



Key features:

- **Managing real Smart Grid devices used by prestigious utilities.**
- **Control of a real wind turbine.**
- **Control of Active Power Generation.**
- **Simulation of different wind speeds.**
- **Isolating grid work mode.**
- **Coupling the generation to the grid: Net-Metering.**
- **Autoconsumption.**
- **Simulation of selling electricity to the grid.**
- **Measuring the input and output power flows generated by the wind turbine (generator-motor group).**
- **Network Analyzer Unit with oscilloscope display to perform an advanced Net Metering.**
- **This Trainer may be expanded with: AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer and/or AEL-FUSG-E. Final User Smart Grid - Smart Energy Trainer.**

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↳ PRODUCTS  
↳ 5.- ENERGY



ISO 9001: Quality Management (for Design, Manufacturing, Commercialization and After-sales service)



European Union Certificate (total safety)



Certificates ISO 14001 and ECO-Management and Audit Scheme (environmental management)



"Worlddidac Quality Charter" and Platinum Member of Worlddidac

## INTRODUCTION

Nowadays, Micro Electrical Grids are very important to achieve the sustainability of the Energy Systems.

Micro Electrical Grids, where each final user can generate its own electricity, are the future.

For this reason, EDIBON has developed the AEL-FUSG-N. Final User Smart Grid - Net Metering Application, through which the user can simulate the sale or consumption of the generated energy. Thus, the user will learn different simulations, such as selling electricity to the grid, Net Metering and measuring the input and output power flows generated by the Renewable Energy simulators.

## GENERAL DESCRIPTION

The complete system consists of:

- a) AEL-FUSG-N. Final User Smart Grid - Net Metering Application.
- b) Required accessories.
- c) Optional accessories.

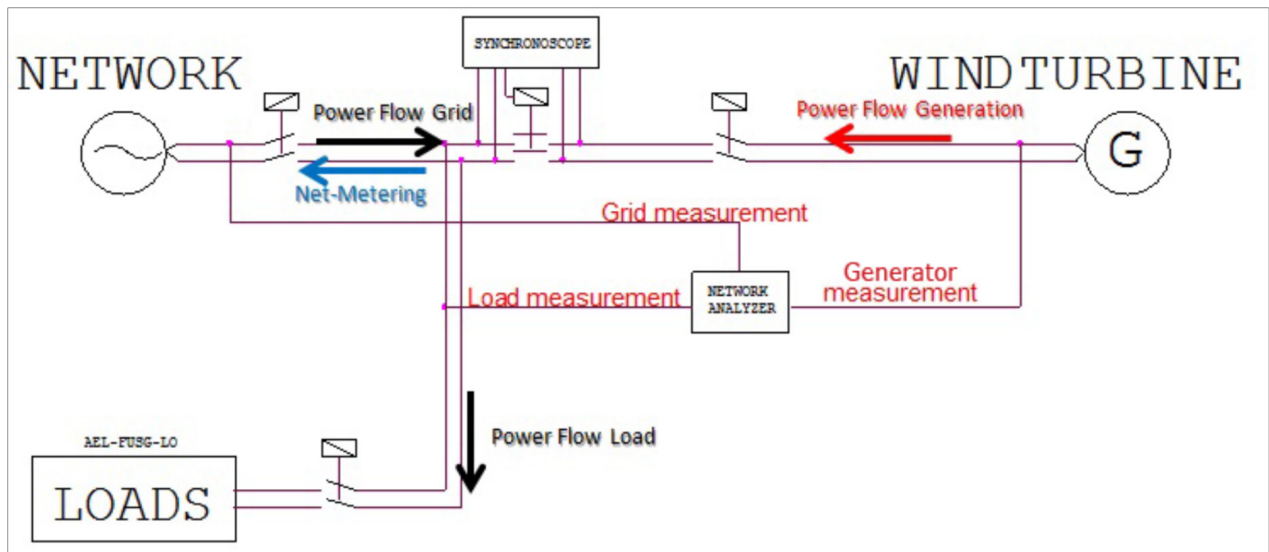
- a) AEL-FUSG-N. Final User Smart Grid - Net Metering Application.

The AEL-FUSG-N is a trainer that reflects actual operations about Net-Metering, auto-consumption and electricity selling. For that purpose, this trainer has a synchronous generator that simulates a wind turbine.

