edibon
Technical Teaching Equipment

Final User Smart Grid Trainer
AEL-FUSG

Key features:

▶ **Managing real Smart Grid devices used by prestigious utilities.**

▶ **Learning about what are the operations between the utilities and the final user.**

▶ **Real time monitoring, remote management and verification of the network quality.**

▶ **Bidirectional communication between the Utility (the student) and the Smart Meter.**

▶ **The final customer can carry out an optimal consumption at home. Learning how to use an actual Home Energy Management System.**

▶ **Scheduling switching schemes, visualizing and comparing the consumption with different loads.**

▶ **Configuring virtual scenes with different sensors and actuators to achieve the optimal consumption and other possibilities to automate the consumption.**

▶ **Remote controlling of smart devices from programming software.**

▶ **Simulating electric heating and programming optimal consumption.**

▶ **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.**

▶ **Possibility to use additional smart meters and optional accessories.**

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↳Products
  ↳Products range
    ↳Units
      ↳5.-Energy

AEL-FUSG.
Final User Smart Grid Trainer

AEL-FUSG-M.
Final User Smart Grid - **Smart Meter Trainer**

Configuration and control software

+
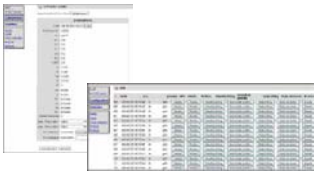
AEL-FUSG-E.
Final User Smart Grid - **Smart Energy Trainer**

Configuration and programming software

+

AEL-FUSG-N.
Final User Smart Grid - **Net Metering Trainer**

GMG4K.
4KW Generator-Group

+

AEL-FUSG-LO.
Smart Grid Loads

Static Loads

Dynamic Loads

Optional accessories

For **AEL-FUSG-M**:

- OSM. Additional Smart Meter with AEL-FUSG-LO Smart Grid Loads
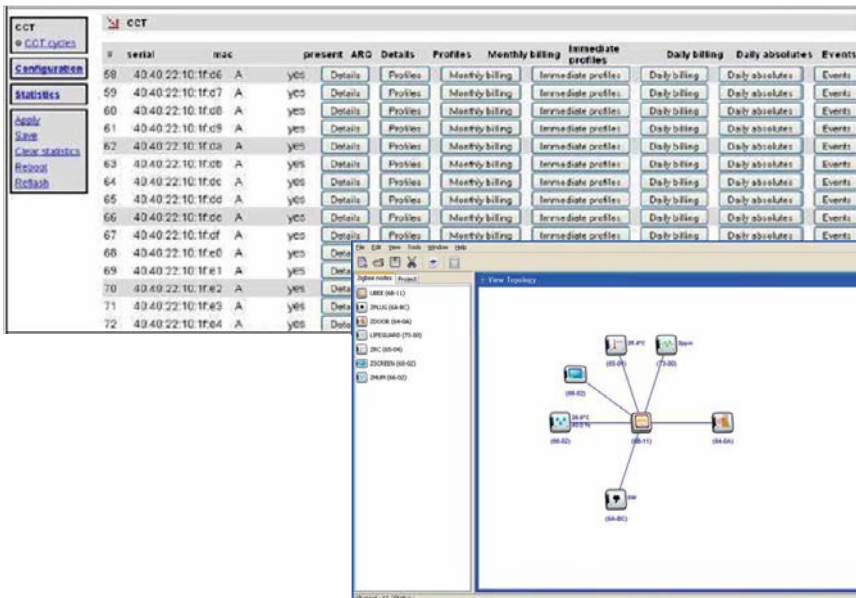
For **AEL-FUSG-E**:

- AEL-HP-EM. Home Emergency Module

- AEL-HP-SE. Home Security Module

- AEL-HE-EN. Home Energy Module

For **AEL-FUSG-N**:

- PPINV. Photovoltaic Panel with Inverter

- SWTI. Small Wind Turbine with Inverter

For **AEL-FUSG-LO**:

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

What is a Smart Grid?

A smart grid is an electrical grid that uses information and communications technology to gather and act on information about the behaviours of suppliers and consumers, in an automated fashion to improve the efficiency, reliability, economics, and sustain ability of the production and distribution of electricity.

Why using a Smart Grid?

Reliability, flexibility, efficiency, load adjustment, sustain ability and demand response are the main factors that allow a better control over the electrical energy parameters.

The AEL-FUSG. Final User Smart Grid Trainer, developed by EDIBON, reflects all these characteristics and will allow the user to carry out real appliances related to current Smart Grids.

GENERAL DESCRIPTION

The AEL-FUSG Trainer consists of three main trainers and a set of static and dynamic loads.

The complete system consist of:

a) AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer.

b) AEL-FUSG-E. Final User Smart Grid - Smart Energy Trainer.

c) AEL-FUSG-N. Final User Smart Grid - Net Metering Trainer.

d) AEL-FUSG-LO. Smart Grid Loads.

e) Optional accessories.

a) AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer.

To understand how current utilities work in the Electrical Grids EDIBON offers the Final User Smart Grid - Smart Meter Trainer (AEL-FUSG-M), a real Smart Grid System where the user can manage an actual Smart Meter.

It is a trainer that reflects the real operation of current Smart Grids. The purpose of the AEL-FUSG-M is to make the user understand how utilities work in a real smart grid environment.

This trainer consist of the following modules:

N-ALI01. Industrial Power Supply.

This module is used to simulate the electrical grid and supply the data concentrator (N-CTT) and other possible elements.

N-CTT. Data Concentrator Module.

This module is a communications concentrator that belongs to a remote management system with automatic meter reading (AMR). The reading is performed through the power line (power line communication or PLC).

This module can communicate with one or more smart meters. Once the user is communicating with the smart meter from the data concentrator, a platform web can be open. The platform web is integrated in the data concentrator and we can see all electrical parameters of the smart meters that are connected to the power line. Besides we can meter the most important electrical parameters, for example: voltages, currents, positive active power, negative active power, positive reactive power, negative reactive power, power factors, positive and negative active energy, positive and negative reactive energy…

N-SM. Smart Meter Module.

This "smart" meter let us know which the consumption of the final customer is at any time. This meter is similar to conventional meters but has the advantage that can send all the electrical parameters of the load (customer) to the utility (data concentrator) in real time. Thus, the utility can know exactly the energy needs of each customer at all times.

