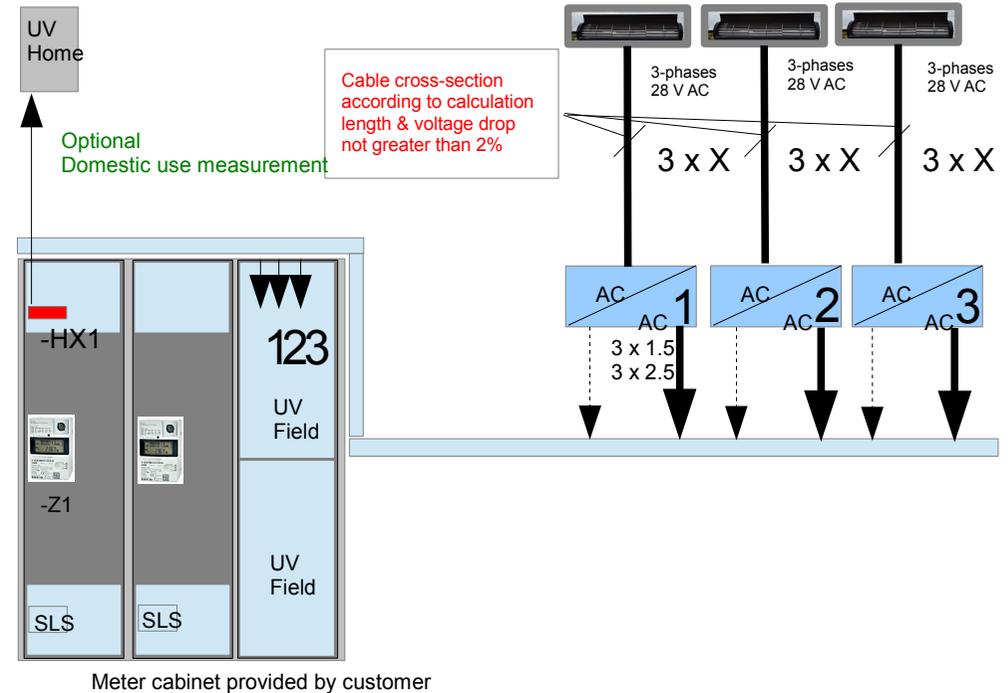
The mounting location and type of attachment must be suitable for the inverter. LWS inverters are usually delivered together with the wind turbine.

**The inverter is "NOT" suitable for outdoor use.**

**However, if using an additional external enclosure, the inverter may also be mounted outside.**

Please ensure that the additional enclosure has the appropriate ventilation, as the inverter has an automatic ventilation system.

**A heat buildup will destroy the inverter!**



**Particular attention to the following instructions is strongly advised**



- \* Sufficient load capacity of the mounting surface and fasteners must be ensured.
- \* Do not expose the inverter to direct sunlight in order to avoid a power reduction due to overheating. Avoid overheating of the device.
- \* Do not expose the inverter to stagnant water, include cable drip loops along the wiring/cabling.
- \* Avoid permanently high humidity and condensation.
- \* If the inverter is installed in a residential area, pay attention to vibration-damping underground, because the inverter develops noises during operation which can be annoying.
- \* During the installation, maintain the minimum clearances and keep other objects away from the units in order to allow sufficient convection cooling.

### 5. Electrical connection

When connecting the inverter to the AC mains, compliance with the connection conditions of the network operator is mandatory! In general, compliance with the applicable electrical rules and regulations as well as the valid electrical standards in the country of installation (VDE in Germany) is mandatory

#### 5.1 Safety equipment

The inputs and outputs meet the requirements of the overvoltage category 2 with regard to lightning protection, and overvoltage category 3 (surge arrester). When integrating the wind turbine into the building's lightning protection, the installation of a category 1 surge arrester is recommended.

With regard to the galvanic isolation between the inverter generator input and the network output, the requirements for clearance and creepage distances according to VDE0750-1 according to IEC60601-1 are met.

The connecting cable of the inverter must be protected with a circuit breaker. It is highly recommended to use fuses with max. 16 amperes and tripping characteristics B or C.

#### Our recommendation: B6A fuse



#### Caution:

Only VDE- and CE-compliant circuit breakers must be used!  
The grading and selectivity of the protective devices must comply with the relevant rules and standards!