The wind turbine will be controlled with a voltage regulator and a prime motor (wind speed). With the voltage regulator the user will control the generation voltage. The prime motor will be controlled through a frequency controller, so the user will control the speed of the generator (generation frequency) and the active power generated.

Besides, a synchroscope is included to synchronize the generator and the grid. This device lets user to study different actual operations: Net-Metering, Auto-consumption, isolated grid mode, parallel operation mode, etc.

Finally, a network analyzer is included to take readings in different important points. This module let us to measure energy demanded by the loads, energy supplied by the grid, energy supplied by the generator and energy injected by the generator in the grid and the loads. All this maneuvers can be done in real time with the main module, the N-PFD (Power Distribution Module).



The AEL-FUSG-N. Application consists of the following modules:

N-ALI01. Industrial Main Power Supply.

This module is used to supply others modules and to simulate the grid.

N-PFD. Power Distribution Module.

This module is used to control the power flows that come from the generator and the grid to supply the loads. Besides, this module has an internal PLC to control automatically the measurement point by means of three switches. This module together the network analyzer (N-EALDG) let us to know the electrical parameters in the grid, in the generator and the loads in order to calculate the Net-Metering electrical parameters.

N-EALDG. Network Analyzer Unit with Computer Data Acquisition+Oscilloscope (PC)+Oscilloscope Display.

This module is used to take readings of the power flows of the loads, the grid and the generator. Thus the user will study the measured energy from different points.

This network analyzer includes data acquisition, PC oscilloscope and screen oscilloscope. It can monitor every electrical parameter involved in an electric network.

The user can measure the flow power injected to the grid and the local consumption in order to carry out the Net Metering.

## General description

### N-VREG. Voltage Regulator.

This module is used to regulate the current excitation of the electrical generator.

This module has a switch to enable and disable the control of the excitation. Through a potentiometer, the user can regulate the amount of the current excitation and control the generator voltage output.

This module has an ammeter in order to show the current excitation level.

### N-ASY. Synchronoscope.

This module is used to synchronize the generator with the grid, so the user can inject energy and makes Net-Metering.

This module has a push-button to enable the synchronization and other push-button to disable the synchronization. Besides, the synchronoscope has different push-buttons to display the phase-angle, voltage-angle and frequencies of the grid and the generator.

### N-REL46. Thermal Electric Motor Protection Module.

Magneto-thermal protection for the generator.

### N-WCA4K. 4 KW Motor Controller Module.

This module is used to control the motor that moves the electrical generator. With this module we simulate the wind speed that is to say, the active power generated. For this purpose the module has a potentiometer that allows control the speed of the motor in order to simulate different speed conditions.

### GMG4K. 4 KW Generator-Group.

This is an unit that simulates a wind turbine in home or industrial installations. To simulate a prime energy, the generator is coupled to an induction motor.

## b) Required accessories:

In order to simulate different real consumptions and to carry out all the practical possibilities proposed AEL-FUSG-M application requires a set of static and dynamic loads. The following loads must be acquired:

AEL-FUSG-LO. Final User Smart Grid - Smart Grid Loads, formed by:

Static Loads:

N-REV. Single Phase Variable Resistor.

This module is used to limit the torque of the universal motor (EMT12).

N-LAM16. Incandescent lamp.

N-IND. Incandescent lamp.

This module is used to simulate a reactive energy consumption.

N-CAR19. Single-phase Bank of commutable Capacitors.

This module is used to simulate a reactive energy compensation.

N-LAM32. LED Lamp.

This module is used to simulate a low consumption light.

N-WCC/M. Controlador de Motores CC (opción intermedia).

N-REF. Single Phase Fixed Resistor. (4 units)

Dynamic Loads:

EMT12. Universal Motor (single-phase).

This motor is used to simulate a washing machine together the eddy current brake.

FRECP. Eddy Current Brake.

This brake is used to reduce the EMT12 speed and to increase the energy consumed by him.

EH. Electric Heating Unit.

This module is used to simulate a conventional electric heating.

## c) Optional accessories:

For AEL-FUSG-N. Final User Smart Grid-Net Metering Application:

It can be included a set of modules to simulate different renewable energy power generation:

PPINV. Photovoltaic Panel with Inverter.

For simulating photovoltaic energy production.

SWTI. Small Wind Turbine with Inverter.

For simulating wind energy production.

