Hybrid Renewable Energy Trainer

HRET- full version - Wind energy, Solar energy, Hydrogen
Modular System of 5 versions

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System designed for technical colleges, universities and other technical/scientific training institutions to perform experiments on solar energy, wind energy and hydrogen/fuel cell technology.

The planned activities are suitable for both basic and advanced levels of training and are designed with user safety in mind in compliance with current standards.

The system consists of modules that can be easily inserted or removed, depending on the type of activity to be performed. The components used to produce the modules are the same as those used in normal industrial equipment.

The main structure consists of an aluminum frame approximately 180 high with a 110x60 cm work surface and three support bars for the modules to be used in the experiments; the modules are interlocking, so that modification of the system is quick and easy. The connections between modules are made with the supplied cables, so that the connections are clearly visible to the students.

A second structure allows modules not needed for the task at hand to be neatly stored.

Two separate structures house the solar module with two 10 W polycrystalline panels with spotlights to simulate solar lighting and the wind turbine simulator driven by a 150 W DC motor.

The accompanying software requires a computer (not included) with Windows 10 operating system or higher, at least 4 GB RAM, i3-class processor or higher.

Solar energy experiments

- The photovoltaic panel
- Open-circuit voltage measurement
- Short-circuit current measurement
- Current-voltage characteristic
- Daily trend in panel voltage without load
- Daily trend in panel voltage under load
- Seasonal trend of panel voltage without load
- Seasonal trend of panel voltage under load
- Series-connected photovoltaic panels
- Examination of photovoltaic panels connected in parallel
- Examination of the photovoltaic panel simulator
- Examination of the effect of shading on photovoltaic panels
- Examination of bypass diode operation
- Examination of the effect of asymmetry on photovoltaic panels
- Examination of the effect of the blocking diode on photovoltaic panels
- Examination of the photovoltaic panel emulator
- Experiments on photovoltaic systems
- Direct load connection of photovoltaic panels
- Off-grid inverter start-up (without load)
- Installation of a basic photovoltaic system (DC load)
- Installation of a basic photovoltaic system (AC load)
- Examination of the output signal of the off-grid inverter with the data acquisition module
- Measurement of the output signal of the off-grid inverter with the energy analysis module
- Measurement of energy absorbed by the off-grid inverter
- Measurement of power output and efficiency of the off-grid inverter
- SCADA application of the off-grid inverter
- Examination of on-grid inverter

Wind energy experiments

- Examination of the relationship between turbine speed and output voltage (no load)
- Examination of the relationship between turbine speed and output voltage (under load operation)
- Examination of the effect of the turbine controller on the relationship between turbine speed and output voltage (no load)
- Examination of the effect of the turbine controller on the relationship between turbine speed and output voltage (under load)
- Examination of turbine output voltage
- Examination of the turbine output voltage with the data acquisition module
- Examination of a wind power system

Experiments on Hydrogen technology and Fuel Cells

- Examination of fuel cell output voltage with an oscilloscope
- Examination of fuel cell output voltage with data acquisition

Solar panel emulator

- Operating voltage: 88÷264 Vac, 47÷63 Hz
- Output voltage 20 V
- Short-circuit current 2 A
- Connection of bypass diode
- Connection of blocking diode
- Connections via 4 mm safety bushings

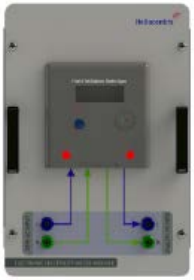
Solar charge controller

- Input voltage 12 V/24 V with automatic switching
- Charge/discharge current 10 A
- Battery, solar, DC load connection terminals
- Connections via 4 mm safety bushings

on-grid inverter

- Input voltage 12 Vdc
- Output voltage 230 Vac
- Input current 4 A max
- Output power 300 W
- Protection fuse
- Connections via 4 mm safety bushings

