COMPLETE PACK FOR THE STUDY OF SOLAR, WIND AND HYBRID ENERGY

ref. PACK-SOLEOL-1 (included item A + B + C + D + E)

SUPPLIED WITH TEACHING RESOURCES STUDENT & TEACHER

Bluetooth®

FULL DESCRIPTION OF ALL ITEMS INCLUDED IN PACK-SOLEOL-1, SEE NEXT PAGE.

ITEM A
ELECTRICAL CABINET

ITEM B
PHOTOVOLTAIC SOLAR PANELS + PYRANOMETER

ITEM C
3-PHASE WIND TURBINE 400W

ITEM D
LOADING ZONE

ITEM E
CONVERSION OF RENEWABLE ENERGY

4 COMPLETE STUDIES POSSIBLE DEPENDING ON THE COMBINATION OF ITEMS SUPPLIED

STUDY N°1

ITEMS A + B +D
SOLAR CENTRAL UNIT WITH NETWORK INJECTION & ISOLATED SITE
DETAILS FOLLOWING PAGES

STUDY N°2

ITEMS A + C + D
WIND TURBINE CENTRAL UNIT WITH NETWORK INJECTION & ISOLATED SITE
DETAILS FOLLOWING PAGES

STUDY N°3

ITEMS A + B + C + D
HYBRID CENTRAL UNIT WITH NETWORK INJECTION & ISOLATED SITE
DETAILS FOLLOWING PAGES

STUDY N°4

ITEMS C + E
RENEWABLE ENERGY CONVERSION
DETAILS FOLLOWING PAGES

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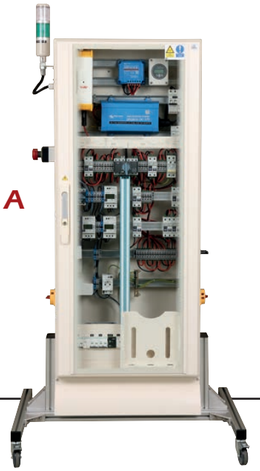
FULL DESCRIPTION OF ALL ITEMS INCLUDED IN PACK-SOLEOL-1



ITEM A

ITEM A. ELECTRICAL CABINET

Technical cabinet of standardized solar central unit on wheeled frame.
Dimensions: 810 x 600 x 1890mm

Comprises

- 2 disconnectors
- 1 500mA -30A differential
- 1 30mA differential
- 1 lightning arrester + fuses
- 3 100 Wh resolution meters
- 1 Mushroom head emergency stop
- 1 source inverter
- 1 charging controller 12/24VDC-15A
- 2 batteries 12V-14Ah
- 1 set of photovoltaic connectors
- 1 500W inverter for network synchronisation
- 1 Voltage converter 24VDC/230VAC-375W

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Requires download in Play Store or Apple Store the free application "Victron Energy".
Display on tablet or Smartphone:
- Voltage – Current of the panel / Power (W)
- Voltage – Current of the battery / Charge current
- On-Off state charge

PARTIAL OR TOTAL RESALE OPERATION

In the cabinet, a DC/AC inverter converts the DC from the photovoltaic panels and/or the wind turbine to AC 220VAC 50Hz, and injects its power in synchronism into the electrical grid. This inverter is protected against any polarity reversal and overload on the DC or AC side. When the panels are not lit, the inverter consumes no current.

Technical characteristics for the inverter coupled to the electrical grid.

INVERTER	Voltage	Max current	Power
INPUT	65~125VDC	8A	
OUTPUT	230VAC-50Hz	2,25A	500W

OPERATION IN ISOLATED SITE WITH NO RESALE

The photovoltaic and/or thewind turbine current charges two 12V sealed batteries coupled in series through a charge controller. This DC voltage is either available on safety terminals at the rear of the cabinet or converted to 250VAC 50Hz by a 200W voltage converter.

Technical characteristics of converter for isolated site.