For AEL-FUSG-LO. Final User Smart Grid - Smart Grid Loads:

AEL-APFC. Single-phase Automatic Power Factor Compensation Application.

## SPECIFICATIONS

The complete system consists of:

- a) AEL-FUSG-N. Final User Smart Grid - Net Metering Application.
- b) Required accessories.
- c) Optional accessories.

a) **AEL-FUSG-N. Final User Smart Grid - Net Metering Application**, consist of the following modules:

**N-ALI01. Industrial Main Power Supply.**

This module is used to supply other modules.

- Three-phase differential protection.
- Three-phase output: 380 VAC.
- Single-phase output: 230 VAC.
- Safety key.
- Emergency stop button.
- Required power supply: three-phase 380 VAC.

**N-PFD. Power Distribution Module.**

This module is used to control the power flows that come from the generator and the grid to supply the loads. Besides, this module has an internal PLC to control automatically the measurement point by means of three switches. This module together the network analyzer (N-EALDG) let us to know the electrical parameters in the grid, in the generator and the loads in order to calculate the Net-Metering.

**N-EALDG. Network Analyzer Unit with Computer Data Acquisition + Oscilloscope (PC)+Oscilloscope Display.**

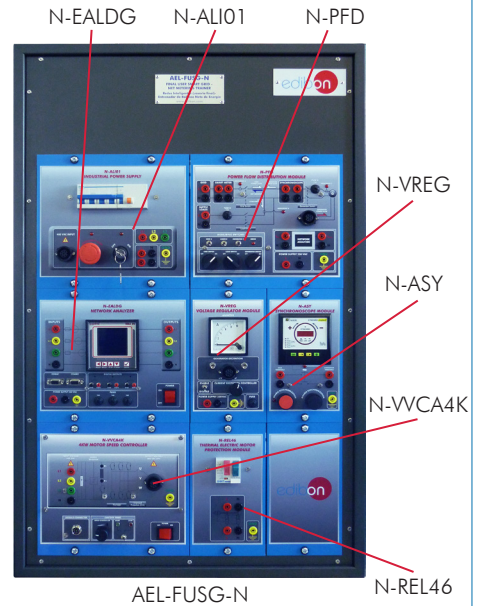
This module is used to take readings of the power flows of the loads, the grid and the generator.

With this unit the user can measure the following parameters:

- +KWh, -KWh, +KVar, -KVar, +KV<sub>a</sub>, -KV<sub>a</sub>, +P, -P, +Q, -Q.

Besides this module can show currents and voltages waves.

This module includes data acquisition PC oscilloscope and screen oscilloscope. It can monitor every electrical parameter involved in an electrical network.



AEL-FUSG-N

N-REL46

**N-VREG. Voltage Regulator.**

This module is used to regulate the current excitation of the electrical generator.

This module has a switch to enable and disable the control of the excitation. Through a potentiometer, the user can regulate the amount of the current excitation.

This module has an ammeter in order to show the current excitation level.

**N-ASY. Synchronoscope.**

This module is used to synchronize the generator with the grid, so the user can inject energy and makes Net-Metering.

This module has a push-button to enable the synchronization and other push-button to disable the synchronization.

Besides it has a display that shows the following parameters:

- Grid frequency.
- Generator frequency.
- Grid Voltage.
- Generator output voltage.
- Grid and Generator phase angle degrees.

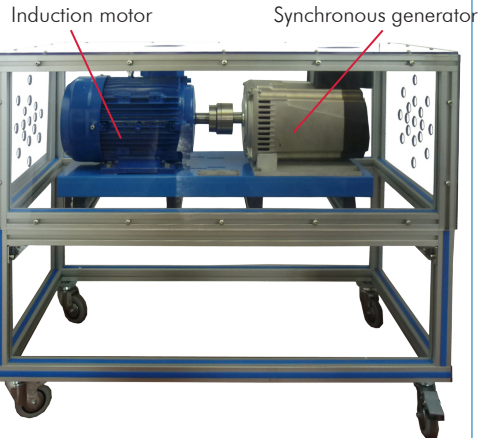
**N-REL46. Thermal Electric Motor Protection Module.**

Magneto-thermal protection for the generator, with a current range from 6 to 10 Amperes, with trip type 10. It provides protection against overcurrent and shortcircuits.