Configuration and control software (platform web).

The N-CTT module includes a platform web to control the Smart Meter.
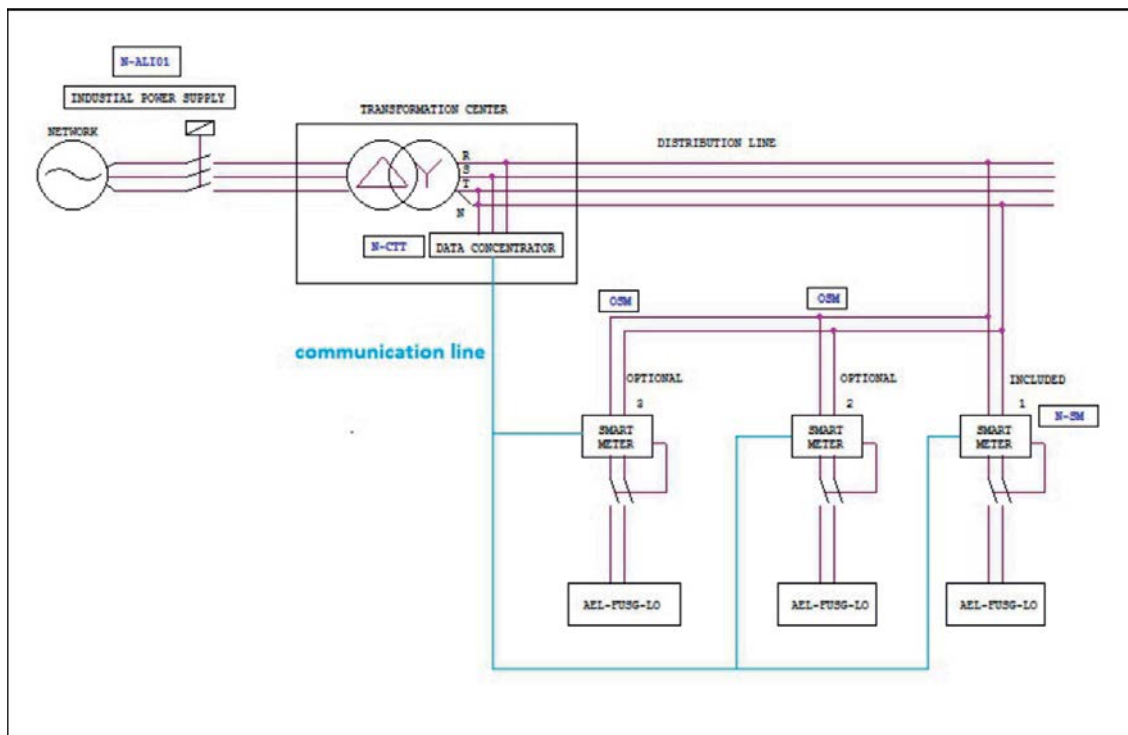
b) AEL-FUSG-E. Final User Smart Grid - Smart Energy Trainer.

The Final User Smart Grid - Smart Energy Trainer (AEL-FUSG-E) is a trainer that reflects the real operation of actual Home Energy Management Systems.

The purpose of the AEL-FUSG-E is to make the user understand how smart devices work in a smart home or industrial environment, controlling the most significant loads.

Through the AEL-FUSG-E Trainer the user will manage the monitoring, programming of consumptions and visualization of the load profile through smart devices. A great characteristic is that all smart devices use ZigBee communication (wireless communication).

This trainer consist of the following modules:

N-HPM. Home Power Module.

This module is used to share the electrical energy to other modules.

Besides, it has a differential circuit breaker and a wireless smart energy meter.

The wireless smart energy meter can communicate with other wireless devices and develop a mesh. Thus, the user can program different conditions from the software, for example, the smart energy meter can be programmed to limit the maximum consumed energy.

N-WLSM. Wireless Light Sensor Module.

This module is used to measure the luminance of a room and to send the measured parameters to the software. Through previous programming, we can associate luminance parameters to the smart relays and switch on/off the lights in function on the amount of light.

N-WSM. Wireless Switches Module.

This module is used to send commands of switching on/off to the N-IOWM (smart relays) with previews software programming.

Besides, this module has a wireless temperature sensor. The temperature sensor can be programmed from the software to control the electric heating (EH module), so we can simulate different temperature control conditions.

N-IOWM. Wireless Outputs Module. (4 units)

This module is used to supply different loads.

This element receives commands by means of radio frequency and it used to supply contactors coil or other loads in function of the programming software.

N-CON02. 3-Pole Contactor. (4 units)

These modules are contactors that receive orders of switching from the N-IOWM to supply energy to the loads.

Control and programming software.

The user can schedule switching schemes, visualize and compare the consumption with different loads, configure virtual scenes with different sensors and actuators to achieve the optimal consumption, among other possibilities to automate the consumption.

All these possibilities are programmed remotely through the software with the PC.
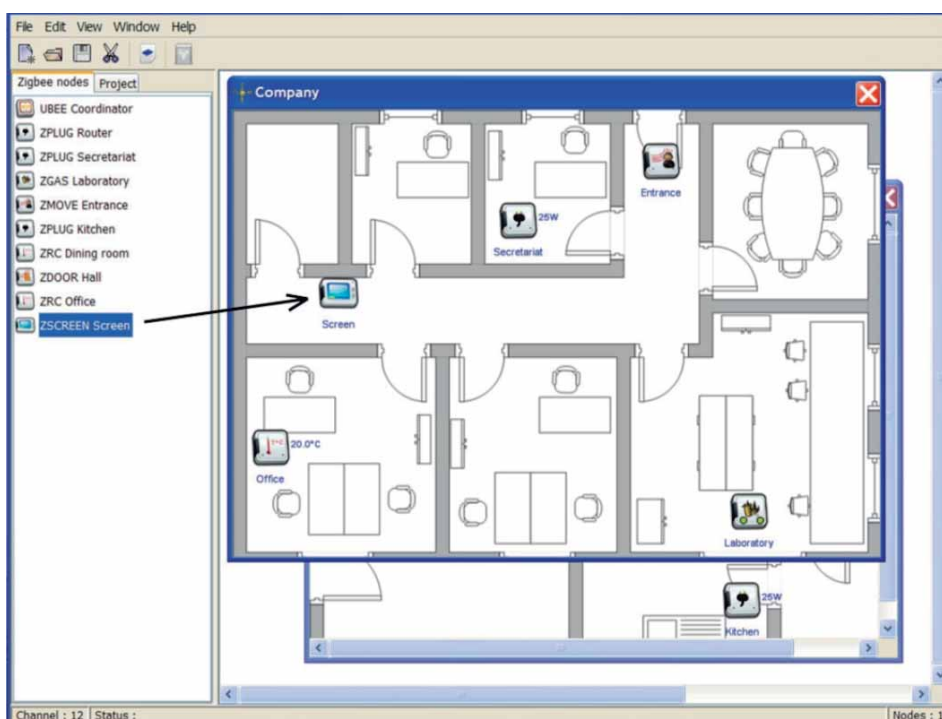
c) AEL-FUSG-N. Final User Smart Grid - Net Metering Trainer.

Through this Trainer 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.

It 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 synchronoscope 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 Flow Distribution Module).

This trainer consist of the following modules:

N-ALI01. Industrial Power Supply.

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

N-PFD. Power Flow 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 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.

N-VREG. Voltage Regulator Module.

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 Module.

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-VVCA4K. 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.
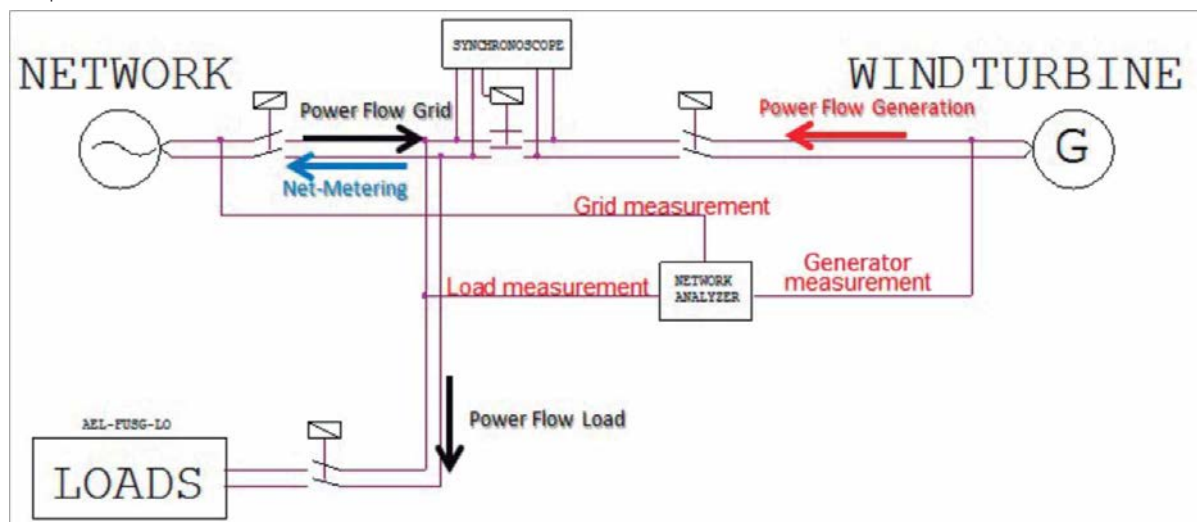
d) AEL-FUSG-LO. Smart Grid Loads.

In order to simulate different real consumptions and to carry out all the practical possibilities proposed AEL-FUSG. Final User Smart Grid Trainer requires a set of static and dynamic loads.

It consists of:

Static Loads:

N-REV. Variable Resistor.

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

N-LAM16. Halogen Lamp.

N-IND. Variable Inductance Load with commutator.

This module is used to simulate a reactive energy consumption.

N-CAR19. Single-Phase Commutable Capacitor Load.

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-VVCC/M. DC Motor Speed Controller.

N-REF. Resistor Load with commutator. (4 units)

Dynamic Loads:

EMT12. Universal Motor.

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 Module.

This module is used to simulate a conventional electric heating.

e) Optional accessories:

For AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer:

-OSM. Additional Smart Meter with AEL-FUSG-LO. Smart Grid Loads.

For AEL-FUSG-E. Final User Smart Grid - Smart Energy Trainer:

It can be included a series of home automation modules to complete the knowledge about smart control systems:

-AEL-HP-EM. Home Emergency Module.

-AEL-HP-SE. Home Security Module.

-AEL-HE-EN. Home Energy Module.

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

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

-PPINV. Photovoltaic Panel with Inverter.

-SWTI. Small Wind Turbine with Inverter.

For AEL-FUSG-LO. Smart Grid Loads:

Optionally, in order to study the automatic reactive power compensation the AEL-FUSG-LO can be supplied with the following application:

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

The complete AEL-FUSG. Final Smart Grid Trainer consists of:

a) AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer.

b) AEL-FUSG-E. Final User Smart Grid - Smart Energy Trainer.

c) AEL-FUSG-N. Final User Smart Grid - Net Metering Trainer.

d) AEL-FUSG-LO. Smart Grid Loads.

e) Optional accessories.

a) **AEL-FUSG-M.** Final User Smart Grid - **Smart Meter Trainer**, consist of the following modules:

N-ALI01. Industrial Power Supply.

This module is used to simulate the electrical grid and supply the data concentrator (N-CTT) and other possible elements.

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-CTT. Data Concentrator Module.

The communications concentrator consists of:

- A metering system formed by a number of smart meters (on our case, there is one residential smart meter). The data concentrator communicates with the smart meter by means of a power line.

- Remote control System. It is a web platform that let us have access to the data concentrator, visualize all the smart meters connected to the power line and configure different parameters, visualize all the electrical parameters of the load connected to each smart meter, etc.

Configuration and control software (platform web).

The N-CTT module includes a platform web to control the Smart Meter.

So, the user can perform the following functions:

Real time monitoring, remote management and verification of the network quality.

Relay breaker to limit the maximum consumed power by the final user.

Bidirectional communication between the Utility (the student) and the Smart Meter: the student can control and monitoring the loads state and limit the maximum power required.
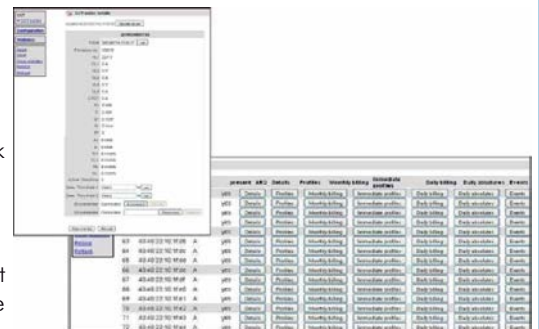
N-SM. Smart Meter Module.

The N-SM Module can carry out the following measurements and controls:

- Current measurements.

- Voltage measurements.

- Active and reactive power measurement in four quadrants.

- Bidirectional measurements of the active and reactive energy in four quadrants.

- Power factor measurements.

- Smart Relay to be controlled from the data concentrator platform web.

- See available optional accessories in page 11.

b) **AEL-FUSG-E.** Final User Smart Grid - **Smart Energy Trainer**, consist of the following modules:

N-HPM. Home Power Module.

This module is used to share the electrical energy to other modules. Besides, it has a differential circuit breaker and a wireless smart energy meter.

The wireless smart energy meter has a ZigBee communication protocol and it can be programmed to control the smart relays that supply the loads. When the consumed energy reaches a programmed value, the smart relay will be opened, so we can limit the energy consumption.

Power supply: 230 Vac. 1 Input terminal. 8 Outputs terminals.

Smart Energy Meter: 2 x 1.5 V AAA batteries.

N-WLSM. Wireless Light Sensor Module.

This module is used to measure the luminance of a room and to send the measured parameters to the software. Through previous programming, we can associate luminance parameters to the smart relays and switch on/off the lights in function on the amount of light.

Wireless communication.

Button battery: 1.5 V.

Luminance sensor.

N-WSM. Wireless Switches Module.

This module is used to send commands of switching on/off to the N-IOWM (smart relays) with previews software programming. Besides this module has a temperature sensor to control the temperature with previously programming.

Wireless communication.

Button battery: 1.5 V.

N-HPM   N-WLSM   N-WSM

N-IOWN

N-CON02

N-IOWM. Wireless Outputs Module. (4 units)

This module is used to supply different loads. This element receives commands by means of radio frequency and it used to supply contactors coil or other loads in function of the programming software.

Wireless communication.

Nominal current: 0.5 A.

Input voltage: 230 Vac.

2 Outputs relays.

N-CON02. 3-Pole Contactor. (4 units)

These modules are contactors that receive orders of switching from the N-IOWM.

Coil voltage: 230 Vac.

Contacts current: 20 A.

Control and programming software.

The AEL-FUSG-E is provided with control and programming software.

The user can schedule switching schemes, visualize and compare the consumption with different loads, configure virtual scenes with different sensors and actuators to achieve the optimal consumption, among other possibilities to automate the consumption.

All these possibilities are programmed remotely through the software with the PC.

- See available optional accessories in pages 11 and 12.
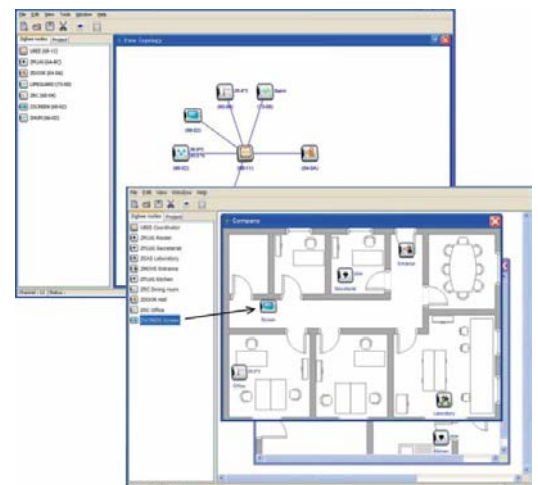
c) **AEL-FUSG-N.** Final User Smart Grid - **Net Metering Trainer**, consist of the following modules:

N-ALI01. Industrial Power Supply.

This module is used to supply others 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 Flow Distribution Module.

This module is used to control the power flows that come from the generator and the grid to supply the loads. Besides, it 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 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, +KVa, -KVa, +P, -P, +Q, -Q.
Besides this module can show currents and voltages waves.
It includes data acquisition PC oscilloscope and screen oscilloscope. It can monitor every electrical parameter involved in an electrical network.

N-VREG. Voltage Regulator Module.

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 Module.

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.
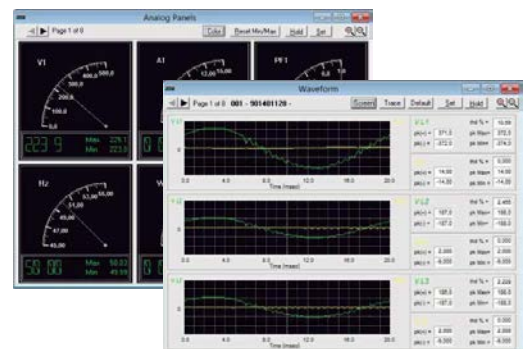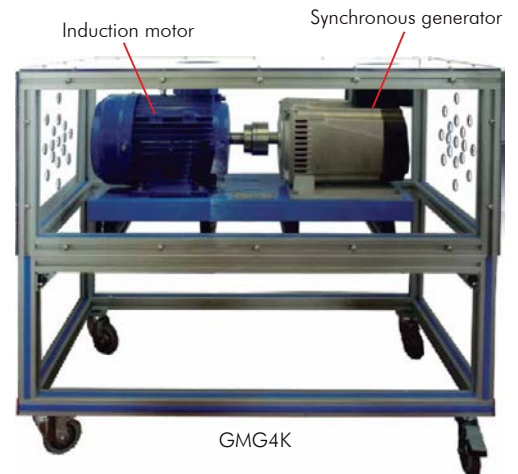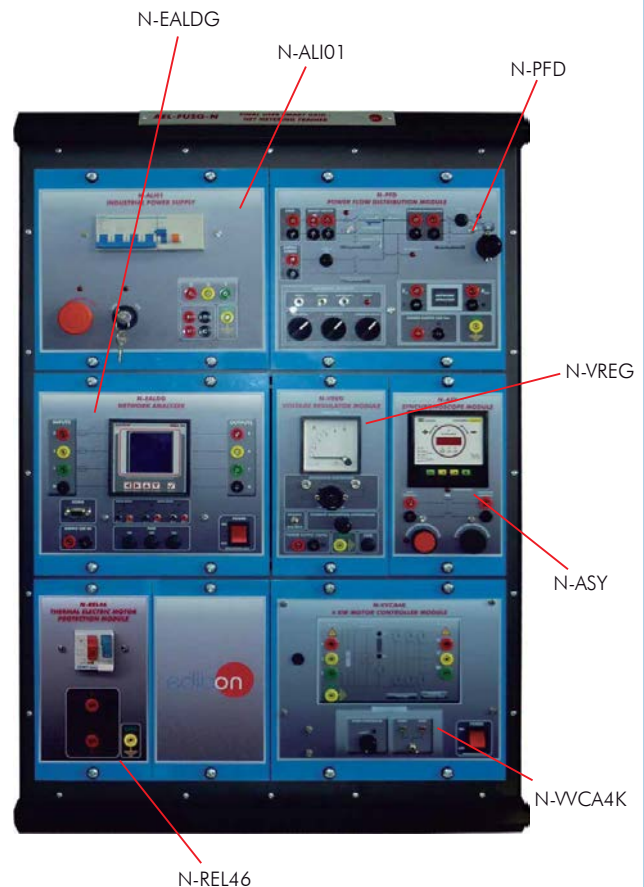
N-REL46. Thermal Electric Motor Protection Module.

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 short-circuits.

N-VVCA4K. 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.
   PMW three-phase output.

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-VVCA4K let us increase or decrease the active power generation.

N-EALDG
N-ALI01
N-PFD
N-VREG
N-ASY
N-VVCA4K
N-REL46

Induction motor   Synchronous generator

GMG4K

Continue...

d) **AEL-FUSG-LO**. **Smart Grid Loads:**

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

It is formed by:

N-REV. Variable Resistor.

Nominal current: 2 A. Nominal power: 500 W.

N-LAM16. Halogen Lamp.

Input voltage: 2 terminals of 230 Vac.

Power: 60W.

N-IND. Variable Inductance Load with commutator.

Nominal current: 2 A.

Inductance: 33 mH; 78 mH; 140 mH; 236 mH.

Commutator.

N-CAR19. Single-Phase Commutable Capacitor Load.

Nominal voltage: 230 Vac.

Capacitance: 7 µF; 14 µF; 21 µF; 28 µF; 35 µF.

Commutator.

N-LAM32. LED Lamp.

Nominal voltage: 230 Vac.

N-VVCC/M. DC Motor Speed Controller.

Adjustable voltage: up to 320 Vdc. Maximum current: 2 A.

N-REF. Resistor Load with commutator. (4 units)

Nominal current: 2 A. Nominal power: 500 W.

EMT12. Universal Motor.

Power: 230 W.

Speed: 5000/9000 r.p.m.

Frequency: 50Hz/60Hz.

V.Armature.: 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 breaking 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 Module.

This module can be used for different purposes.

Load purpose: this module is used like a resistive load of 700 W.
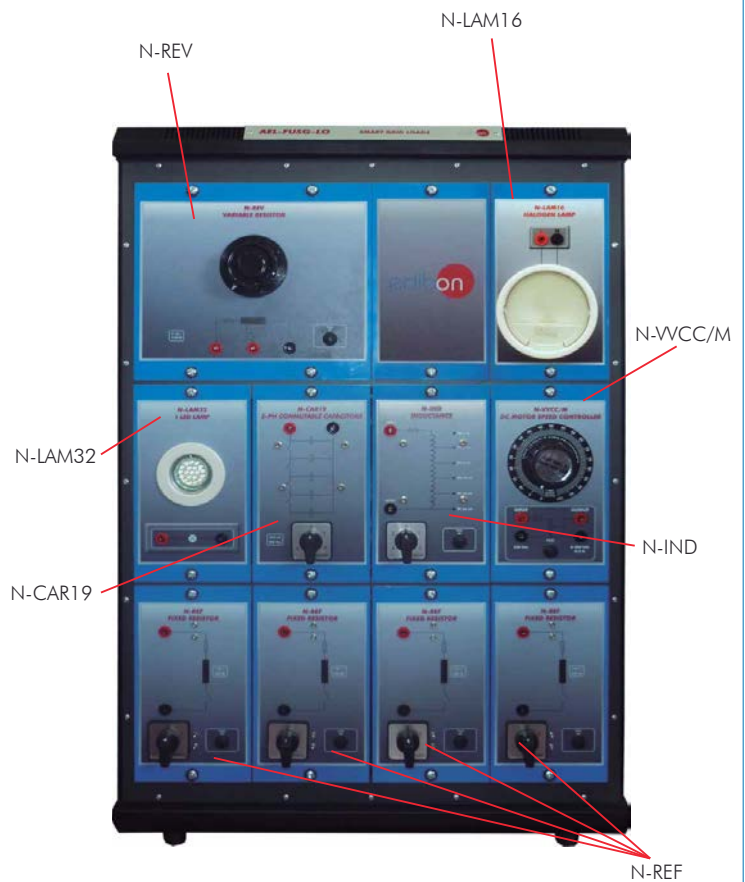
- See available optional accessories in page 11.

The AEL-FUSG Trainer is supplied with:

Cables and Accessories, for normal operation.

Manuals.

EMT12 + FRECP

EH

e) Optional accessories:

For AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer:

-OSM. Additional Smart Meter with AEL-FUSG-LO. Smart Grid Loads.

For AEL-FUSG-E. Final User Smart Grid - Smart Energy Trainer:

It can be included a series of home automation modules to complete the knowledge about smart control systems:

-AEL-HP-EM. Home Emergency Module.

-AEL-HP-SE. Home Security Module.

-AEL-HE-EN. Home Energy Module.

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

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. Smart Grid Loads:

Optionally, in order to study the automatic reactive power compensation the AEL-FUSG-LO can be supplied with the following application:

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

For AEL-FUSG-E. Final User Smart Grid - Smart Energy Trainer:

- AEL-HP-EM. Home Emergency Module:

It consists of different sensors to detect emergency conditions like flooding, fire and gas. Each sensor is provided with a smart relay and they can be associated by programming.

It includes the following elements:

N-LEAK. Leakage Water Module.

This module is used to detect water leaks. N-LEAK module has a sensor that is activated when a water leakage is detected and it sends a status signal to the software.

Wireless communication.

Button battery: 1.5V.

N-GASD. Carbon Monoxide Detector Module.

This module is used to detect smoke and gas leaks. This device emits a sound signal when smoke or carbon monoxide is detected. Besides, it sends a status signal to the software.

Wireless communication.

Button battery: 1.5V.

N-IOWM. Wireless Outputs Module. (2 units)

This module is used to supply different loads. This element receives commands by mean of radio frequency and it is used to supply contactors coil or other loads in function of the programming software.

Wireless communication.

Nominal Current: 0.5A.

Input Voltage: 230 VAC.

2 Outputs relays.

N-DET12. Gas Electro-valve.

This module is used to cut off the flow in case of alarm. This device receives orders of switching from the N-IOWM.

Input voltage: 2 terminals of 220Vac.

Power: 14W.

Maximum working pressure: 500 mbar.

Closing period: 0.1 sec.

N-DET10. Water Electro-valve.

This module is used to cut off the flow in case of leak. This device receives orders of switching from the N-IOWM.

Input voltage: 2 terminals of 220Vac.

- AEL-HP-SE. Home Security Module:

It consists of different sensors to detect emergency intrusion situations. Each sensor is provided with smart relay and they can be associated by programming.

It includes the following elements:

N-WISM. Wireless Intrusion Sensor Module.

This module is used to detect when the door or windows is opened or closed. When the sensor detects that the door is opened, it sends a signal to the software. Through previous programming, we can associate status signal to the smart relays.

Wireless communication.

Button battery: 1.5V.

N-WMSM. Wireless Motion Sensor Module.

This module is used to detect some movement. This element has a detector presence that contains an infrared sensor allowing to detect the movements in a maximum of 10 m.

Wireless communication.

N-IOWM. Wireless Outputs Module. (2 units)

This module is used to supply different loads. This element receives commands by mean of radio frequency and it used to supply contactors coil or other loads in function of the programming software.

Wireless communication.

Nominal Current: 0.5A.

Input Voltage: 230 VAC.

2 Outputs relays.

N-LAM16. Halogen Lamp.

Input voltage: 2 terminals of 230VAC.

Power: 60W.

N-TIM05. Bell + Buzzer.

Input voltage: 2 terminals of 230VAC.

Bell decibel: 70dB.

Buzzer decibel: 80dB.

- AEL-HE-EN. Home Energy Module:

It is formed by different environmental sensors, like light and temperature. It also includes smart switches and relays for general purpose. Each pair of sensor and switch is provided with a smart relay and they can be associated by programming.

It includes the following elements:

N-WSM. Wireless Switches Module.

This module is used to send commands of switching on/off to the N-IOWM (smart relays) with previews software programming. Besides this module has a temperature sensor to control the temperature with previously programming.

Wireless communication.

Button battery: 1.5V.

N-IOWM. Wireless Light Module. (2 units)

This module is used to supply different loads. This element receives commands by mean of radio frequency and it used to supply contactors coil or other loads in function of the programming software.

Wireless communication.

Nominal Current: 0.5A.

Input Voltage: 230 VAC.

2 Outputs relays.

N-WLSM. Wireless Light Sensor Module.

This module is used to measure the luminance of a room and to send the measured parameters to the software. Through previous programming, we can associate luminance parameters to the smart relays and switch on/off the lights in function on the amount of luminance.

Wireless communication.

Button battery: 1.5V.

Luminance sensor.

N-SEL04. 4 Pilot-Lights.

This module consists of two red lights and two green lights.

Input voltage of pilot lights: 2 terminals of 230VAC.

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

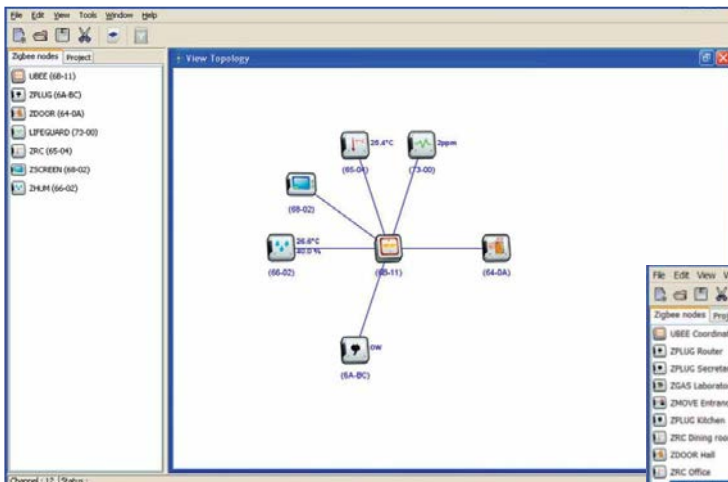Measurement details, load profiles, monthly billing, inmediate profiles, daily billing.

Instantaneous measurements, power demand threshold.

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

This screen shows the virtual devices programming.

This screen shows a home virtual plan with the devices distribution.
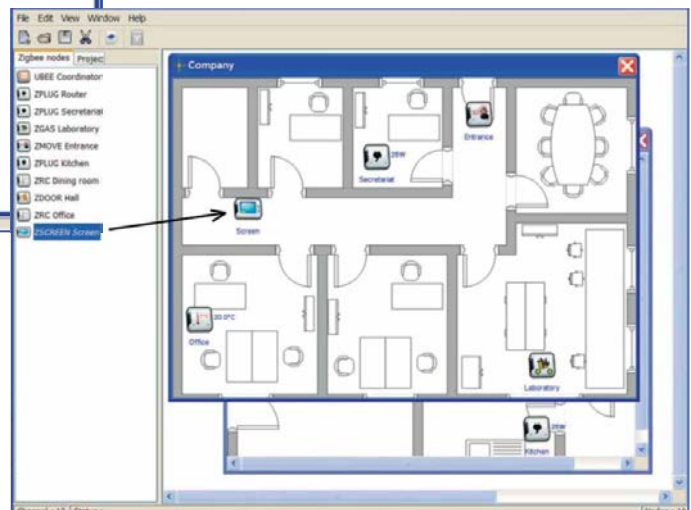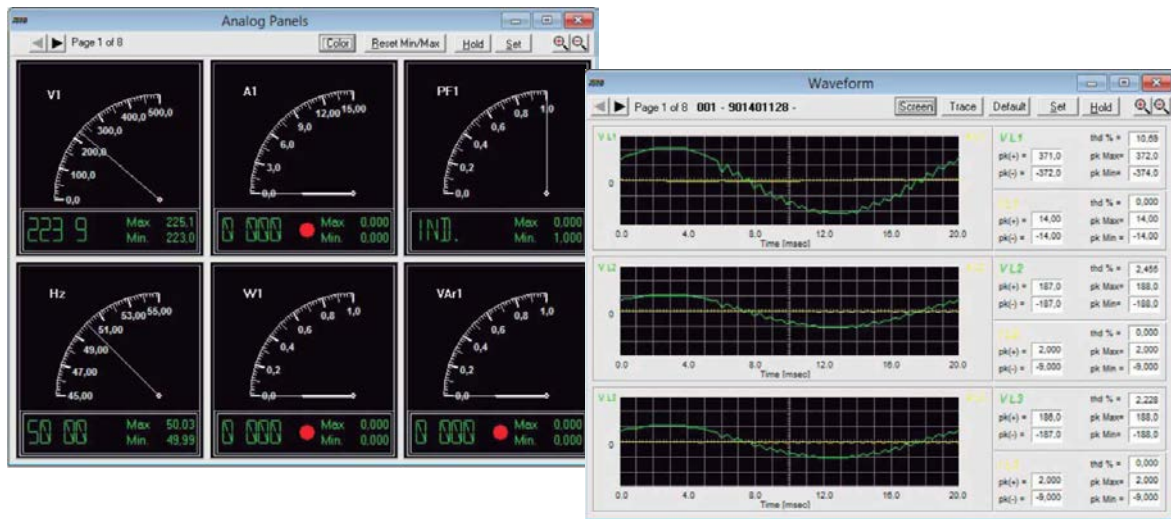
AEL-FUSG-N. Final User Smart Grid - Net Metering Trainer

N-EALDG software screen. Measures indicators panel.

Some Practical Possibilities:

AEL-FUSG-M. Final User Smart Grid – Smart Meter Trainer:

1.- Communication process with the data concentrator.

2.- Remote control of the smart meter relay.

3.- Real time monitoring of the energy consumed by the loads.

4.- Power factor comparison with different load combinations using the data concentrator web server.

5.- Comparison of the energy consumption from the utility point of view (with the platform integrated in the data concentrator) and from the final user point of view (using the smart meter display).

6.- Power factor correction using capacitor banks. The student can configure different loads and analyze the quality of energy in real time.

7.- Instantaneous measurement of the current, voltage, active power and power factor.

NOTE: All practical exercises above can be done remotely, as actual utilities do with real Smart Grids.

AEL-FUSG-E. Final User Smart Grid – Smart Energy Trainer:

8.- Studying the energy efficiency increase by using capacitor banks to compensate the reactive power of loads.

9.- Real time monitoring of local consumptions with induction, resistor or capacitive loads.

10.- Simulation of different consumptions and scheduling of the Home Energy Management System devices by the final customer.

11.- Study of the optimal load demand and programming the smart devices according to different programming schemes.

12.- Controlling and programming the loads maximum accumulated consumption.

13.- Programming the panel´s inputs and outputs.

14.- Illumination control.

15.- Temperature control system.

16.- Programming the moment of the activating of washing machine.

17.- Remote scheduling of smart devices (Smart relays, thermostat, different sensors, etc.).

18.- Developing switching schemes for appliances connected to the smart relays or thermostat with the management platform.

Practical exercises of AEL-FUSG-E Trainer with AEL-FUSG-M Trainer:

19.- Measurement of energy consumption at home or by an industrial consumer and comparison of this measurement with the utility´s register (smart meter).

20.- Simulation of different consuming periods and scheduling of the Home Energy Management System devices.

21.- Telemetering of the energy consumed by the loads using the data concentrator platform.

AEL-FUSG-N. Final User Smart Grid – Net Metering Trainer.

22.- Synchronization operations of the generator.

23.- Real time monitoring of local consumptions with induction, resistor or capacitive loads.

24.- Simulation of renewable energy generation through Generator-Motor Group.

25.- Measurement of the energy generated by the Generator-Motor Group.

26.- Net Metering. Measuring the energy consumed and the energy injected to the grid and, finally, measuring the positive or negative energy balance.

27.- Measuring of the energy consumption by the loads without generator.

28.- Measuring the energy consumption by the loads with the generator and the grid controlling the power flows from the generator.

29.- Net-Metering operations: selling energy to the grid.

Other practical exercises that can be carry out with AEL-FUSG Trainer (complete system):

30.- Measurement of energy consumption at home or by an industrial consumer and comparison of this measurement with the utility´s register (smart meter).

31.- Remote scheduling of Smart devices (Smart plug, Smart relays, thermostat, different sensors, etc.)

32.- Development of switching schemes through the management platform for appliances connected to the smart plugs, smart relays or the thermostat.

33.- 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).

DIMENSIONS & WEIGHTS

AEL-FUSG. Final User Smart Grid Trainer:

AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer:

-Dimensions: 640 x 320 x 670 mm. approx.
(25.19 x 12.59 x 26.37 inches approx.)

-Weight: 20 Kg. approx.
(44 pounds approx.)

AEL-FUSG-E. Final User Smart Grid - Smart Energy Trainer:

-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.)

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

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.)

AEL-FUSG-LO. 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.)

Some configurations

▶ Configuration for <u>1 end user</u>:

1 of AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer.
1 of AEL-FUSG-LO. Smart Grid Loads.
1of AEL-FUSG-E. Final User Smart Grid - Smart Energy Trainer.
1 of AEL-FUSG-N. Final User Smart Grid - Net Metering Trainer.
1 of optional accessories:
    AEL-HP-EM. Home Emergency Module.
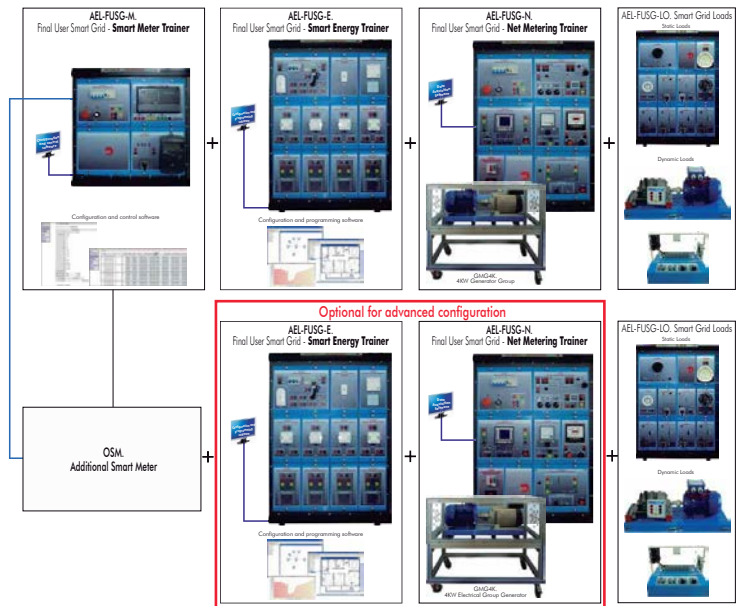   AEL-HP-SE. Home Security Module.
    AEL-HE-EN. Home Energy Module.
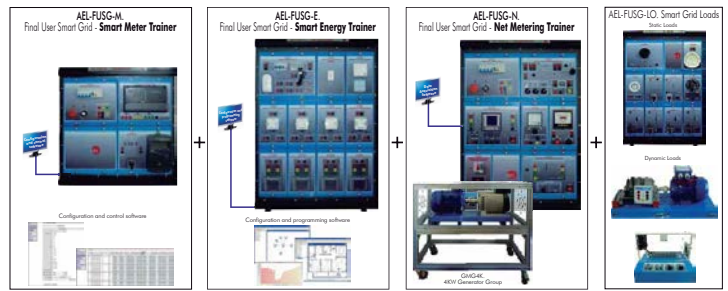
▶ Configuration for <u>2 end users</u>:

1 of AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer.
1 of AEL-FUSG-LO. Smart Grid Loads.
1 of OSM. Additional Smart Meter with AEL-FUSG-LO. Smart Grid Loads.
1 of AEL-FUSG-E. Final User Smart Grid - Smart Energy Trainer.
1 of AEL-FUSG-N. Final User Smart Grid - Net Metering Trainer.

Optional for advanced configuration:
1 of AEL-FUSG-E. Final User Smart Grid - Smart Energy Trainer.
1 of AEL-FUSG-N. Final User Smart Grid - Net Metering Trainer.
1 of optional accessories:
    AEL-HP-EM. Home Emergency Module.
   AEL-HP-SE. Home Security Module.
    AEL-HE-EN. Home Energy Module.

▶ Configuration for <u>3 end users</u>:

1 of AEL-FUSG-M. Final User Smart Grid - Smart Meter Trainer.
1 of AEL-FUSG-LO. Smart Grid Loads.
2 of OSM. Additional Smart Meter with AEL-FUSG-LO. Smart Grid Loads.
1 of AEL-FUSG-E. Final User Smart Grid - Smart Energy Trainer.
1 of AEL-FUSG-N. Final User Smart Grid - Net Metering Trainer.

Optional for advanced configuration:
2 of AEL-FUSG-E. Final User Smart Grid - Smart Energy Trainer.
2 of AEL-FUSG-N. Final User Smart Grid - Net Metering Trainer.
1 of optional accessories:
    AEL-HP-EM. Home Emergency Module.
    AEL-HP-SE. Home Security Module.
    AEL-HE-EN. Home Energy Module.

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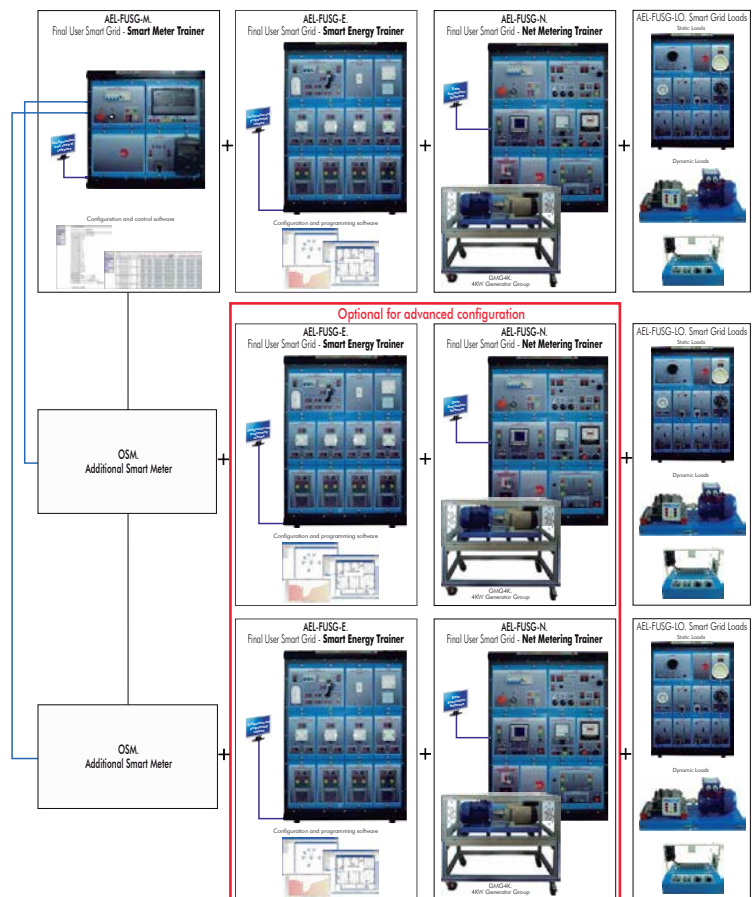
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