Electronic measuring instrument



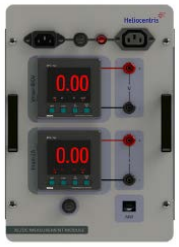
- Three phases
- Voltage 220/400 V
- Frequency 50 Hz
- Operating current 0.2 to 0.5 A
- Protection fuse
- Connections via 4 mm safety bushings

off-grid inverter module

Electronic potentiometer

- Touch screen
- Adjustable linear resistance 1÷1 kΩ, 100 W
- Adjustable to 1 Ω
- Various resistance levels and time intervals
- Connections via 4 mm safety bushings

AC/DC measurements



- Ammeter dc/ac 0÷5 A
- DC/AC voltmeter 0÷500 V
- Operating voltage 230 V, 50 Hz
- Connection to software via RS 485 port
- Connections via 4 mm safety bushings

220 Vac lamp

- -E27 or E14 lamp holder
- Low consumption bulb
- LED bulb
- Connections via 4 mm safety bushings

Solar panel with adjustable incidence

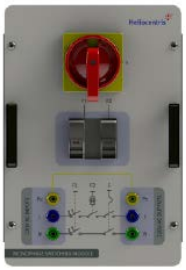
- 45x45 aluminum profile frame
- 2 x 10 W polycrystalline panels
- 3 different settings to simulate the position of the sun
- Position indicator
- 500 W projector
- Connections via 4 mm safety bushings

Lamp module 12 VDC

- Input voltage 12 Vdc
- Output voltage 230 Vac
- Sine output
- Output power 300 W
- Thermal and overload protection
  Short-circuit and reverse connection protection
- Connections via 4 mm safety bushings

- 20 W halogen lamp
- 2 W LED lamp
- Operating voltage 12 V
- Connections via 4 mm safety bushings

Modulo switching monofase



- Switch 0-1
- Loss of current and fuse protection
- Connections via 4 mm safety bushings

Accumulator module

- Maintenance-free
- Voltage 12 V
- Capacity 7 Ah
- Overcurrent protection
- Connections via 4 mm safety bushings

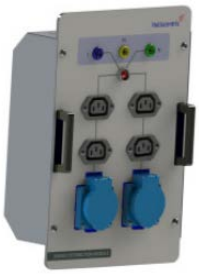
Wind turbine charge control module

- Nominal battery voltage 12/24 V
- Turbine breaking voltage 15/30 V
- Aluminum housing with cooling function
- Connections via 4 mm safety bushings

PC interface module

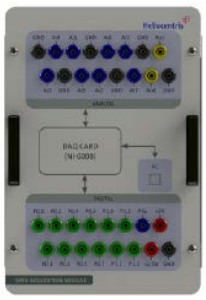
- IEC connector, lamp and fuse
- 2 independent analogue outputs for PC (0÷5 V)
- 1 USB output
- 2 RS 485 outputs
- 1 RS 232 output
- Connections via 4 mm safety bushings

Power distribution module



- 4 IEC sockets
- 2 industrial sockets with earth
- Connections via 4 mm safety bushings

Data acquisition module



- -8 analogue inputs (14 bit, 20 kS/s)
- 2 static analogue outputs (12 bit, 9.1 mV)
- 12 digital inputs/outputs
- Digital counter
- USB socket
- Connections via 4 mm safety bushings

Wind turbine module

- Power 200 W
- Aluminum body
- Driven by DC 150W motor
- Connections via 4 mm safety bushings

Wind simulator module

- IEC socket, fuse and indicator light
- Switch for manual/pC-controlled mode
- Manual or PC-controlled DC motor rpm setting
- 200 W power
- Connections via 4 mm safety bushings

Analogue measurement module

- Analogue ammeter 0÷5 A
- Analogue voltmeter 0÷20 V
- Connections via 4 mm safety bushings

Diode module

- 6 high-current diodes
- Connections via 4 mm safety bushings

Light source control module

- Manual or PC control Analogue input connector for manual control
- Output power 1000 W
- Connections via 4 mm safety bushings