**N-WCA4K. 4 KW Motor Controller Module.**

This module is used to control the motor that moves the electrical generator. With this module we simulate the wind speed. For this purpose the module has a potentiometer that allows control the speed of the motor, that is to say, the wind speed. Thus, the user can increase or decrease the generated active power.

- Required power supply: 230 VAC.
- Enable control switch.
- Control speed potentiometer.
- Nominal power: 4KW.
- PWM: Three-phase output.



GMG4K

**GMG4K. 4 KW Generator-Group.**

This is an unit that simulates a wind turbine in home or industrial installations.

The generator has a nominal power of 3.5KVa and it is moved by mean of induction motor to simulate the wind speed.

It includes:

- Induction motor: 4 KW.
- Synchronous generator: 3.5 Kva.

When the electrical generator is synchronized with the grid, the potentiometer of the N-WCA4K let us increase or decrease the active power generation.



**Cables and Accessories**, for normal operation.  
**Manuals.**



## Specifications

### b) Required accessories:

In order to simulate different real consumptions and to carry out all the practical possibilities proposed AEL-FUSG-M application requires a set of static and dynamic loads that represent different consumption generally used at home, industries and other places.

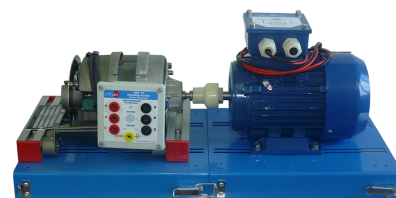
The following loads must be acquired:

AEL-FUSG-LO. Final User Smart Grid - Smart Grid Loads:

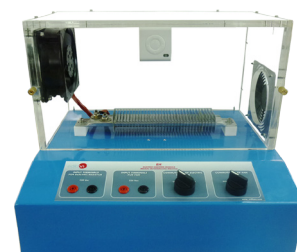
It is formed by:

- N-REV. Single Phase Variable Resistor.  
Nominal current: 2 A.  
Nominal power: 500 W.
- N-LAM16. Incandescent lamp.  
Input voltage: 2 terminals of 230 VAC.  
Power: 60W.
- N-IND. Single Phase Inductance.  
Nominal current: 2 A.  
Inductance: 33 mH; 78 mH; 140 mH; 236 mH.  
Commutator.
- N-CAR19. Single-phase Bank of commutable Capacitors.  
Nominal voltage: 230 Vac.  
Capacitance: 7 mF; 14 mF; 21 mF; 28 mF; 35 mF.  
Commutator.
- N-LAM32. LED Lamp.  
Nominal voltage: 230 VAC.
- N-WCC/M. DC Motor Speed Controller (intermediate option).  
Adjustable voltage: up to 320 VDC.  
Maximum current: 2 A.
- N-REF. Single Phase Fixed Resistor. (4 units)  
Nominal current: 2 A.  
Nominal power: 500 W.
- EMT12. Universal Motor (single-phase).  
Power: 230 W.  
Speed: 5000/9000 r.p.m.  
Frequency: 50Hz/60 Hz.  
V.Armeture.: 230 V.
- FRECP. Eddy Current Brake.  
FRECP is an unit designed to work as a magnetic brake by means of the induction of Foucault's parasitic currents.  
The FRECP is similar to an electrical motor, since it has a stator winding, the inductor, that we will feed with a DC voltage. We will change the braking torque by means of this direct voltage.  
The braking torque is proportional to the current injected.  
Nominal current: 1.67 A.  
Maximum current: 1.8 A.  
Maximum braking torque: 1.4 Nm.  
Bench - support.  
DC power supply.
- EH. Electric Heating Unit.  
This module can be used for different purposes.  
Load purpose: this module is used like a resistive load of 700 W.

**IMPORTANT!** These loads can be used simultaneously with AEL-FUSG-M. Final User Smart Grid - Smart Meter Application, AEL-FUSG-E. Final User Smart Grid - Smart Energy Application and AEL-FUSG-N. Final User Smart Grid- Net Metering Application.



EMT12 + FRECP



EH

### c) Optional accessories:

For AEL-FUSG-N. Final User Smart Grid-Net Metering Application:

It can be included a set of modules to simulate different renewable energy power generation:

- PPINV. Photovoltaic Panel with Inverter.  
For simulating photovoltaic energy production.
- SWTI. Small Wind Turbine with Inverter.  
For simulating wind energy production.

