**WIND**

**SUN**

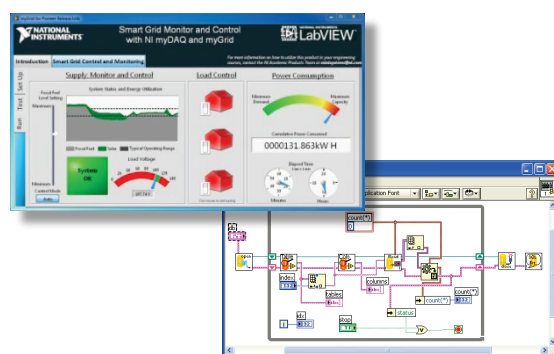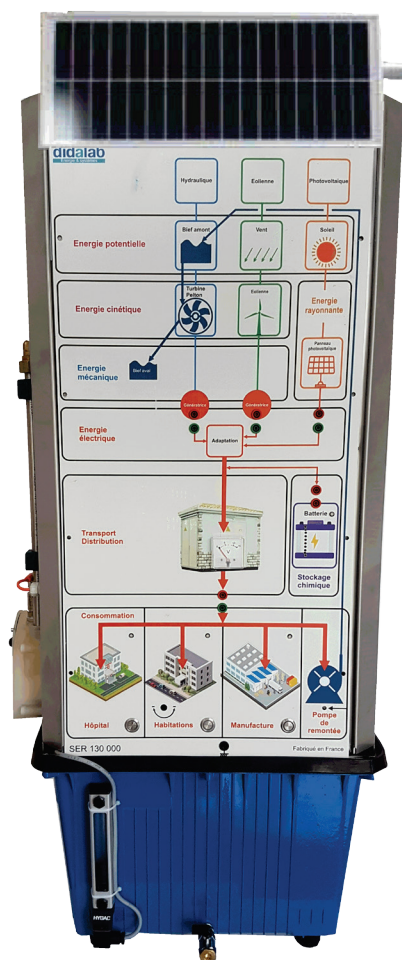**WATER**

**SER 130 package**

## Hydrelec 3E : 3-energy Power plant, hydropower, wind power and sun.

➢ Hydrelec 3E power plant (SER130) has been especially developed to study the technologies used in **Smart Grid,** production and storage of renewable energies (hydraulic, wind and sun). It is representative of numerous installations (Grand'Maison or Lac Noir in France, and mainly **El Hierro Island** in Spain). It has been conceived to be able to study a typical 24-minute operation cycle representing 24 hours.

➢ The operating part includes all the operational components in a **Smart Grid** station:
- **Hydraulic system**, high tank, upwelling pump, **Pelton** turbine associated to a generator,
- **Solar system,** polycristal solar panel and its sun collector (light spot),
- **Wind system**, 510 mm wind turbine, 90 W and its fan,
- **Chemical system (energy storage)**, battery and its load storage

➢ The control part can either be:
- **S7-1200 PLC** with its **KTP700 HIM** from **Siemens**®,
- **CompactRIO** associated with its control program operating with **LabVIEW**®.