VOLTAGE CONVERTER	Voltage	Max Current	Power
INPUT	20~32 VDC	11A	210W
OUTPUT	230VAC 50Hz	1,5A	300VA

ITEM B

ITEM B TWO PHOTOVOLTAIC SOLAR PANELS 200WC (FOR EACH PANEL) ON TILTING FRAME WITH LINK CABLE AND PYRANOMETER

- Open circuit voltage: 46V DC
- Short-circuit current: 6;3A
- Optimum operating voltage: 37V DC
- Optimum operating current: 5;7A
- Maximum power: 215Wc (variation of ± 10% depending on the series)
- Sealed connections IP65 – 1000V on the rear of the panel.
- Type of cells: Monocrystalline silicon
- Robust aluminium frame.
- Useful surface area of the cells 1.5m².
- Output 37VDC – 5;7A – 200Wc per panel on 2 photovoltaic terminals.
- Device for measuring the tilt angle
- Tilt adjustable from 5° to 70°
- Two ball joints with clamping levers for positioning the panel to the required tilt angle.
- Light and easy to move.
  Folded position: 1620 x 1060 x 100mm
  Unfolded to 70° position: 2100 x 1060 x 700mm
- 30-m cable for connecting the solar panels to any type of solar system.
- 1 pyranometer measures the power of solar radiation in W per m2: W / m2

ITEM D

ITEM D LOADING ZONE FOR NETWORK INJECTION AND ISOLATED SITE

Wheeled frame which reproduces domestic electrical installations on a vertical panel and enables the use of the voltage sources (AC + DC) produced by the solar central unit. Dimensions: 1000 x 500 x h 1600mm
The frame is supplied assembled, fully cabled, ready to operate, with safety leads for the measuring units, technical data and cabling diagram.

LEFT PART: LOADING ZONE FOR ISOLATED SITE USE

This part includes a standard unit with standardized protection described below, and the different loads.

- 1 differential circuit-breaker 16A/30mA
- 1 two-pole fuse holder with fuse cartridges gPV 10x38 1000V
- 2 24V DC low energy consumption light fittings with switches
- 2 light fittings 230VAC with switches
- 1 230VAC 50Hz 2P+E socket
- 1 mimic unit with safety terminals for I and U measurements in different circuits.

RIGHT PART: LOADING ZONE FOR USE ON SITE WITH ELECTRICITY NETWORK

This part includes a standard unit with standardized protection described below, and the different loads.

- 1 connection circuit-breaker 500mA
- 1 differential circuit-breaker 16A/30mA
- 3 thermal-magnetic circuit breakers
- 2 light fittings 60W-230VAC with switches
- 1 500W convector
- 1 230VAC 50Hz 2P+E socket
- 1 mimic unit with safety terminals for I and U measurements in different circuits.

ITEM C

ITEM C 3-PHASE WIND TURBINE 400W

Wind turbine features

- Three-phase output 3 x 85V AC - 400W at 440 rpm on safety terminals.
- Direct current output 110V DC - 400W at 440 rpm on safety terminals.
- Selection of these outputs by using an included rectifier or by direct connection.

Features of the wind simulation

- Squirrel-cage three-phase asynchronous motor.
- Speed controller simulating wind turbine speed 0-440 rpm.
- Using the supplied SOMOVE software, the PC operations are:
  - Acceleration of the wind speed.
  - Deceleration of the wind speed.

General features

- Wheeled frame with brakes
- Overall dimensions: 750 x 670 x (h) 1500 mm
- Top cover made with aluminium frame and Lexan sides (translucent and unbreakable).
- Power supply 2P+N+E 230V AC - 50/60 Hz (5m lead with mains plug)
- Supplied with: Practical assignments in the form of measurements/tests; RJ45-USB cable for linking between the speed controller and the PC. **Schneider® SoMove software.**

ITEM E

ITEM E CONVERSION OF RENEWABLE ENERGY

This converter operates on the same principle as an industrial model. It treats the electrical power supplied by a wind turbine. The output cannot be synchronized with the network but can be used in isolated site.