For AEL-FUSG-LO. Final User Smart Grid - Smart Grid Loads:

AEL-APFC. Single-phase Automatic Power Factor Compensation Application.

## EXERCISES AND PRACTICAL POSSIBILITIES

- 1.- Synchronization operations of the generator.
- 2.- Real time monitoring of local consumptions with induction, resistor or capacitive loads.
- 3.- Simulation of renewable energy generation through Generator-Motor Group.
- 4.- Measurement of the energy generated by the Generator-Motor Group.
- 5.- Net Metering. Measuring the energy consumed and the energy injected to the grid and, finally, measuring the positive or negative energy balance.
- 6.- Measuring of the energy consumption by the loads without generator.
- 7.- Measuring the energy consumption by the loads with the generator and the grid controlling the power flows from the generator.
- 8.- Net-Metering operations: selling energy to the grid.

Additional practical possibilities:

- If the user acquires the AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer and AEL-FUSG-E. Final User Smart Grid - Smart Energy Trainer, then he can perform, among many others, the following practical exercises:
- 9.- Measurement of energy consumption at home or by an industrial consumer and comparison of this measurement with the utility's register (smart meter).
  - 10.- Remote scheduling of Smart devices (Smart plug, Smart relays, thermostat, different sensors, etc.) according to the tariff proposed by the utilities.
  - 11.- Development of switching schemes through the management platform for appliances connected to the smart plugs, smart relays or the thermostat.
  - 12.- Scheduling the energy consumption for optimal periods of sunlight.

## REQUIRED SERVICES

- Electrical supply: single phase, 220 V/50 Hz. or 110 V/60 Hz.
- Computer (PC).
- AEL-FUSG-LO. Final User Smart Grid - Smart Grid Loads.

## DIMENSIONS AND WEIGHTS

AEL-FUSG-N. Final User Smart Grid - Net Metering Application:

Modules in Rack:

- Dimensions: 640 x 320 x 920 mm approx.  
(25.19 x 12.59 x 36.22 inches approx.)
- Weight: 35 Kg approx.  
(77 pounds approx.)

GMG4K:

- Dimensions: 1180 x 700 x 740 mm approx.  
(46.45 x 27.55 x 29.13 inches approx.)
- Weight: 80 Kg approx.  
(176.3 pounds approx.)

Required accessory:

AEL-FUSG-LO. Final User Smart Grid - Smart Grid Loads:

Static Loads in Rack:

- Dimensions: 640 x 320 x 920 mm approx.  
(25.19 x 12.59 x 36.22 inches approx.)
- Weight: 30 Kg approx.  
(66 pounds approx.)

EMT12:

- Dimensions: 285 x 250 x 260 mm approx.  
(11.22 x 9.84 x 10.24 inches approx.)
- Weight: 8 Kg approx.  
(17.6 pounds approx.)

FRECP:

- Dimensions: 285 x 250 x 270 mm approx.  
(11.22 x 9.84 x 10.63 inches approx.)
- Weight: 8.25 Kg approx.  
(18.2 pounds approx.)

EH:

- Dimensions: 450 x 340 x 300 mm approx.  
(17.71 x 13.38 x 11.81 inches approx.)
- Weight: 4 Kg approx.  
(8.81 pounds approx.)

## ADDITIONAL APPLICATIONS

- AEL-FUSG-M. Final User Smart Grid - Smart Meter Application.

To study a real Smart Meter used by Utilities.

- AEL-FUSG-E. Final User Smart Grid - Smart Energy Application.

The user can improve its knowledge about the influence of the load demand through home energy devices.

Managing a real Home Energy Management System.

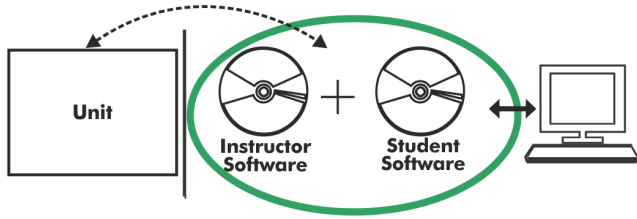
Developing different automation programs to get an efficient consumption.

## SOME SOFTWARE SCREENS

N-EALDG software screen. Measures indicators panel.