### 5.2 Assignment of the AC cable - Mains connection - Grid - 230 V

The maximum conductor cross-section for the AC connection is 2.5 mm.  
Depending on the cable length, the responsible electrician must calculate the correct dimensioning.  
Compliance with the current regulations is mandatory.

**L1** → black (phase)

**N** → blue (neutral conductor)

**PE** → green/yellow (protective conductor)



**It is mandatory to connect the protective conductor.**



**Mains connection L/N/PE  
230 V AC**

### 5.3 DC connection (optional only type: P)

The connection cables of the inverter must be connected to the electrical generator of the turbine and the solar modules.  
Only use suitable splash-proof plugs or enclosures with clamps. If necessary, these must be extended. Ensure to use an equivalent cable with at least the same cross-section.

### 6 Communication

#### a) RS interface - WLAN

The HF-500-230-V1.X (higher than 1.01 series) wind inverters are equipped with a single communication interface (RS485) in order to connect a dedicated data acquisition system.

\* optional accessory (wireless interface) for data transfer

#### b) Service Display - CAT5 interface

The system uses a CAT5 socket in order to connect to the service display.

\* Service display can be plugged in

RS for  
WLAN  
module



Service Display

**! Caution! Do not attempt to connect the service display with the ROUTER or the network. Non-compliance can destroy the inverter!**

# 7. Initial start-up

## The steps/Initial startup/Inspection

1. The turbines are installed and connected on the assembly site

2. Install the inverter(s) in the designated assembly location  
 . Compliance with the installation instructions is mandatory!

3. Connect the turbines to the 3-phase connection of the inverter  
 ! The sequence is irrelevant.

**At this point, the inverter must not be connected to the mains voltage!**



4. Connect the IEC connector to the supply lead that was pulled from the meter cabinet or the sub-distributor.  
 Insert the IEC socket into the IEC connector on the inverter

**! Ensure that the power is still disconnected!**



5. Check that the connections in the sub-distribution or meter cabinet are all properly wired.

6. Also check all connections to and/or from the turbines.

7. When all connections have been inspected, switch on the appropriate circuit breakers.

8. The system is now ready. There are no settings required on the inverter.



9. Complete the installation log.

10. Take a photograph of the installation of the inverters & turbines

11. Send this information to the installation e-mail for trade partners (see contact details)

### Accessories

! Use only the spare parts and accessories supplied or released by us. The use of unauthorised replacement parts and accessories may affect the function and safety of the device.

### Check the function!

A) If all connections are correct, check the fan on the right-hand side of the inverter whether a blue LED light can be seen.  
 If a blue LED light can be seen, the inverter has performed the mains synchronisation and will start working as soon as sufficient input voltage is available.

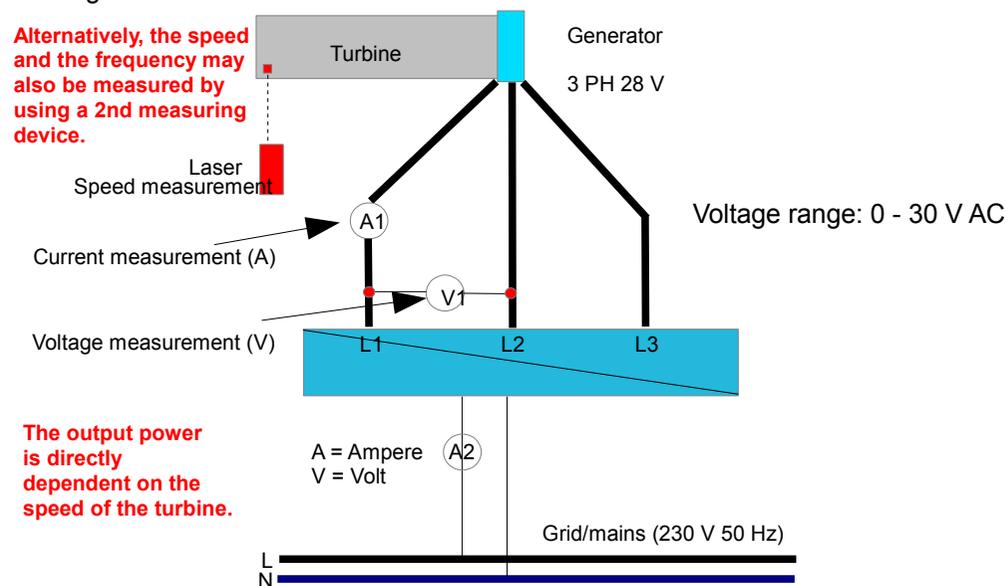
B) Now, the "Service Display" on the inverter can be plugged in (see overview) and the current data such as:

- mains voltage:
- input voltage of the turbine after conversion to volts
- the mains frequency

can be see. or...