- The converter's synoptic, printed on the front, facilitates location of the components and measurement points.
- The three-phase voltage from the wind turbine is applied through 4 safety terminals Ø4mm. The wind turbine-to-converter interconnection is made using laboratory leads.
  Inputs between 80 and 120V three-phase.
- A main switch located on the top of the box, starts and stops the converter's power supply.
- Safety terminals Ø4mm located between each component enable the voltages and currents to be measured at each conversion step.
- A thermal-magnetic circuit-breaker protects the transformer primary against any overload.
- Output converter 500W/230V.
- A differential circuit-breaker 30mA protects the output to the use network cabled according to neutral system TT.
- Unit on casters dimensions: 700 x 500mm. Height 355mm
- Included, one rheostat 470Ω

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STUDY N°1 USING ITEM A + ITEM B + ITEM D: SOLAR CENTRAL UNIT WITH NETWORK INJECTION & ISOLATED SITE

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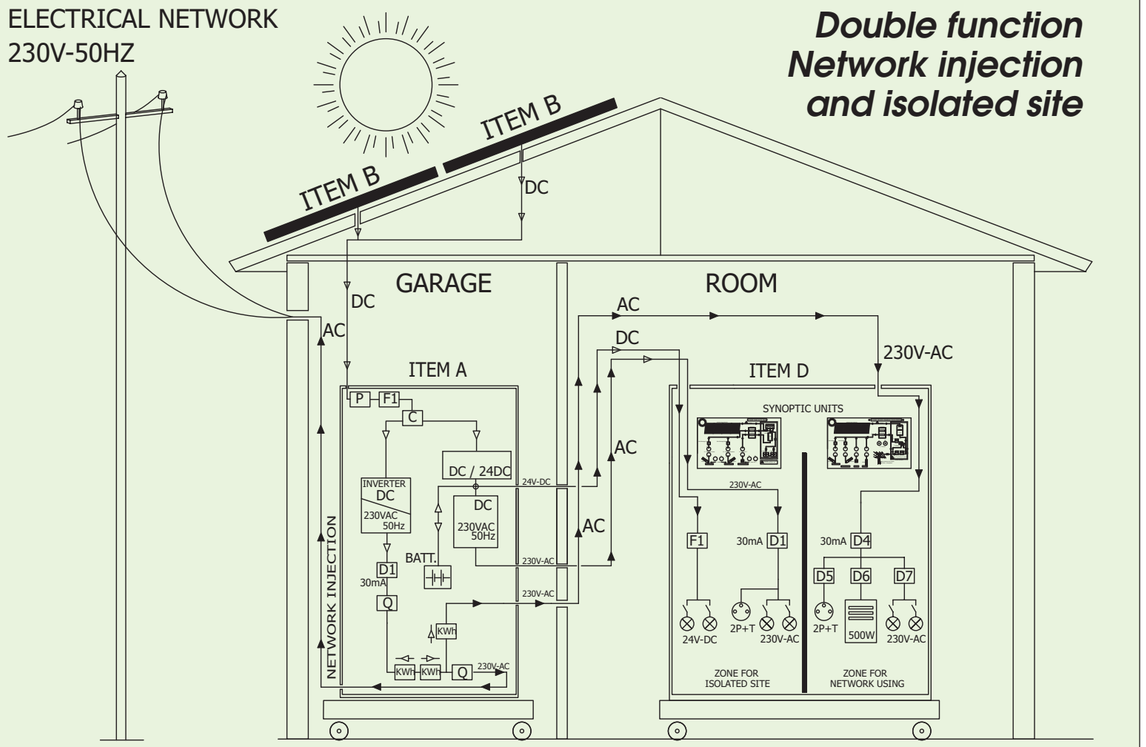
Requires download in Play Store or Apple Store the free application "Victron Energy".
Display on tablet or Smartphone:
- Voltage – Current of the panel / Power (W)
- Voltage – Current of the battery / Charge current
- On-Off state charge



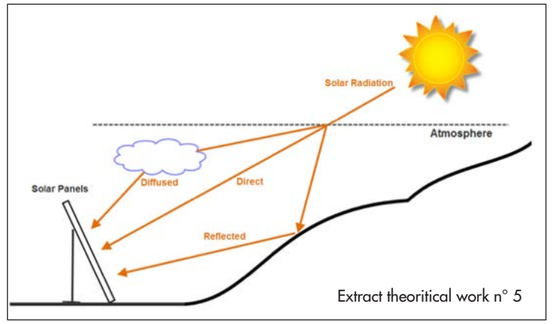
Double function Network injection and isolated site