## Training levels

ISCED 2011 :    **level 3, cat 35** (upper secondary education ; vocational) **;**
**level 4** (post secondary but non-tertiary education)**;**
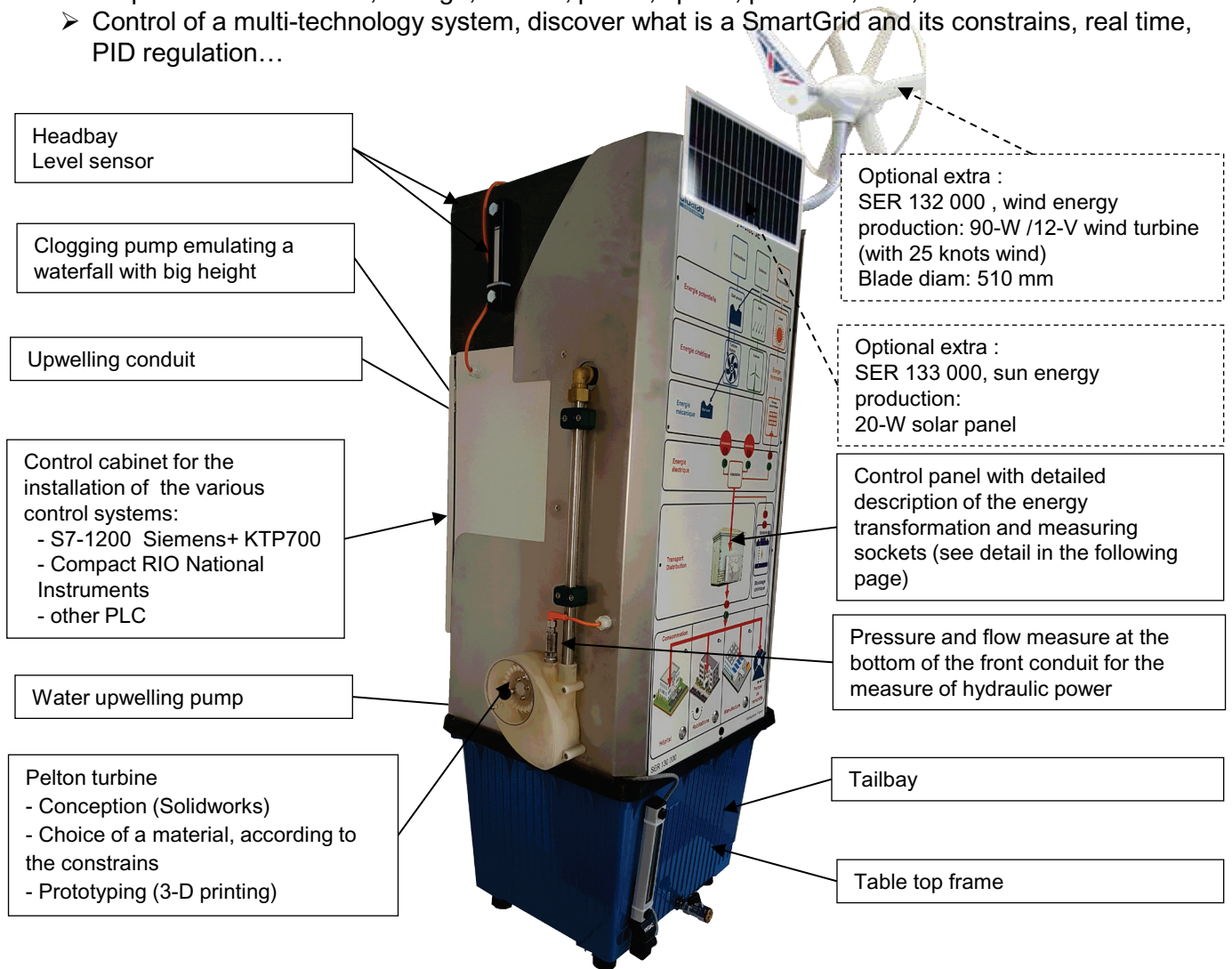
# Technical description

Hydrelec 3E, SER130000 is an evolving system; it allows the study of green energy production ; water in its basic version, wind and sun as optional extra.
Various control units are available :

➤ Siemens® S7-1200 PLC, its KTP 700 HMI and associated software TIA Portal
➤ Compact RIO developed by National Instruments®, its programs operating with LabVIEV®

The system is very evolving; with its basic version you can:

➤ Acquire the main values, voltage, current, power, speed, pressure, flow,
➤ Control of a multi-technology system, discover what is a SmartGrid and its constrains, real time, PID regulation…

| | |
|---|---|
| Headbay<br>Level sensor | Optional extra :<br>SER 132 000 , wind energy production: 90-W /12-V wind turbine (with 25 knots wind)<br>Blade diam: 510 mm |
| Clogging pump emulating a waterfall with big height | Optional extra :<br>SER 133 000, sun energy production:<br>20-W solar panel |
| Upwelling conduit | |
| Control cabinet for the installation of the various control systems:<br>- S7-1200 Siemens+ KTP700<br>- Compact RIO National Instruments<br>- other PLC | Control panel with detailed description of the energy transformation and measuring sockets (see detail in the following page) |
| Water upwelling pump | Pressure and flow measure at the bottom of the front conduit for the measure of hydraulic power |
| Pelton turbine<br>- Conception (Solidworks)<br>- Choice of a material, according to the constrains<br>- Prototyping (3-D printing) | Tailbay |
| | Table top frame |