AC energy analyser module

- Operating voltage 100÷240 Vac, 110-250 Vdc
- Input current 5 A
- Accuracy ±1%.
- IEC connector with fuse and indicator light
- PC connector
- Connections via 4 mm safety bushings

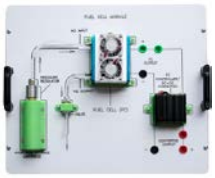
Isolated measuring module

- Measuring voltage 0÷500 V
- Scales 0÷500 V, 0÷50 V, 0÷5 V
- Measuring current 0÷5 A
- 2 channels
- IEC socket with fuse and indicator light
- Connections via 4 mm safety bushings

Linear potentiometer module

- 0÷1 kΩ
- 0÷50 Ω max 6 A
- 51÷200 Ω max 2 A 201÷1000 Ω max 0.6 A
- Connections via 4 mm safety bushings

Fuel cell module



- Nominal cell power: 30 W
- 14 cells
- Rated performance: 8.4 V; 3.6 A
- Venting valve voltage: 6 V
- an voltage: 5 V
- Hydrogen pressure: 0.45÷0.55 bar
- Maximum gas flow: 0.42 L/min
- Hydrogen purity: 99.995%.
- Efficiency min. 39% at full speed
- Connections via 4 mm safety bushings

Electronic load module

- Touch screen
- Power 100 W
- Voltage and current can be set via touch screen
- Controllable via PC
- Connections via 4 mm safety bushings

DC power supply module

- -Adjustable 0÷30 V power supply with short-circuit and overload protection
- Adjustable current 0÷5 A
- Colour LCD display shows instantaneous current, voltage and power values
- -Connections via 4 mm safety bushings

AC/DC measuring module

- Ammeter (0÷5 A ac/dc)
- Voltmeter (0÷500 V ac/dc)
- Supply voltage 230 Vac, 50 Hz
- Connection to software via RS 485
- LCD screen
- Connections via 4 mm safety bushings

Solar panel emulator module

- -Operating voltage 88_264 Vac, 47÷63 Hz
- Output voltage 20 V
- Short-circuit current: 2 A
- Connection for bypass diode and blocking diode
- Connections via 4 mm safety bushings

Solar charge controller module

- Automatic 12/24 V input switching
- Charge and discharge current 10 A
- Terminals for solar/battery/DC charge connection
- Connections via 4 mm safety bushings

description of modules	Item 2010 solar	Item 2020 wind	Item 2040 solar wind	Item 2050 solar H2 fuel Cell	Item 2000 solar wind H2 fuel Cell
Main frame with shelf and monitor	●	●	●	●	●
Support structure with cable carrier	●	●	●	●	●
Solar panel module with light source (Photovoltaic panel - light source)	●	-	●	●	●
Wind turbine module	-	●	●	-	●
Monophase switching module Energy Distribution Module	●	●	●	●	●
Energy Distribution Module	●	●	●	●	●
Accumulator module	●	●	●	●	●
Analogic measurement module	●	●	●	●	●
AC/DC measurement module	●	●	●	●	●
Potentiometer module	●	●	●	●	●
Lamp module 12 Vdc	●	●	●	●	●
(Lamp module 220 Vac	●	●	●	●	●
AC energy analyzer module	●	●	●	●	●
Isolated measurement module	●	●	●	●	●
Data acquisition module	●	●	●	●	●
PC interface module	●	●	●	●	●
Wind Simulator module	-	●	●	-	●
Light source control module	●	-	●	●	●
Solar charge regulator module	●	-	●	●	●
Wind turbine charge control module	-	●	●	-	●
Off grid inverter module	●	●	●	●	●
On grid inverter module	●	●	●	●	●
Electronic potentiometer module	●	●	●	●	●
Solar panel simulator modul 2x	●	-	●	●	●
Diode Module	●	-	●	●	●
Electronic load module	●	●	●	●	●
Electronic electricity meter module	●	-	●	●	●
DC power supply					
Fuel cell module	-	-	-	●	●
Cable set	●	●	●	●	●
Software (on USB stick)	●	●	●	●	●