**AEL-FUSG/ICAI. Interactive Computer Aided Instruction Software System:**



With no physical connection between unit and computer, this complete software package consists of an Instructor Software (EDIBON Classroom Manager -ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft -ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

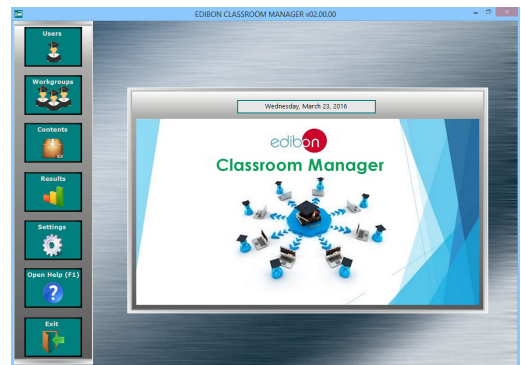
Instructor Software

**- ECM-SOF. EDIBON Classroom Manager (Instructor Software).**

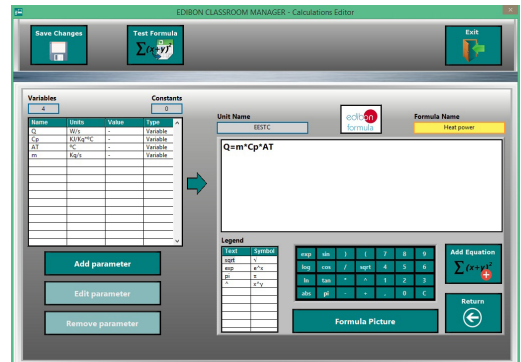
ECM-SOF is the application that allows the Instructor to register students, manage and assign tasks for workgroups, create own content to carry out Practical Exercises, choose one of the evaluation methods to check the Student knowledge and monitor the progression related to the planned tasks for individual students, workgroups, units, etc... so the teacher can know in real time the level of understanding of any student in the classroom.

Innovative features:

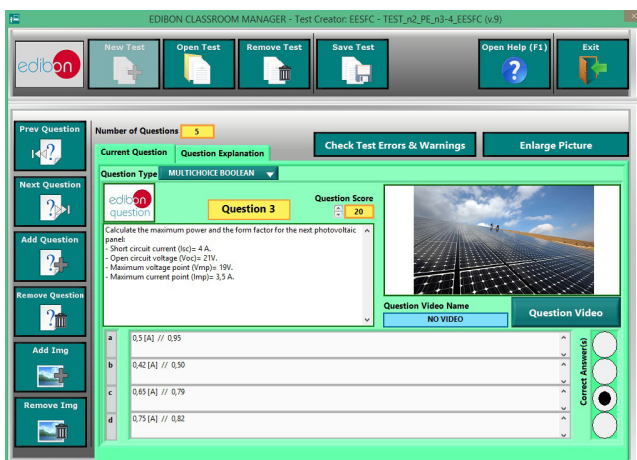
- User Data Base Management.
- Administration and assignment of Workgroup, Task and Training sessions.
- Creation and Integration of Practical Exercises and Multimedia Resources.
- Custom Design of Evaluation Methods.
- Creation and assignment of Formulas & Equations.
- Equation System Solver Engine.
- Updatable Contents.
- Report generation, User Progression Monitoring and Statistics.



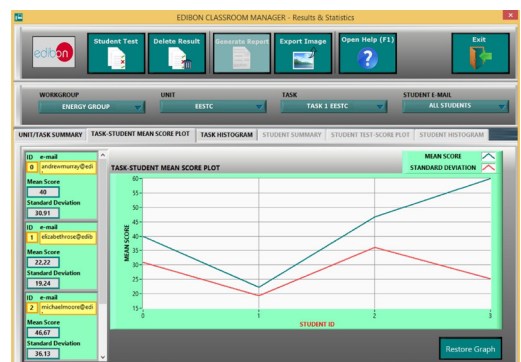
ECM-SOF. EDIBON Classroom Manager (Instructor Software) Application Main Screen



ECAL. EDIBON Calculations Program Package - Formula Editor Screen



ETTE. EDIBON Training Test & Exam Program Package - Main Screen with Numeric Result Question



ERS. EDIBON Results & Statistics Program Package - Student Scores Histogram



Optional  
Student Software

- ESL-SOF. EDIBON Student Labsoft (Student Software).