**A lot of scenarios can be imagined, example of a typical scenario:**
Energy request from a customer (hospital, residential building or factory) is done by activation of a « On/Off » locking push-button) for each customer,
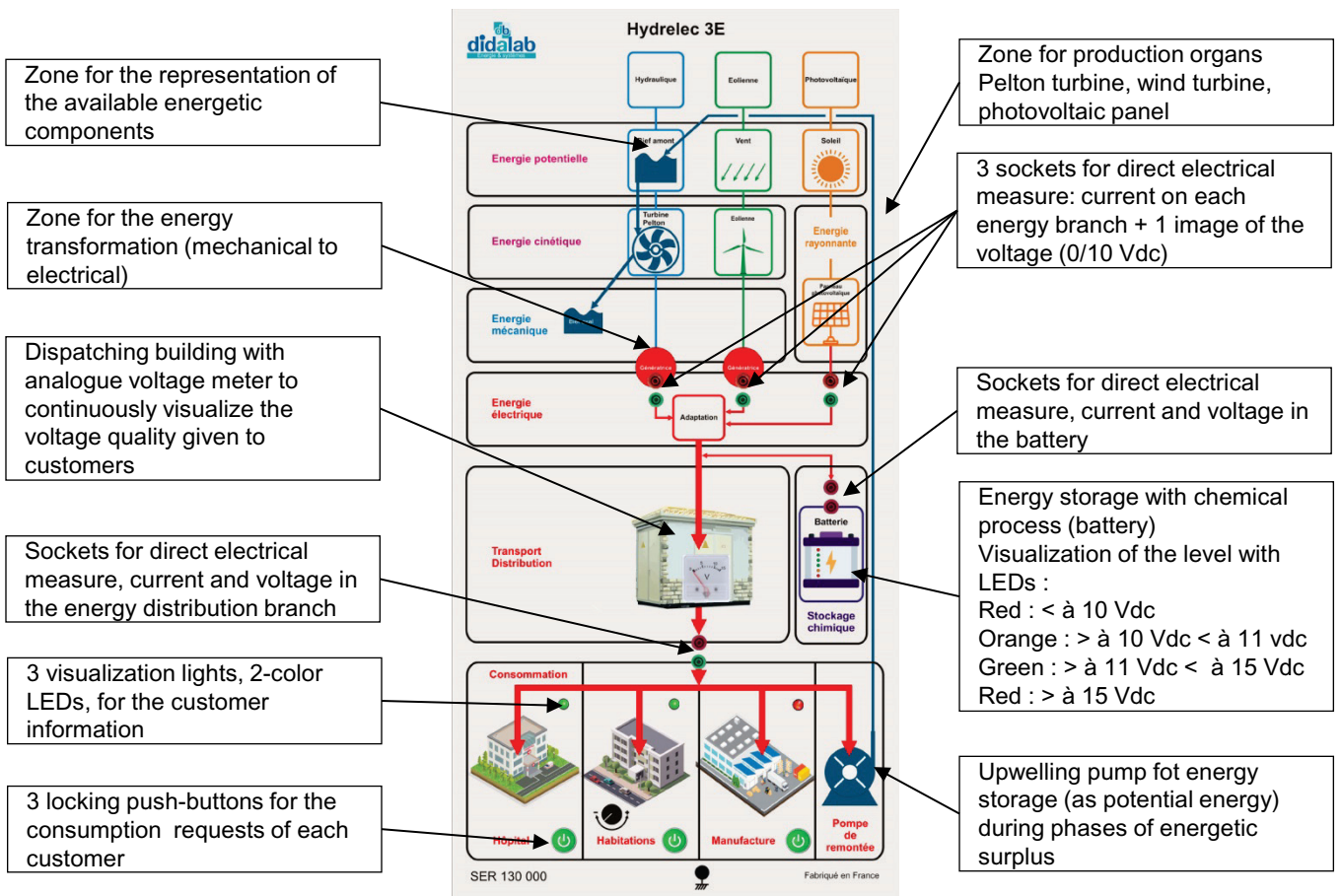
➤ The available energy is sufficient, the light is green, control button on "On", the user is connected with a lit green light, control button on "Off", the user is disconnected with a twinkling green light
➤ The energy is available but limited, control button on « On », the red light flashes 15s before power cut, and the consumption load will be disconnected in the 15s,
➤ The energy is available but not sufficient, the light is red and the customer is disconnected, whatever the user request ( ''On'' or ''Off''),

To respect the notion of Smart Grid, the control system will have to manage the customers requests, manage the available energies, according to the priorities

➤ The hospital, hyper priority level 1, but capable of autonomy, due to generator sets,
➤ Residential building is priority level 2,
➤ The factory, with less priority level 3, benefits from an industrial very advantageous price but with the risk of frequent unballastings.