EDUCATIONAL OBJECTIVES

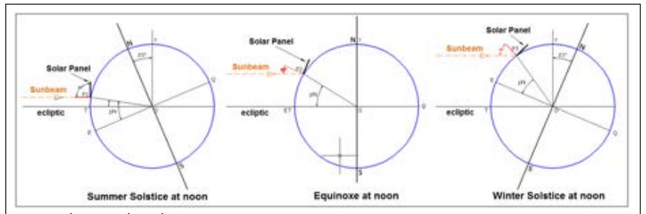
- Understand the different elements of a photovoltaic system.
- Understand the safety components involved in the system.
- Electrical measurements of different parameters.
- Analyz and interpret results.
- Studying the efficiency and impacts related to the positioning of the solar panels.
- Studying the chain of solar energy (production, storage, consumption, resale, energetic behavior).
- Wiring of a photovoltaic system.

THEORETICAL WORK IN TEACHER / STUDENT FORM

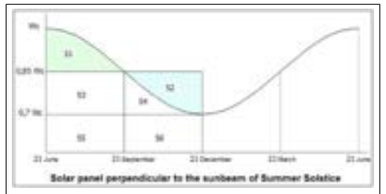
1 - Advantages, disadvantages between different types of amorphous, polycrystalline, monocrystalline photovoltaic cells.
2 - Study of the composition of a solar panel
3 - Study of the SERIAL / PARALLEL connection of two photovoltaic panels.
4 - Operating principle of a photovoltaic cell.
5 - Study of Direct / Diffused / Reflected solar radiation. SEE
6 - Study of the panel angle at the Equinox at Noon, Summer Solstice at Noon, and Winter Solstice at Noon. SEE
7 - Study of the panel tilt angle for optimal use in the mountains.
8 - Study of the panel tilt angle for optimal use by the sea.
9 - Calculation of the amount of energy captured according to the angle of inclination of the panel SEE



Extract theoritical work n° 5



Extract theoritical work n° 6



Extract theoritical work n° 9

PRACTICAL WORK IN TEACHER / STUDENT FORM

1 - Realization of the customer quote following the site study
2 - Identification of components in restitution mode and isolated site
3 - Creation of wiring diagrams
4 - Search for the best orientation of solar panels
5 - Electrical couplings of solar panels according to the chosen operating mode
6 - Wiring of photovoltaic components into the cabinet
7 - Tests with the load zone
8 - Readings of electrical quantities U / I panels, U / I inverter, U / I batteries, U / I use
9 - Calculation of the efficiency of the installation with calculation of the different electrical powers
10 - Analysis of the power values on the energy meters in the cabinet
11 - Calculation of the discharge time of the batteries according to the load
12 - Setting up the Bluetooth communication to compare the readings made with the measuring devices and the application
13 - Maintenance:
    - o System lock out for safety intervention in the electrical cabinet.
    - o Finding the fault
    - o Repair (change of fuses)
    - o Influence of the orientation of the solar panels on the efficiency of the installation

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STUDY N°2 USING ITEM A + ITEM C + ITEM D: WIND TURBINE CENTRAL UNIT WITH NETWORK INJECTION & ISOLATED SITE