C) manually, by "simply" checking the measurement according to the wiring diagram.

**Alternatively, the speed and the frequency may also be measured by using a 2nd measuring device.**



**The output power is directly dependent on the speed of the turbine.**

**The output of the inverter is activated at approx. 16 V AC at the inlet. This requires a corresponding speed of the turbine.**



**Never attempt to repair the inverter.**

The device does not contain any components that can be serviced and/or repaired by the user. Contact the factory's customer service department or the appropriate dealership. Subsequently, an RMA (Return material Authorization) or a ticket number will be issued in order to handle the malfunction

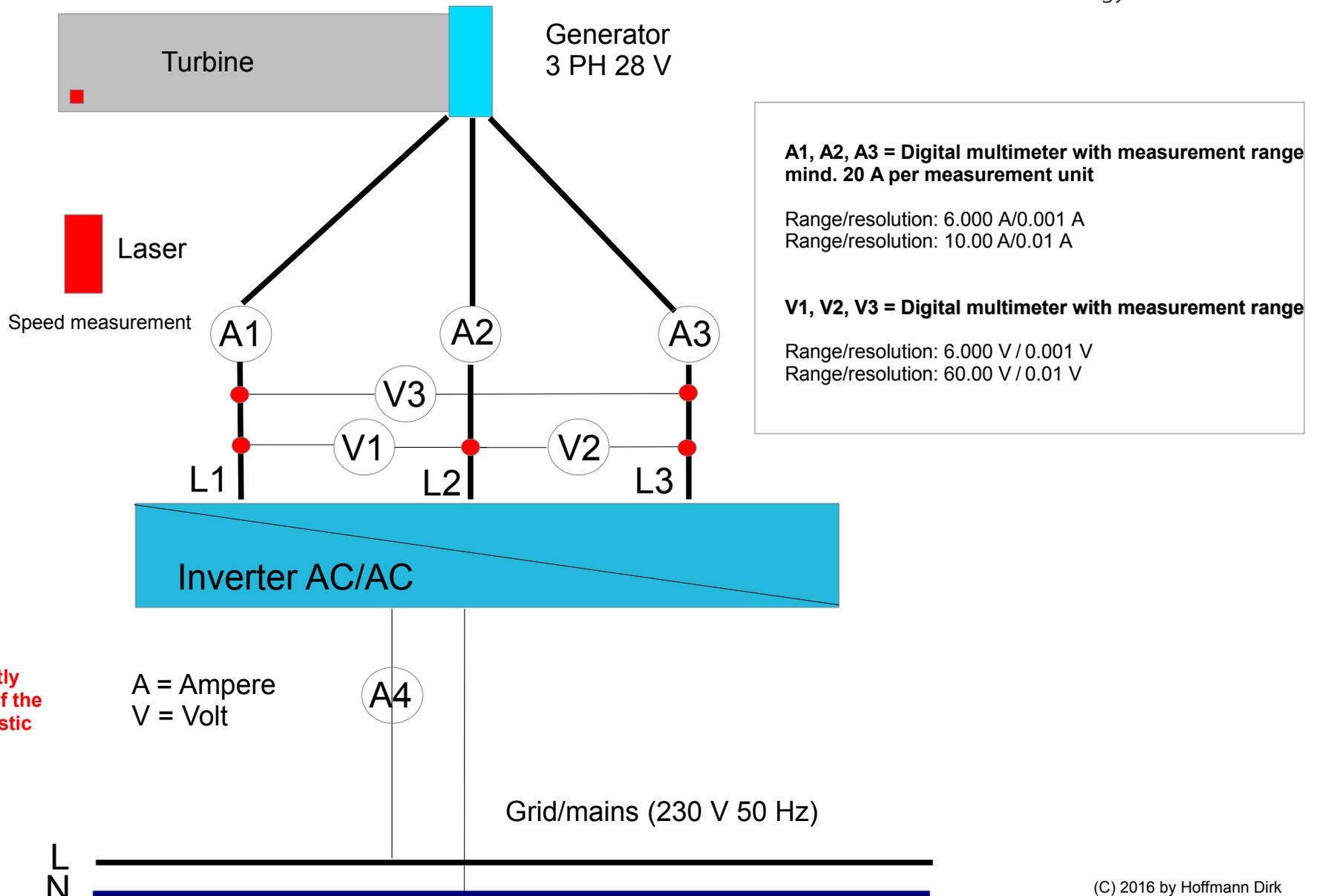
**Never attempt to disconnect the input cables of the turbine or the PV modules when connected to the power.**

**The following errors are displayed on the start page via the "Display" service:**

- 1) Excess temperature The inverter stops all functions if the inside temperature reaches 75°C.
- 2) Input voltage too low: The supplied voltage at the AC input is too low, the RPM of the turbine is insufficient
- 3) Input voltage too high: The turbine speed (RPM) is too high and may require to be re-configured or set to DUMP load.
- 4) Grid Error: The connection to the grid is interrupted

### 7.3 Troubleshooting measurement

**The steps to be taken before calling the service : Measure the work range!**



# 7.4 Troubleshooting measurement protocol

Measurement protocol -sample

Messprotokoll für LWS Turbinen und Systeme



Datum:

Monteur:

Kunde:

PLZ/Ort:

Inverter Ser-Nr:

Inverter Typ:

Pos	Drehzahl / RPM Turbine				Spannung(V)-Voltage Turbine		Strom(A)- Current Turbine			Inverter Ausgang Output AC	
	RPM Messung	Frequenz Hz AC	Faktor	RPM	Volt AC L1-L2	L2-L3	Ampere AC L1	L2	L3	Spannung Voltage	Strom Current
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											

**Bemerkungen:**

Ort \_\_\_\_\_ Datum \_\_\_\_\_ Monteur \_\_\_\_\_

## 8. Decommissioning



### 8 Decommissioning

The device must be switched off the power immediately if the following situations occur:

- // The housing is damaged
- // Water has permeated the housing
- // There are objects inside the housing or there are loose objects in it.
- // Smoke is emitting from the housing.
- // The mains cable is damaged
- // The turbine supply line is damaged

#### **In this case, proceed as follows:**

1. Turn off the pre-fuse of the device.
2. Disconnect the plug of the mains supply cable and the plugs of the supply lines from the device.
3. If necessary, contact the dealership.
4. Create a log
5. Send the defective device incl. a copy of the log to the manufacturer or your dealership

## 8. Decommissioning

### 8.1 Exchanging the inverter

If the inverter is defective, do not attempt to repair it. Instead, report the defect to your dealership and have a replacement device sent to you.

How to change the inverter correctly:

1. Start by switching off the mains fuse and disconnecting the power plug
2. Disconnect the old device by unplugging all connectors
3. Loosen the brackets and remove the inverter
4. Install the new inverter
5. Restore the connectors. Start with the mains plug first!
6. Only switch on the mains fuse at the end!



#### **Packaging instructions:**

If possible, always use in the original packaging for the transport or choose an equivalent packaging method that is suitable for the size and weight of the device!

### 8.2 Disposal

At the end of the device's service life, dispose of the LWS wind inverter according to the current e-waste disposal regulations or return the device to the dealership.

### Technical data (V1.0) :

Input type: AC 3 PH  
Input range: 13 - 35 V AC  
Input current max: 20 A  
Input power max: 650 W  
Input max voltage: 35 V AC

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Output type: AC 1-phase  
Output voltage: 230 V  
Output voltage range: 190 - 260 V

Output current max: 4.5 A  
Output frequency: 47 to 51.5 Hz

Output signal: pure sine wave

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Working temperature range: -20 to 45°C  
Temperature range inside: -20 to 70°C

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Certificate: VDE4105  
IEEE1547  
CE

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Cooling: yes-fan 2x  
Efficiency > 92%

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Over current protection: yes  
Over temp. protection: yes  
Revers polarity protection: yes  
Anti-island protection: yes

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RS485: yes for Service

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Programable characteristics curve yes  
Special features Password protected  
Brake/DumpLoad yes optional  
Brake programmable yes/ON/OFF/Value

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L x W x H 323 x 132 x 86  
Weight: 4.2 kg  
Protection type: IP30



## Legal information – Contacts



### Turbines & Accessories

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### Inverter & Accessories

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