# Control panel, version A, initial package

✓ It consists of a front panel, silk-screened on which a interface electronic card is fixed. It allows the piloting of numerous controls: energy transformation, circulation ways (unidirectional, bidirectional on a unique path or on two unidirectional paths),

✓ It includes measuring points for the currents and the tensions produced by 4 various organs of power production (2 generators, hydro-electric and wind power, 1 solar panel and 1 storage of energy by battery). These measuring points, with Ø 4-mm security sockets allow the discovery of the use of basic measuring devices (current, tension, power).

✓ 3+1 energy users with various priority levels (hospital, residential building and factory), each one presents its signalisation (green/red) showing their level to access energy according to the availability and priority level

Zone for the representation of the available energetic components

Zone for the energy transformation (mechanical to electrical)

Dispatching building with analogue voltage meter to continuously visualize the voltage quality given to customers

Sockets for direct electrical measure, current and voltage in the energy distribution branch

3 visualization lights, 2-color LEDs, for the customer information

3 locking push-buttons for the consumption requests of each customer

Zone for production organs Pelton turbine, wind turbine, photovoltaic panel

3 sockets for direct electrical measure: current on each energy branch + 1 image of the voltage (0/10 Vdc)

Sockets for direct electrical measure, current and voltage in the battery

Energy storage with chemical process (battery) Visualization of the level with LEDs :
Red : < à 10 Vdc
Orange : > à 10 Vdc < à 11 vdc
Green : > à 11 Vdc < à 15 Vdc
Red : > à 15 Vdc

Upwelling pump fot energy storage (as potential energy) during phases of energetic surplus

➢ Connection by screw terminal with extractible screw, this kind of connection allows the students to realize cablings of the controlling organ by traditional cabling. This choice of terminal with extractible screw allows their replacement as soon as they are damaged while protecting the motherboard of the system,

## Pedagogical practicals:

**Energy**

➢ **Energy…Electricity production**
- hydraulic energy (waterfall)
- fluid energy (wind)
- solar energy (photovoltaïc)

➢ **Energy storage « Smart Grid »**
- potential energy (stored water)
- chemical (battery)

**Innovation**

➢**Material and structures: study of the turbine**
- Choice of a material according to the constraints
- Prototyping (3-D printing)

**Communication**

➢**Information…**
- Acquire: pressure and flow meters
- Control: Siemens PLC, Compact RIO, LabVIEW software
- Communicate: Ethernet network
- Electric network managment: Smart Grid, dispatchings managment.

## Standard configurations for **Hydrelec 3E :**

| SER130B: Basic package «Operating part for the study of an hydroelectric power plant » including: | | |
|---|---|---|
| **Reference** | **Description** | **Qty** |
| SER130000 | Pack for the study of hydroelectric power plant on an aluminium frame (1 customer,12W) | 1 |
| SER130040 | Booklet for practical works | |

| SER130C : Complete package «Operating part for the study of 3-energy powe rplant » including: | | |
|---|---|---|
| **Reference** | **Descripton** | **Qty** |
| **SER130B** | **Basic package «Operating part for the study of an hydroelectric power plant »** | **1** |
| SER132000 | Ccomplete kit for wind energy production (90-W wind turbine with fan) | 1 |
| SER133000 | Complete kit for sun energy production (photovoltaic panel with sun collector (light spot)) | 1 |

| SER130S7 : Complete package «Operating part for the study of 3-energy power plant controlled by Siemens PLC» including: | | |
|---|---|---|
| **Reference** | **Description** | **Qty** |
| **SER130C** | **Complete package «Operating part for the study of 3-energy powerplant »** | **1** |
| RSI200B | Control system with Siemens S7-1200 PLC, its KTP700 HMI, and TIA Portal programmation software | 1 |

| SER130CRIO: Complete package «Operating part for the study of 3-energy power plant controlled by Compact RIO & LabVIEW» including: | | |
|---|---|---|
| **Reference** | **Description** | **Qty** |
| **SER130C** | **Complete package «Operating part for the study of 3-energy powerplant »** | **1** |
| RNI200B | Compact RIO rack, On/Off and analogue input/outputs, with programs operating with LabVIEW (LabVIEW licence not supplied) | 1 |

**Dimensions:**

Dimensions: l/p/h :70x850x2500 mm
Weight:                   60kg (empty)

**didalab**
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