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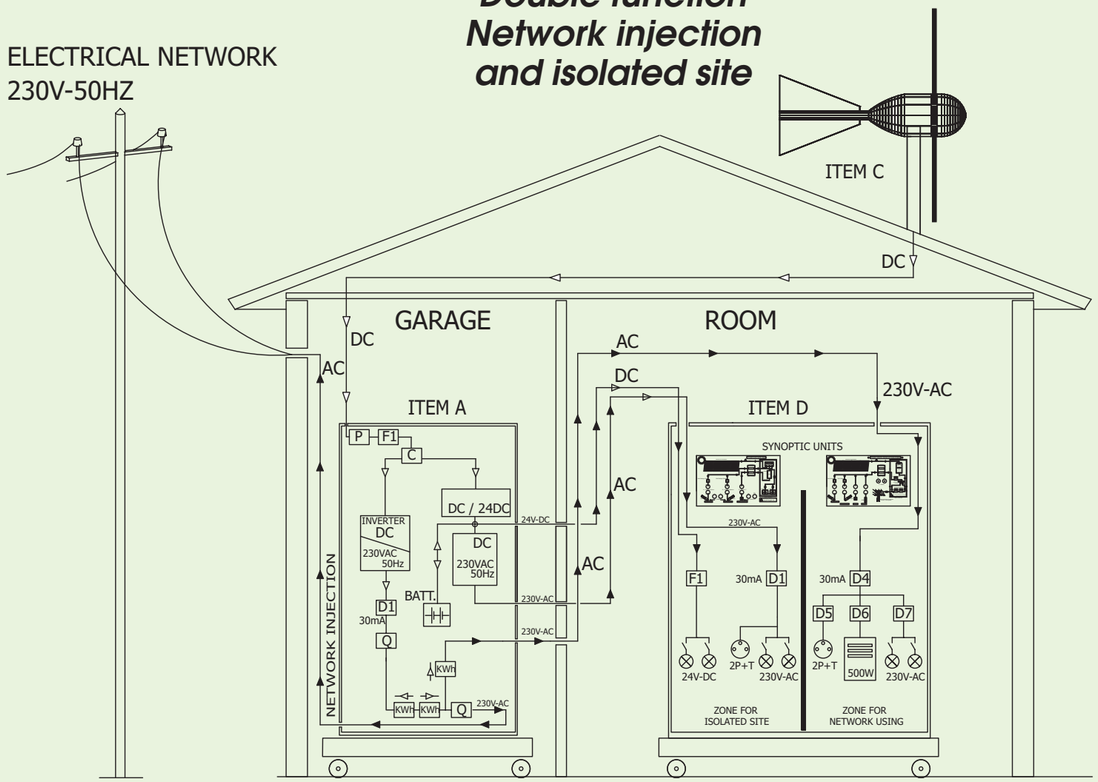
Requires download in Play Store or Apple Store the free application "Victron Energy".
Display on tablet or Smartphone:
- Voltage – Current of the panel / Power (W)
- Voltage – Current of the battery / Charge current
- On-Off state charge

ITEM A

ITEM C

ITEM D

Double function
Network injection
and isolated site



EDUCATIONAL OBJECTIVES

- Discover the different elements of a wind central unit
- Apprehend and understand the security elements present.
- Perform electrical measurements of the various quantities.
- Analyze & interpret the results.
- Study the efficiency and the effects linked to the speed of rotation of the wind turbine.
- Study the energy chain (production, storage, use, resale, energy behavior).
- Wire a wind turbine installation.
- Compare the energy powers between different energy consumers. (24V / 230V lamps, convector, etc.)

THEORETICAL WORK IN TEACHER / STUDENT FORM

1 - Study on the location of wind turbines in Portugal
2 - Study of the different components of the wind turbine
3 - Study of the power of a wind turbine according to its size
4 - Study of the energy production of a wind turbine as a function of the wind
5 - Calculation of characteristics and research of components following specifications defined by the customer.
6 - Realization of the estimate
7 - Identification of components in restitution mode and isolated site.

PRACTICAL WORK IN TEACHER / STUDENT FORM

1 - Creation of wiring diagrams
2 - Wiring of components in the cabinet
3 - Parameterization of the variable speed drive and control of the wind turbine.
4 - Tests with the load zone
5 - Readings of electrical quantities U / I wind turbine, U / I inverter, U / I batteries, U / I use
6 - Calculation of the efficiency of the installation with calculation of the different electrical powers
7 - Analysis of the power values on the energy meters in the cabinet
8 - Calculation of the discharge time of the batteries according to the load
9 - Setting up the Bluetooth communication to compare the readings between the measuring devices and the application
10 - Maintenance :
- o System lock out for safety intervention in the electrical cabinet.
- o Finding the fault
- o Repair (change of fuses)
- o Influence of the rotation speed of the wind turbine on the efficiency of the installation

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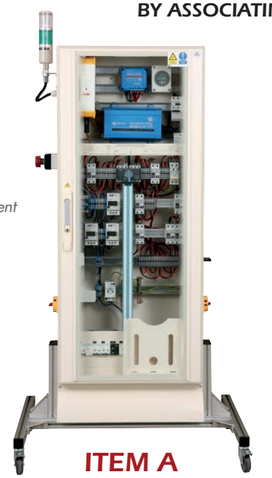
STUDY N°3 USING ITEM A + ITEM B + ITEM C + ITEM D: HYBRID CENTRAL UNIT WITH NETWORK INJECTION & ISOLATED SITE

PRACTICAL AND THEORETICAL WORKS POSSIBLE BY ASSOCIATING THE ELEMENTS A + B + C + D

Bluetooth®

Requires download in Play Store or Apple Store the free application "Victron Energy".
Display on tablet or Smartphone:
- Voltage – Current of the panel / Power (W)
- Voltage – Current of the battery / Charge current
- On-Off state charge

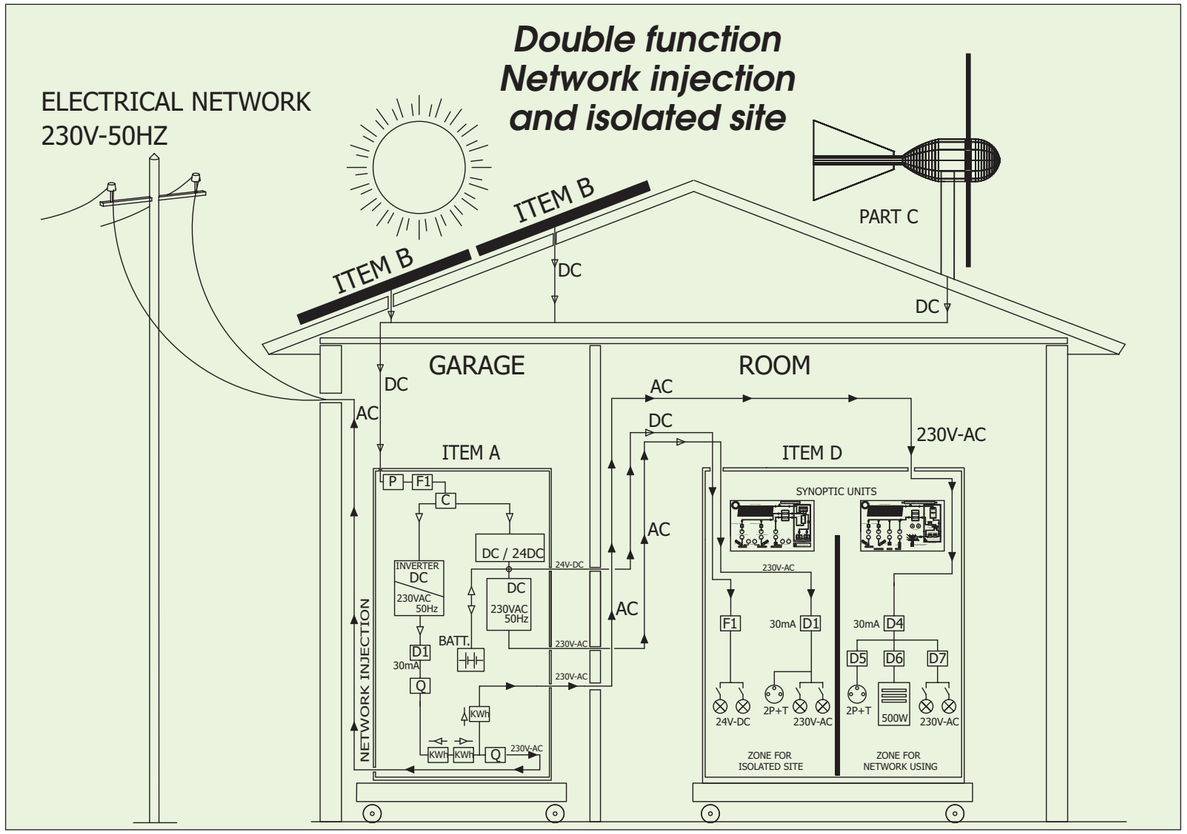


ITEM A

ITEM B

ITEM C

ITEM D



EDUCATIONAL OBJECTIVES

- Discover the different elements of a hybrid installation (photovoltaic and wind power)
- Apprehend and understand the present safety elements.
- Perform electrical measurements of the various quantities.
- Analyze & interpret the results.
- Study the yield and the linked effects to the pannels positioning and the rotation speed of the wind turbine.
- Study the energy chain (production, storage, use, resale, energy behavior).
- Wire a hybrid installation.
- Compare the energy powers between different energy consumers. (24V / 230V lamps, convector, etc.)

THEORETICAL WORK IN TEACHER / STUDENT FORM

In addition to all the theoretical work related to the study of a solar central unit and a wind central unit described in the previous pages, this composition makes possible to carry out theoritical work specific to a hybrid installation combining solar panels and wind power.

- Calculation of characteristics and research of components following specifications defined by the customer.
- Realization of the estimate
- Identification of components in restitution mode and isolated site.

PRACTICAL WORK IN TEACHER / STUDENT FORM

1 - Creation of wiring diagrams
2 - Electrical couplings of solar panels with the wind turbine according to the chosen operating mode
3 - Wiring of components in the cabinet
4 - Parameterization of the variable speed drive and control of the wind turbine.
5 - Tests with the load zone
6 - Readings of electrical values U / I panels, U / I wind turbine, U / I inverter, U / I batteries, U / I use
7 - Installation efficiency calculation of the different electrical powers
8 - Analysis of the power values on the energy meters in the cabinet
9 - Calculation of the discharge time of the batteries according to the load
10 - Setting up the Bluetooth communication to compare the readings between the measuring devices and the application
11 - Maintenance :
- o LSystem lock out for safety intervention in the electrical cabinet.
- o Finding the fault
- o Repair (change of fuses)
- o Influence of the orientation of the solar panels on the efficiency of the installation
- o Influence of the speed of rotation of the wind turbine on the efficiency of the installation

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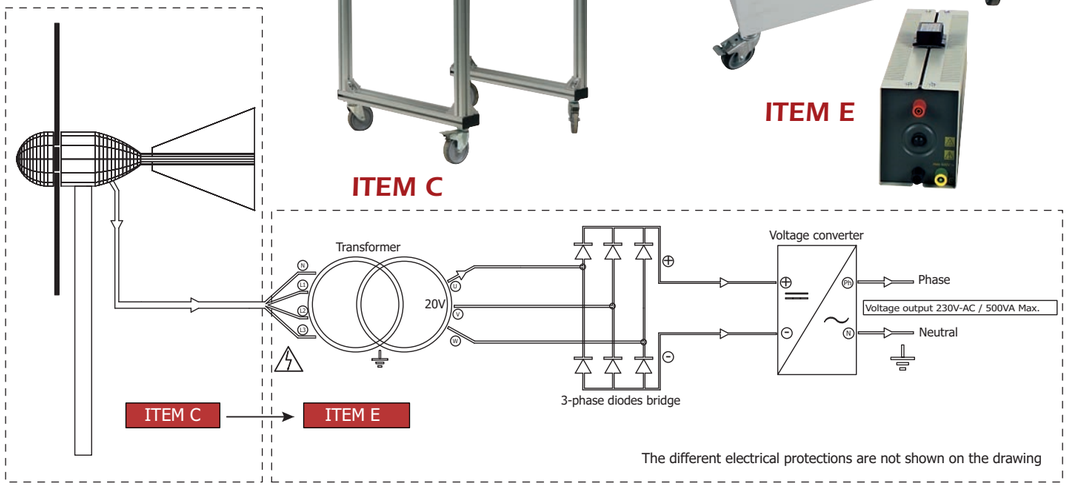
STUDY N°4 USING ITEM C + ITEM E
WIND TURBINE WITH RENEWABLE ENERGY CONVERSION BOX

PRACTICAL AND THEORETICAL WORKS POSSIBLE BY ASSOCIATING THE ELEMENTS C + E

ITEM E

ITEM C



The different electrical protections are not shown on the drawing

EDUCATIONAL OBJECTIVES

- Discover the different elements of a wind turbine
- Carry out electrical measurements of the various quantities (three-phase and continuous)
- Analyze and interpret the results
- Study the yield and the effects linked to the wind force
- Study the energy chain (production, electrical conversion, use, energy behavior)
- Control and configure the variable speed drive from a PC
- Study the conversion of the electrical energy from 3-phase to single-phase.
- Make some measurements with a clamp-on ammeter.

THEORETICAL WORK IN TEACHER / STUDENT FORM

- Study the conversion of three-phase voltage 400V into single-phase voltage 230V.
- Study an isolation transformer
- Study a rectifier bridge

PRACTICAL WORK IN TEACHER / STUDENT FORM

- Sizing of electrical components according to the voltage and power of the wind turbine
- Creation of the wiring diagram
- Parameterization of the variable speed drive according to the characteristics of the wind force
- Readings of intensities and tensions according to the force of the wind
- Power calculation
- Calculation and plotting of electrical efficiency.
- Parameter setting of the drive to observe the torque and the rotation frequency on the PC screen
- Maintenance :
  - o Visualization and correction of the influence of wind force on single-phase power.
  - o Visualization and correction of the consequences of a power overload

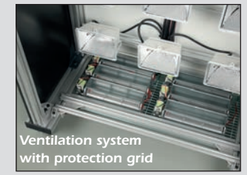
ADDITIONAL PRODUCTS FOR PACK-SOLEOL-1

Artificial solar source

ref. SOL-ARTI2-N — **PACK-SOLEOL-1 requires 2 artificial solar sources, one per panel**

This source for getting around the loss of sunlight by illuminating the solar panel with artificial light whose spectrum is close to sunlight. While not having as much luminosity as unclouded sunlight, it illuminates with sufficient intensity for the panel to generate 1/3 of its peak power Wc (corresponding to sunlight at 1kW/m²). The solar panel can be removed easily in order to replace a spotlight quickly if necessary. The unit located on the back of the spotlights panel includes

- a key-operated emergency stop button for cutting the electricity supply to the spotlights
- a digital thermometer shows the temperature at the surface of the solar panel. Accuracy 1°C.
- a potentiometer for lighting adjustment, by dimmer built into the unit
- a flow control for the forced ventilation
- automatic power supply cut-off to the spotlights in the event of abnormal temperature rise of the solar panel



Ventilation system with protection grid

Solar Analyser

- Current/voltage graph drawing (characteristic of the solar panel)
- Autoscan search of the solar panel maximum power – Pmax (60V – 6A)
- Maximal voltage Vmaxp at Pmax power
- Maximal voltage Imaxp at Pmax power
- Opened circuit voltage Vopen
- Short-circuit opened Ishort
- I = f(V) graph with a cursor
- Efficiency calculation in %
- Power by area unit (in W/m2)
- Manual test for a particular point
- Range 10V / accuracy 0.001V
  Range 60V / accuracy 0.01V
  Range 1A / accuracy 0.1mA
  Range 6A / accuracy 1mA
  Accuracy 1% + 18dgt

ref. VA200

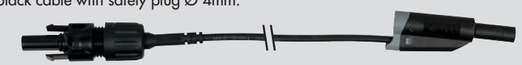
Package includes:

- bag
- AC power
- accumulators
- cables connecting panels
- USB cable & software.

Leads for connecting solar panels

1 meter cable to connect your solar panels to all security Ø4mm terminals solution up to 20A.

Female solar connector of M type, polarity « - », black cable with safety plug Ø 4mm. **ref. RSN-100**



Male solar connector of M type, polarity « + », red cable with safety plug Ø 4mm. **ref. RSR-100**