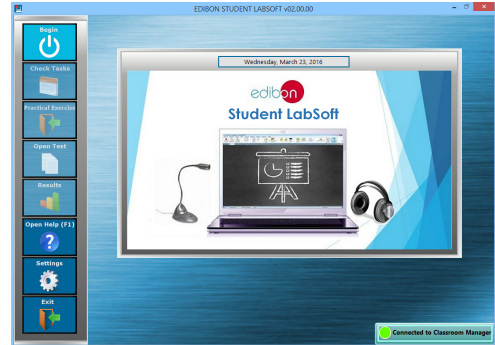
ESL-SOF is the application addressed to the Students that helps them to understand theoretical concepts by means of practical exercises and to prove their knowledge and progression by performing tests and calculations in addition to Multimedia Resources. Default planned tasks and an Open workgroup are provided by EDIBON to allow the students start working from the first session. Reports and statistics are available to know their progression at any time, as well as explanations for every exercise to reinforce the theoretically acquired technical knowledge.

Innovative features:

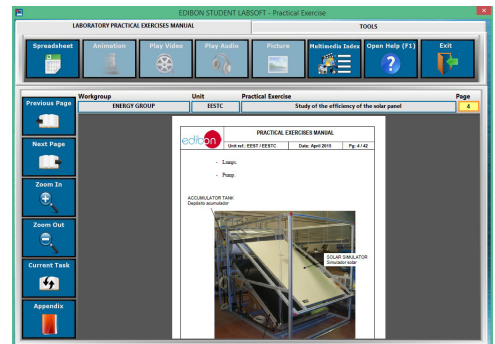
- Student Log-In & Self-Registration.
- Existing Tasks checking & Monitoring.
- Default contents & scheduled tasks available to be used from the first session.
- Practical Exercises accomplishment by following the Manual provided by EDIBON.
- Evaluation Methods to prove your knowledge and progression.
- Test self-correction.
- Calculations computing and plotting.
- Equation System Solver Engine.
- User Monitoring Learning & Printable Reports.
- Multimedia-Supported auxiliary resources.

For more information see ICAI catalogue. Click on the following link:

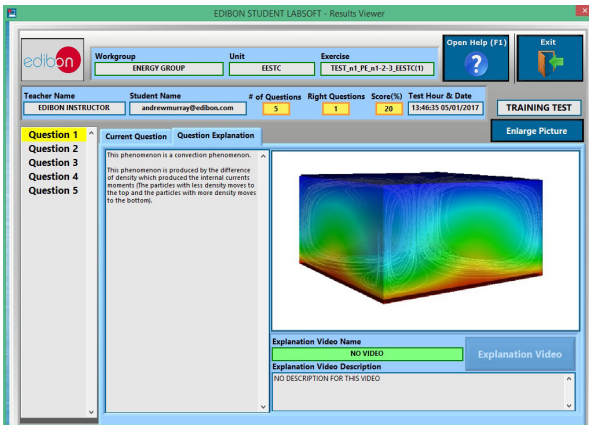
[www.edibon.com/en/files/expansion/ICAI/catalog](http://www.edibon.com/en/files/expansion/ICAI/catalog)



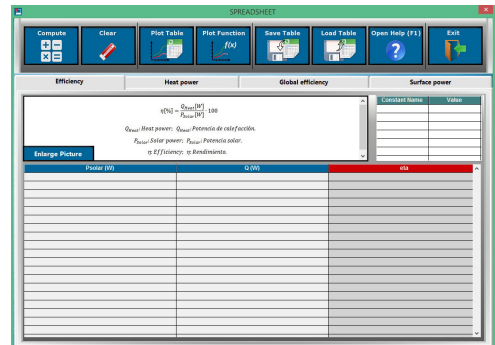
ESL-SOF. EDIBON Student LabSoft (Student Software) Application Main Screen



EPE. EDIBON Practical Exercise Program Package Main Screen



ERS. EDIBON Results & Statistics Program Package - Question Explanation



ECAL. EDIBON Calculations Program Package Main Screen

\* Specifications subject to change without previous notice, due to the convenience of improvement of the product.



C/ Julio Cervera, 10-12-14. Móstoles Tecnológico.  
28935 MÓSTOLES. (Madrid). ESPAÑA - SPAIN.  
Tel.: 34-91-6199363 Fax: 34-91-6198647  
E-mail: edibon@edibon.com Web: [www.edibon.com](http://www.edibon.com)

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REPRESENTATIVE:

