Energy Power Plants Application,
with SCADA

AEL-EPP

edibon

Engineering and Technical
Teaching Equipment

①Unit: AEL-EPP. Energy Power Plants Application, with SCADA

EDIBON
SCADA **System**

②
Software for:
- Computer Control
- Data Acquisition
- Data Management

③ Cables and Accessories

④ Manuals

Computer
(included in the supply)

Teaching Technique used

EDIBON PATENT

Key features:

➤ **Advanced Real-Time SCADA.**

➤ **Open Control + Multicontrol + Real-Time Control.**

➤ **Specialized EDIBON Control Software based on LabVIEW.**

➤ **Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.**

➤ **Capable of doing applied research, real industrial simulation, training courses, etc.**

➤ **Remote operation and control by the user and remote control for EDIBON technical support, are always included.**

➤ **Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).**

➤ **Designed and manufactured under several quality standards.**

➤ **Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.**

➤ **This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.**

For more information about Key Features, click here

OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL

POWERED BY

LabVIEW

www.edibon.com
↳PRODUCTS
↳4.- ELECTRICITY

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 power generation from different energy sources is essential to get a reliable and robust electrical power system. Hydroelectric, thermal and eolic power plants play an important role in the energy mix in a country. Depending on the moment of the day, the climatology and the total power demanded at any time, the energy production may come from different energy sources. For this reason it is very interesting and important to understand how these type of energy sources work.

GENERAL DESCRIPTION

The Energy Power Plants Application, "AEL-EPP", has been designed by Edibon to study the basic operation principles of power plants as well as the substations which are responsible for receiving the generated energy.

The application AEL-EPP offers different training levels that will provide the user with the essential knowledge and skills about the fundamental control, operation and functioning principles of power plants with their respective electricity generation systems. Some of the power plants simulators which are recommended with this application are, for example, the Biomass Energy Power Plant Simulator, the Wind Energy Power Plant Simulator and the Geothermal Energy Power Plant Simulator. These simulators are based on a series of mathematical models that will provide the student with the most significant concepts about power plants. Moreover, for a better understanding, this application includes a series of modules, devices and electric machines that will react according to the functioning of each plant.

The application AEL-EPP includes a specific manual where the aspects regarding high voltage power systems are explained. Its theme covers fundamental aspects such as the synchronous generators control and regulation, the electrical supply quality, frequency regulation for the balance among energy generation and demand etc.

On the other hand, it is provided a series of modules and equipments for the implementation of all the theoretical concepts previously studied in the manual.

One of the main advantages of this application is its modular character and its flexibility to be expanded in the future. This allows fulfilling different configurations of real power systems.

The application AEL-EPP includes a data control and acquisition software, SCADA, which will allow the user to control remotely the power system. The SCADA software allows carrying out the most significant operations carried out in in real power systems such as the turbine and generator speed and voltage control, coupling maneuvers of the generator with the grid (synchronization), isolated operations with the synchronous generator, voltage and current measurements at different points of the power system, power curves displaying etc.

The application AEL-EPP includes the following elements:

- N-ALI01. Industrial Main Power Supply.
- N-PSUB2. Power Generation Substation Module 2.
- N-PPCM1. Control and Protection of Turbine-Generator Group Module 1.
- EMT6/1K. 1kW/1P Three-Phase Synchronous Generator.
- SERV01. AC Servomotor 1.
- N-EALD. Network Analyzer Module with Data Acquisition.

  Required elements:

- N-REFT/3C. 3x300 W Three-Phase Configurable Resistors Module.
- N-INDT/3C. 3x300 Var Three-Phase Configurable Inductances Module.
- N-CAR19T/3C. 3x300 Var Three-Phase Configurable Capacitors Module.
- AEL-PC. Touch screen and computer.

Recommended Power Plants Simulation Softwares:
- PSV-HPPS-SOF. Hydroelectric Power Plants Simulator.
- PSV-GSPP-SOF. Gas Power Plants Simulator.
- PSV-WPPP-SOF. Wind Powered Power Plant Simulator.
- PSV-BPP-SOF. Biomass Power Plant Simulator.
- PSV-GPP-SOF. Geothermal Power Plants Simulator.
- PSV-HSPP-SOF. Heliothermic Solar Power Plant Simulator.

This Computer Controlled Unit is supplied with the EDIBON Computer Control System (SCADA), and includes: The unit itself + Data Acquisition and Data Management Software Packages, for controlling the process and all parameters involved in the process.

With this unit there are several options and possibilities:
- Main items: 1, 2, 3 and 4.
- Optional items: 5, 6 and 7.

Let us describe first the main items (1 to 4):

① **AEL-EPP. Unit.**
The AEL-EPP application includes the following elements:
- N-ALI01. **Industrial Main Power Supply.**
  Supply voltage: 400 VAC, 3PH+N+G.
  ON-OFF removable key.
  Output voltage connections:
    Three-Phase + Neutral: 400 VAC.
    Single-Phase: 230 VAC.
  Three-Phase supply hose with IP44 3PN+E 32A 400V connecting plug.
  Differential magnetothermal, 4 poles, 25A, 300mA AC 6KA.

N-ALI01

- N-PSUB2. **Power Generation Substation Module 2.**
  Supply voltage: 400 VAC, 3PH+N+G
  ON/OFF switch.
  Power and signals connection:
    Auxiliary connection.
    Three-phase turbine supply hose with IP44 3PN+E 32A 400V connecting plug.
    Three-phase generator supply hose with IP44 3PN+E 32A 400V connecting plug.
  Three switches to choose between the different modes:
    Local and remote control mode.
    Manual and automatic speed control.
    Manual and automatic excitation control
  Three control switches to:
    Start and stop the turbine.
    Give permission to synchronize the generator with the grid.
    Give permission to close 52NET circuit breaker.
  Two potentiometers to regulate:
    Turbine speed.
    Generator excitation.
  Emergency stop button.
  Two circuit breakers for synchronization and stand-alone operations.
  Different terminals to measure.
  Ethernet connection: RJ45 communication port for SCADA remote control.

N-PSUB2

- N-PPCM1. **Control and Protection of Turbine-Generator Group Module 1.**
  Automatic speed and voltage controller (easygen):
    Enables to connect up to 16 electric generators in parallel-island with distribution of active and reactive load and start/stop in function of the load demand.
    Enables to connect a generator in parallel with the grid.
    Enables different switches control modes, such as opening, closing and synchronization.
    Analogical outputs to control voltage and frequency regulators.
    Three-phase measurement of the grid and the generator voltage.
    Three-phase measurement of the generator intensity and power.
    Single-phase measurement of the grid intensity.
  Protection system.
  Generator:
    Maximum/minimum voltage (59/27), maximum/minimum frequency (81O/U), voltage asymmetry, detection of dead busbars, overvoltage (32), load unbalance (46), negative sequence power/reduced power (32R/F), overcurrent by defined curve (50/51), inverse time overcurrent (IEC255), measured ground fault (50N/51N), phase rotation, switches faults.
  Network:
    Maximum/minimum voltage (59/27), maximum/minimum frequency (81O/U), vector jump, phase rotation.
  Six alarms:
    Alarm 1: Reverse power.
    Alarm 2: Overcurrent.
    Alarm 3: Over/undervoltage.
    Alarm 4: Inverse Time Overcurrent.
    Alarm 5: Over/under frequency.
    Alarm 6: Shutdown Alarms.
  Four operation signals:
    Ready for operation.
    Start request.
    Synchronization conditions.
    Permission for synchronization.
  Back-up protections:
    Current relay.
    Reverse Power relay.
  Ethernet connection: RJ45 communication port.

N-PPCM1

- EMT6/1K. **1kW/1P Three-Phase Synchronous Generator.**
    Nominal power: 1000 VA.
    Power factor: 0.8.
    Nominal output voltage: 3x 400V AC.
    Frequency: 50/60 Hz.
    Speed: 3000 r.p.m.
    Nominal output current: 0.8 A.
    Nominal excitation current: 5 A.

EMT6/1K

- SERV01. **AC Servomotor 1.**
    Nominal power: 2000 W.
    Nominal voltage: 400V AC.
    Nominal speed: 3000 r.p.m.
    Nominal current: 5A.

SERV01

- N-EALD. **Network Analyzer Module with Data Acquisition.**
    ON-OFF switch.
    Supply voltage: 400V AC.
    Input terminals: Input connection with the measurement point.
    Output terminals: Output connection with the measurement point.
    Digital outputs: Three digital outputs are used for pulses or alarms, or for combining both.
    RS-485 Communication port.
    Fuses: 3x10 A.
    Network Analyzer Display. It shows:
        Active, reactive and apparent power.
        Active, reactive and apparent energies.
        Lines and phase currents.
        Line and phase voltages.
        Frequencies.
        Power Factor.

N-EALD

Required elements:
- N-REFT/3C. **3x300 W Three-Phase Configurable Resistors Module.**
    Configurable Star and Delta connections.
    Three banks with three three-phase resistors of 1600 Ω.
    Nominal voltage: 400V AC.
    Nominal power: 3 x (3 x 300) W.

N-REFT/3C

- N-INDT/3C. **3x300 VAr Three-Phase Configurable Inductances Module.**
    Configurable Star and Delta connection.
    Three banks with three three-phase inductances of 5 H.
    Nominal voltage: 400V AC.
    Nominal power: 3 x (3x300) VAr.

N-INDT/3C

- N-CAR19T/3C. **3x300 VAr Three-Phase Configurable Capacitors Module.**
    Configurable Star and Delta connection.
    Three banks with three three-phase capacitors of 2 μF.
    Nominal voltage: 400V AC.
    Nominal power: 3 x (3 x 300) VAr.

N-CAR19T/3C

- AEL-PC. **Touch Screen and Computer.**
    Touch Screen:
        Energy efficiency class: A.
        Screen diagonal: 68.6 cm (27 inch (s)).
        Power consumption (operating): 26 watts.
        Annual energy consumption: 38 kWh.
        Power consumption (standby / off) 0.49 watts.
        Screen resolution: 1920 x 1080 pixels.
    Computer:
        Processor Number: Intel Core i7-6600U Processor (4M Cache, up to 3,40 GHz).
        Cache: 4 MB Intel Smart Cache.
        Clock speed: 2.6 GHz.
        # Of Cores/# of Threads: 2/4.
        Max. TDP/Power: 15 W.
        Memory Types: DDR4-2133, LPDDDR3-1866, DDR3L-1600.
        Graphics: Intel HD Graphics 530.
        Slot for PCI Express.

AEL-PC

- **All necessary cables to realize the practical exercises are included.**

The complete unit includes as well:

> Advanced Real-Time SCADA.
>
> Open Control + Multicontrol + Real-Time Control.
>
> Specialized EDIBON Control Software based on LabVIEW.
>
> Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.
>
> Capable of doing applied research, real industrial simulation, training courses, etc.
>
> Remote operation and control by the user and remote control for EDIBON technical support, are always included.
>
> Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).
>
> Designed and manufactured under several quality standards.
>
> Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.
>
> This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

② **AEL-EPP/CCSOF. Computer Control + Data Acquisition + Data Management Software:**

The three softwares are part of the SCADA system.

Compatible with actual Windows operating systems. Graphic and intuitive simulation of the process in screen. **Compatible with the industry standards.**

Registration and visualization of all process variables in an automatic and simultaneous way.

Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Management, processing, comparison and storage of data.

It allows the registration of the alarms state and the graphic representation in real time.

Comparative analysis of the obtained data, after the process and modification of the conditions during the process.

Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.

This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.
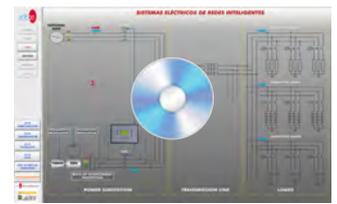
AEL-EPP/CCSOF

③ **Cables and Accessories**, for normal operation.

④ **Manuals:**

This unit is **supplied with 7 manuals**: Required Services, Assembly and Installation, Control Software, Starting-up, Safety, Maintenance & Practices Manuals.

＊References 1 to 4 are the main items: AEL-EPP + AEL-EPP/CCSOF + Cables and Accessories + Manuals are included in the minimum supply for enabling normal and full operation.

EXERCISES AND PRACTICAL POSSIBILITIES TO BE DONE WITH THE MAIN ITEMS

Operations with electrical generator and governor:

1.- Generator island grid operations.

2.- Generator parallel grid operations.

3.- Generator manual voltage regulation operations.

4.- Generator manual frequency regulation operations.

5.- Study of synchronous generator power factor regulation.

6.- Studying of turbine regulation (frequency control) in island mode.

7.- Study of turbine regulation (frequency control) in parallel grid mode.

8.- Study of excitation/voltage regulation in island mode.

9.- Study of excitation/voltage regulation in parallel grid mode.

10.- Analysis of active and reactive power control.

11.- Automatic control of active power.

12.- Automatic control of reactive power.

Particular practical exercises related to power plants:

Wind Powered Power Plant Simulator.

13.- Demonstration the working principles of mechanism of wind powered power plant simulator.

14.- Manual wind flow control.

Biomass Power Plant Simulator.

15.- Demonstration the working principles of mechanism of biomass power plant simulator.

16.- Manual biomass control.

Geothermal Power Plant Simulator.

17.- Demonstration the working principles of mechanism of biomass power plant simulator.

18.- Manual water flow control.

Heliothermic Solar Power Plant Simulator.

19.- Demonstration the working principles of mechanism of Heliothermic Solar Power Plant Simulator.

20.- Solar irradiation manual control.

Hydroelectric Power Plants Simulator.

21.- Demonstration of the operation principles of hydroelectric power plants mechanisms.

22.- Manual control of the turbine components.

Gas Power Plants Simulator.

23.- Demonstration of the operation principles of gas power plants mechanisms.

24.- Manual control of the fuel mass flux in the combustion chamber.

Other possibilities to be done with this unit:

25.- Many students view results simultaneously.

To view all results in real time in the classroom by means of a projector or an electronic whiteboard.

26.- The Computer Control System with SCADA allows a real industrial simulation.

27.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.

28.- This unit can be used for doing applied research.

29.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.

- Several other exercises can be done and designed by the user.

REQUIRED SERVICES

- Electrical supply: three-phase, 380V/50 Hz or 208V/60 Hz, 3 kW.
- Computer.

DIMENSIONS AND WEIGHTS

AEL-EPP:

- Dimensions: 1000 x 400 x 1600 mm approx.

(39.37 x 15.75 x 62.99 inches approx.)

- Weight: 100 Kg. approx.

(220 pounds approx.)

SCADA
Main screen
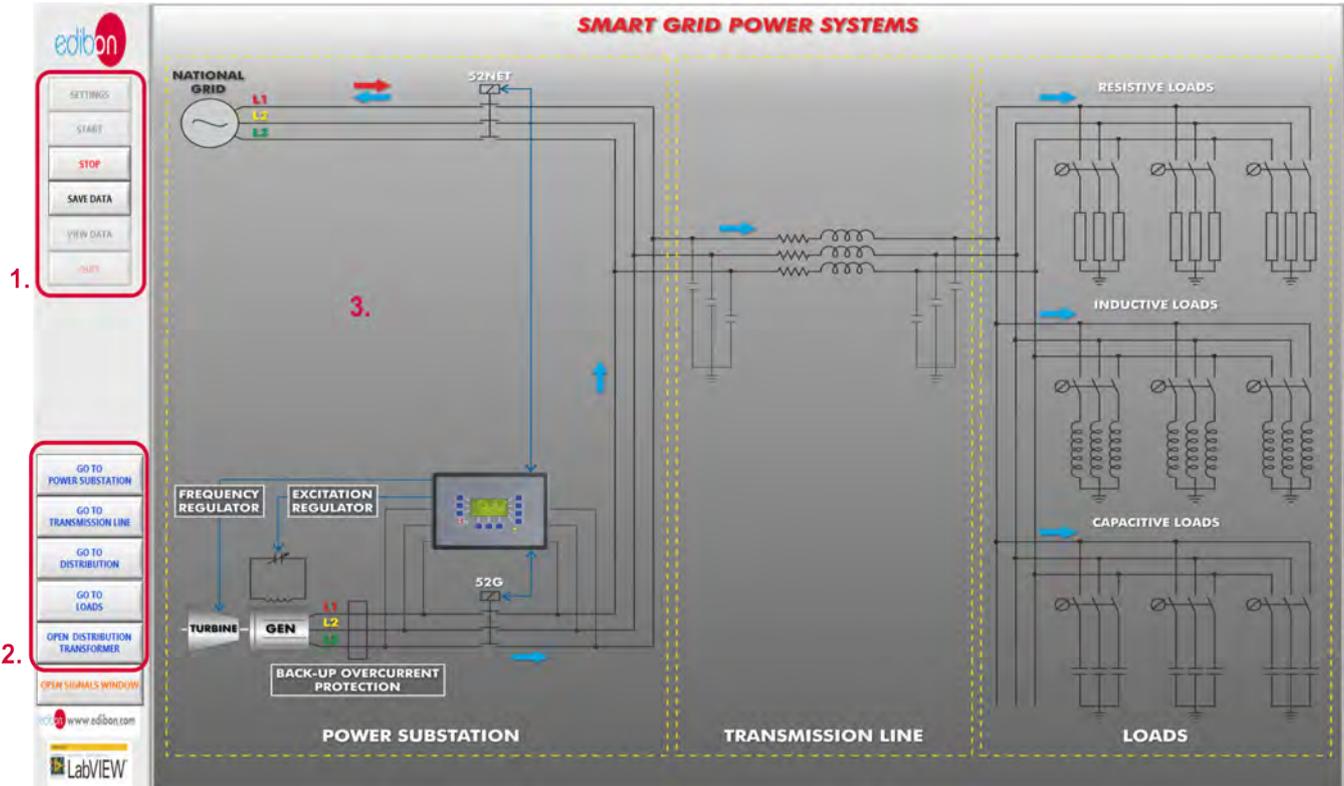
① **SCADA control menu.** It contains the main commands of the system: alarms configuration, start and stop of the system, data saving and viewing saved data.

② **Screen navigation menu. It is used to change between the specific screens of the system (power substation, transmission line and loads) and to visualize the signals measured in real time (open signals window).**

③ Diagram of the application.
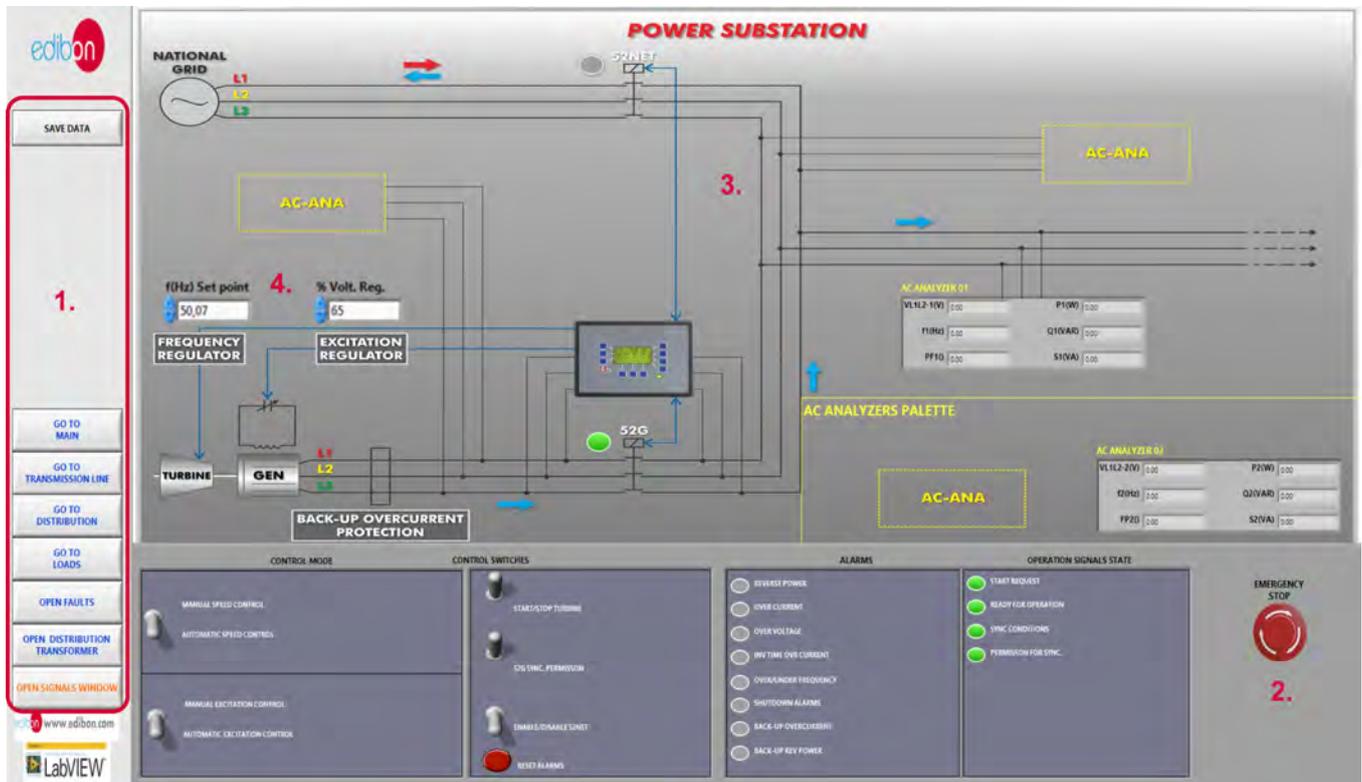
① Navigation menu and save data button.

② **Power substation control panel:** - Manual / Automatic Speed Control switch. - Manual / Automatic Excitation Control switch. - Control switches group: Start/Stop turbine, 52G synchronization permission, Enable/Disable 52NET and reset alarms. - Alarms monitoring: Revers power, over current, over voltage, inverse time over current, over frequency, shutdown alarms, back-up over current and back-up reverse power. - Operation signals state: start request, ready for operation, sync conditions, permission for sync. - Emergency stop.

③ **Diagram of the power substation.** In the right of the screen has an "AC analyzers palette" with the measures of the network analyzers. These analyzers can be moved to different positions.

④ Manual speed and voltage control regulators.

Transmission Line menu. This screen shows a three-phase diagram where the concentered parameters of the transmission line can be visualized. The impedance of each phase line can be modified changing the resistances, inductances and capacitances values.

① Navigation menu and save data button.

② **AC analyzers palette and calculations.** These tables show the measures taken by the analyzers and the different between them with the aim of obtain the line losses. The analyzers can be moved to the positions named as AC-ANA in the three-phase diagram.

③ Diagram of the transmission line. It has two buttons to save the configuration of the transmission line and to reset them to the factory values.

Power distribution substation menú. This screen shows a power distribution system diagram with double bus bar topology. This menu allows carry out all maneuvers relating to these type of power substations, such as coupling bus bars, opening and closing logic of disconnectors and breakers, etc.

① Navigation menu and save data button.

② **AC analyzers palette** for power distribution substation electrical measurements.

③ Power distribution substation diagram. It has the conjunction of lamps which indicate the disconnectors and breakers state.

④ Power distribution substation control panel. It has de function of opening and closing of controlling disconnectors and breakers.

Loads menu. This screen shows a three-phase diagram where the resistive, inductive and capacitive loads can be visualized.

① Navigation menu and save data button.

② **AC analyzers palette.** It shows the measures taken by the analyzers. The analyzers can be moved to the positions named as AC-ANA in the three-phase diagram.

③ **Diagram of the loads.** It has nine push-buttons for remote control of resistive, inductive and capacitive loads commutation.
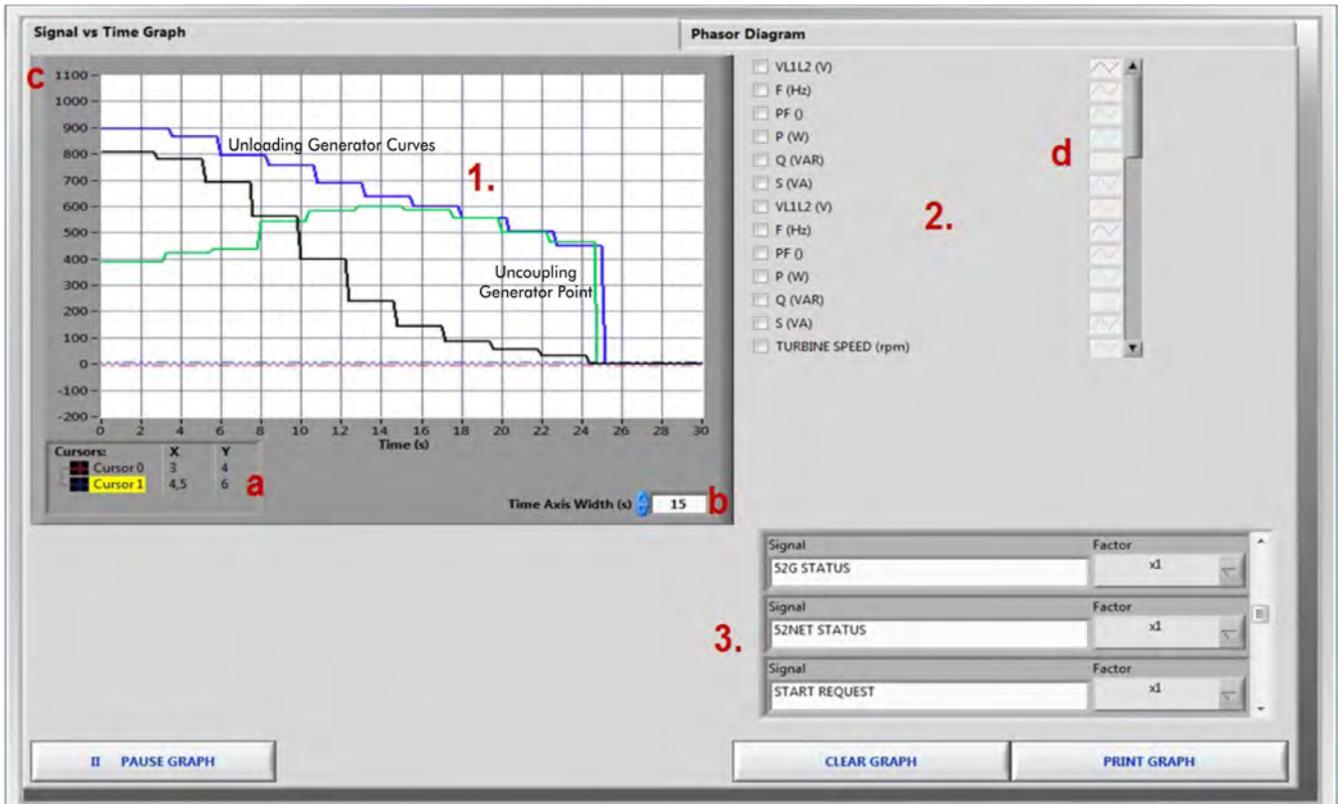
① **Real time graph.** It displays the variables selected and it is possible to take measures using two cursors (**a**) and modify the time (**b**) and the amplitude (**c**) scales. These three curves (apparent, active and reactive powers) represent uncoupling process of the generator and grid.

② **Variable selector.** In this section the variables showed in the real time graph are selected and configured.

③ **Multiplier of digital variables.**
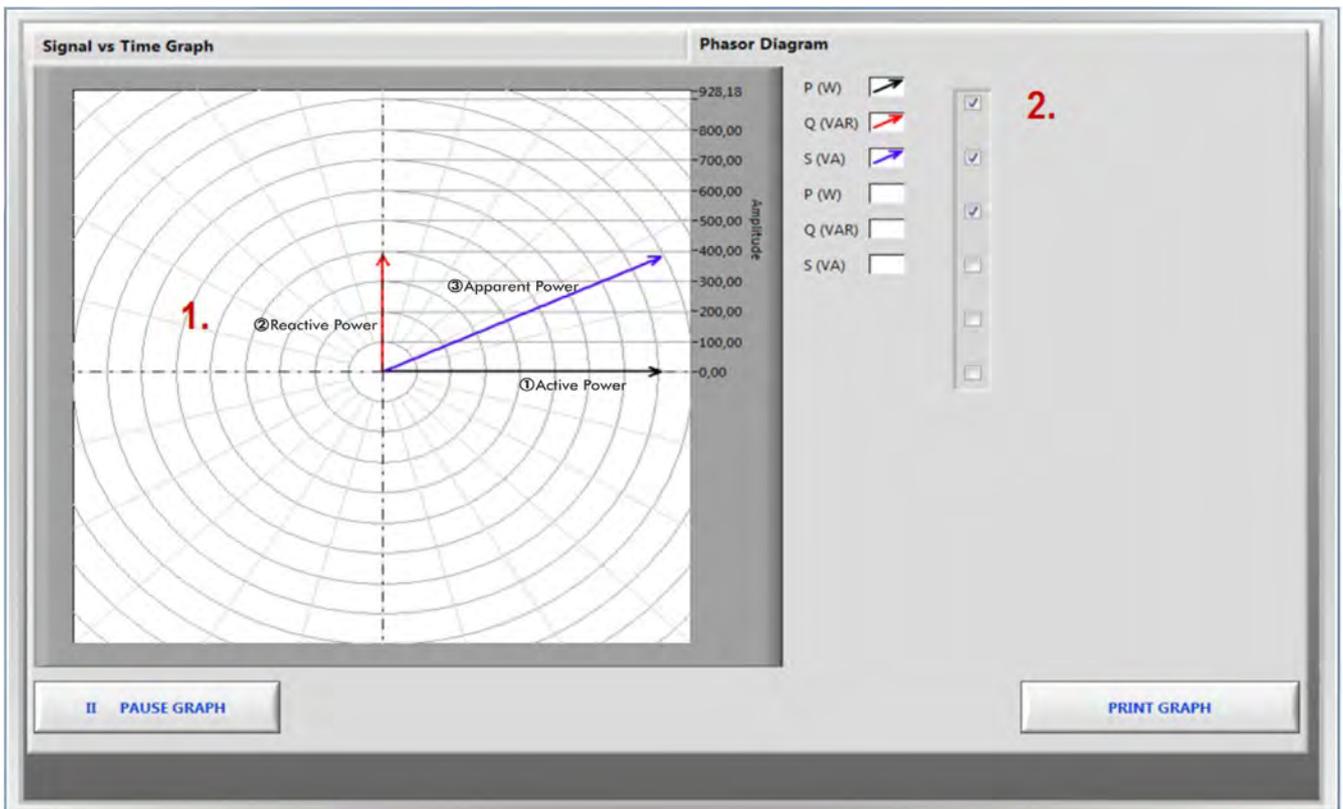
① **Real time graph.** It displays the variables selected. This picture shows the phasors diagram of the active, reactive and apparent powers of the network analyzers.

② **Variable selector.** In this section the variables showed in the real time graph are selected.

Some **real** results obtained from this Application

This picture shows a PID frequency signal report since the generator is synchronized with the grid till the generator is uncoupled of it.
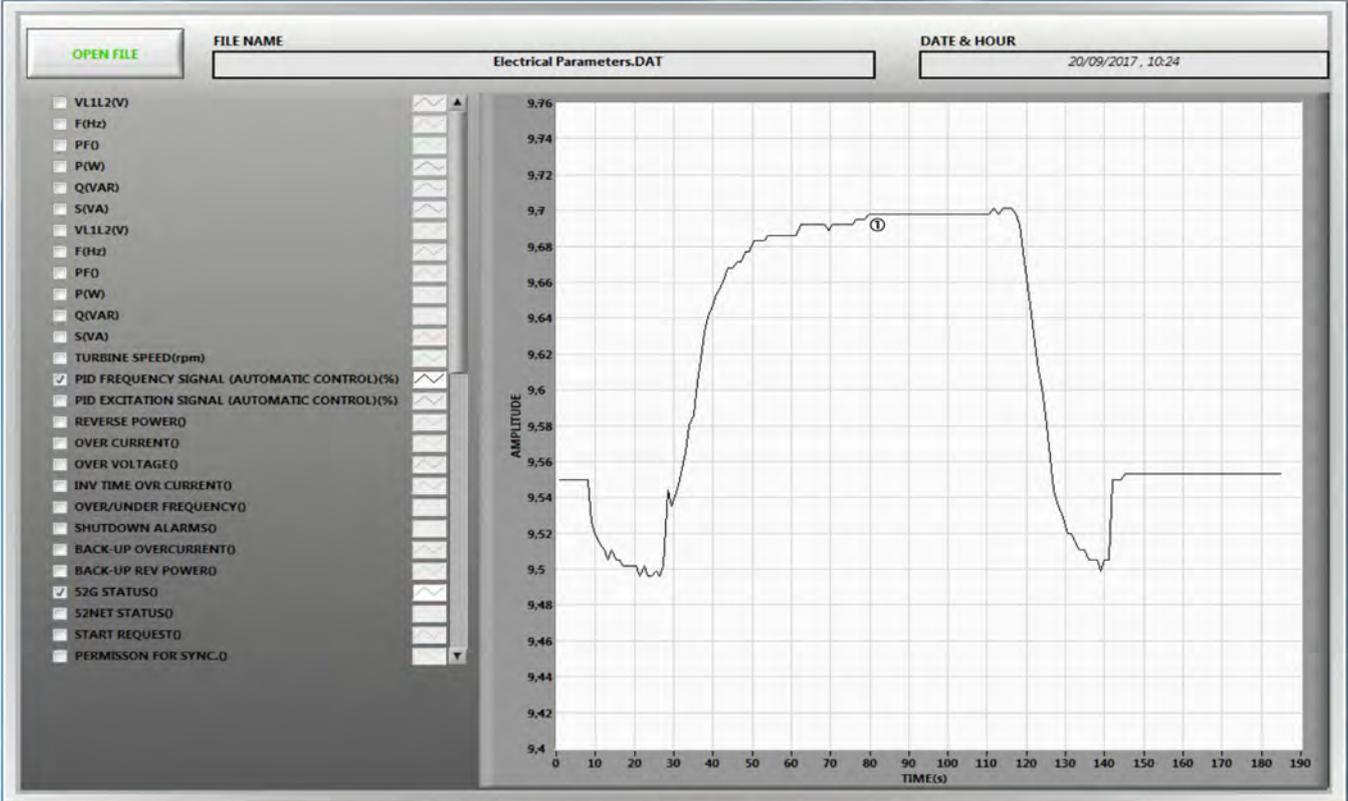
① PID Frequency Signal Reported.

This picture shows the processes of synchronization, active and reactive power generation and uncoupling generator.
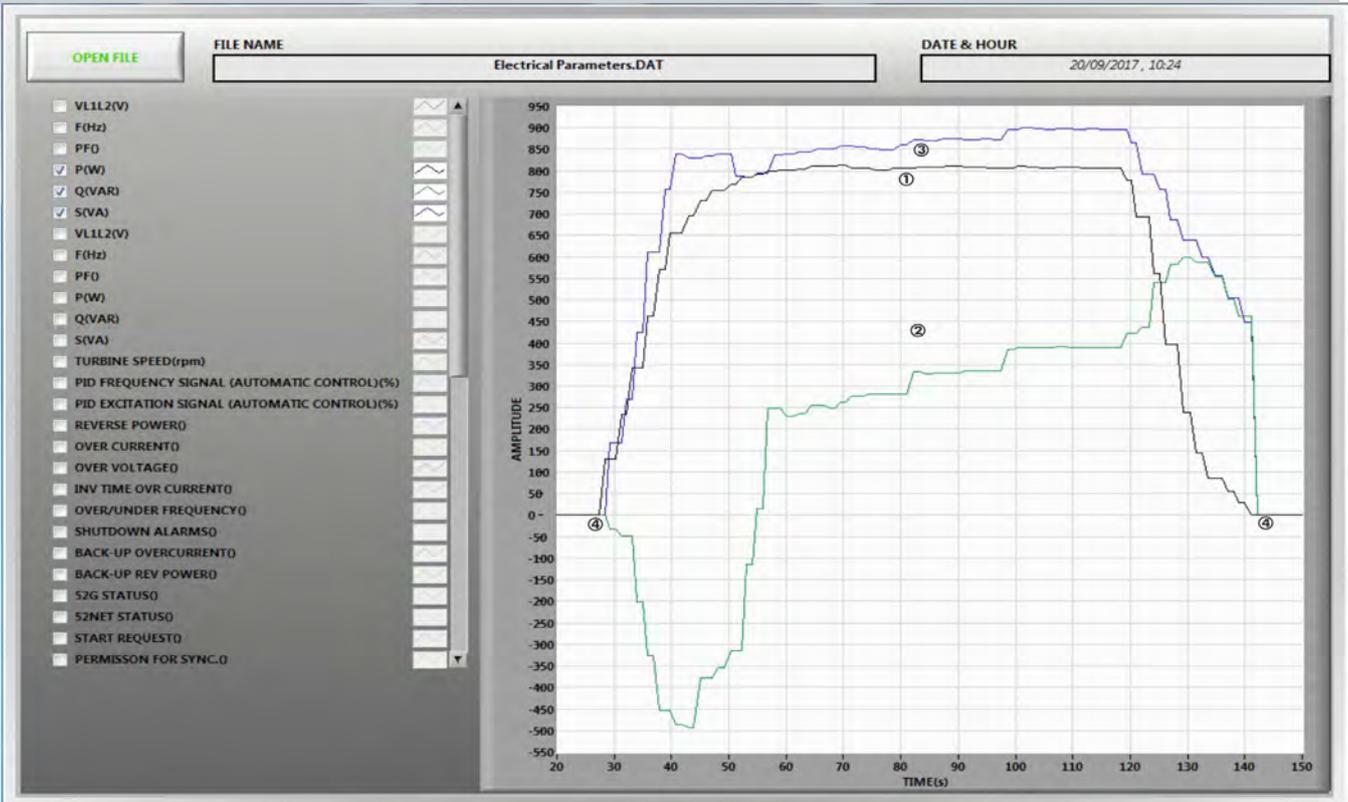
① Generator Active Power Wave.
② Generator Reactive Power Wave.
③ Generator Apparent Power Wave.
④ Synchronization.
⑤ Uncoupling generator.

Some **real** results obtained from this Application

This picture shows the generator starting, as well as the voltage and requency regulation of the same one.
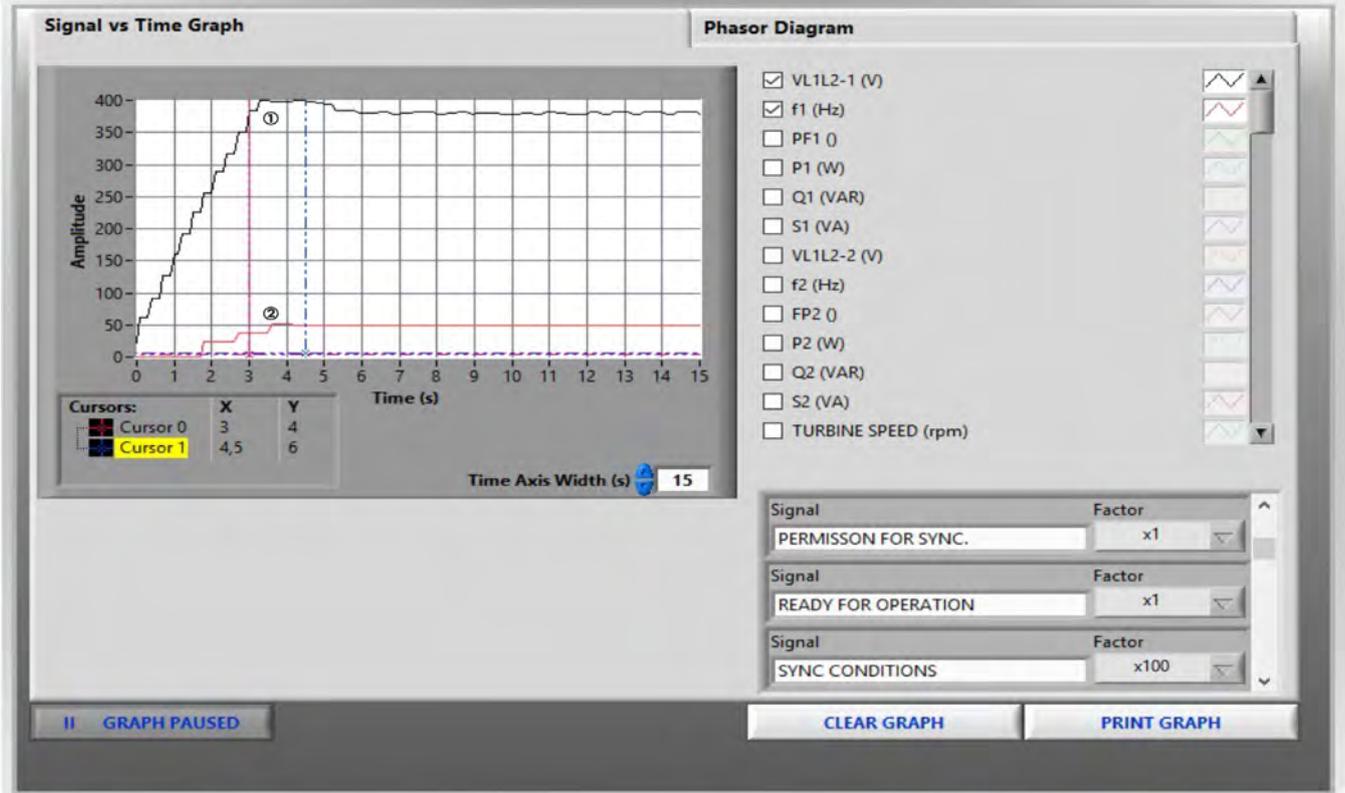
① Generator Voltage Wave.
② Generator Frequency Wave.

This picture shows different active power stages and the generator responses against these stages.
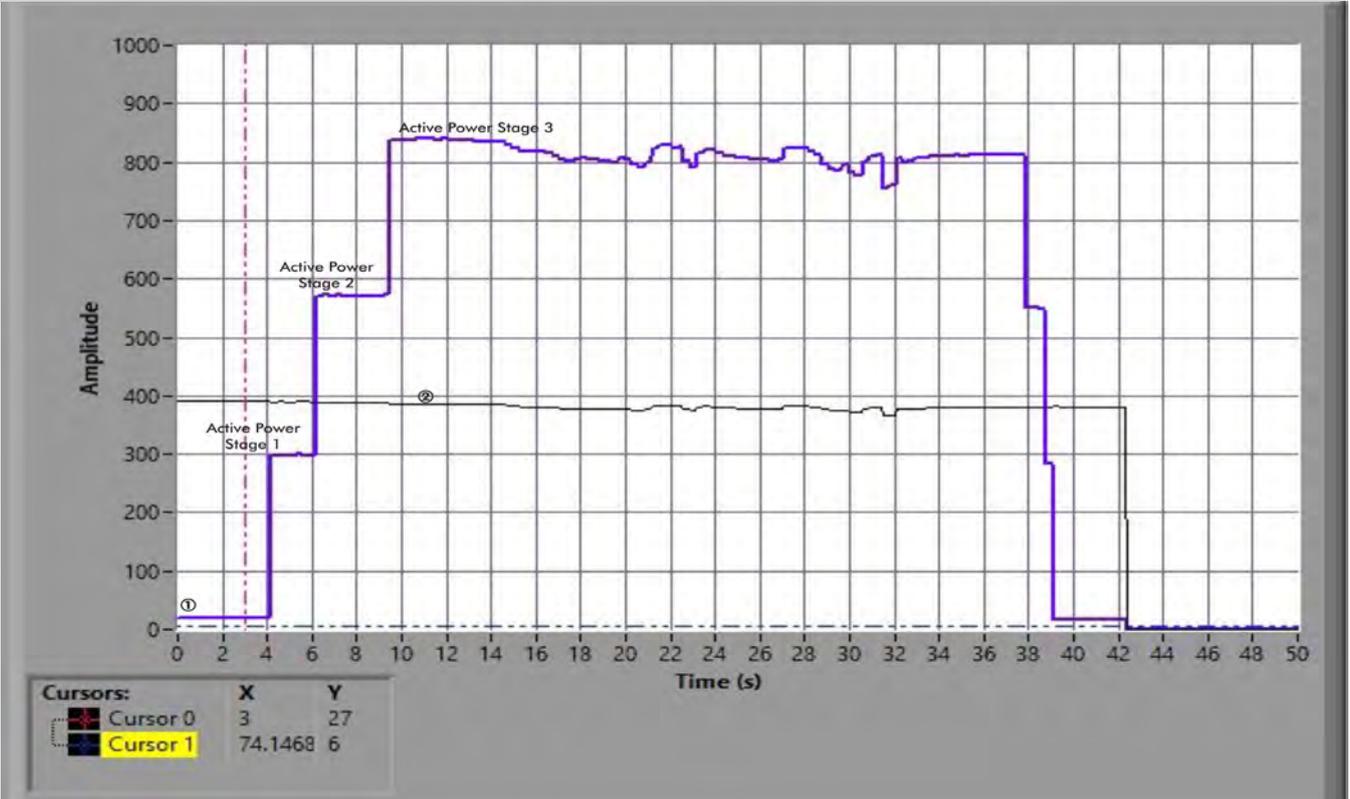
① Active power generator wave with three load stages.
② Generator voltage wave.

Some **real** results obtained from this Application

This picture shows the synchronization process between the generator and the grid. In the first stage, the turbine is unstable (0 - 6 sec.) and there are fluctuations in P and Q powers up to 6 seconds. After this point, the active power generator ramp is linear up to 18 seconds. Finaly, the generator works in permanent regime.
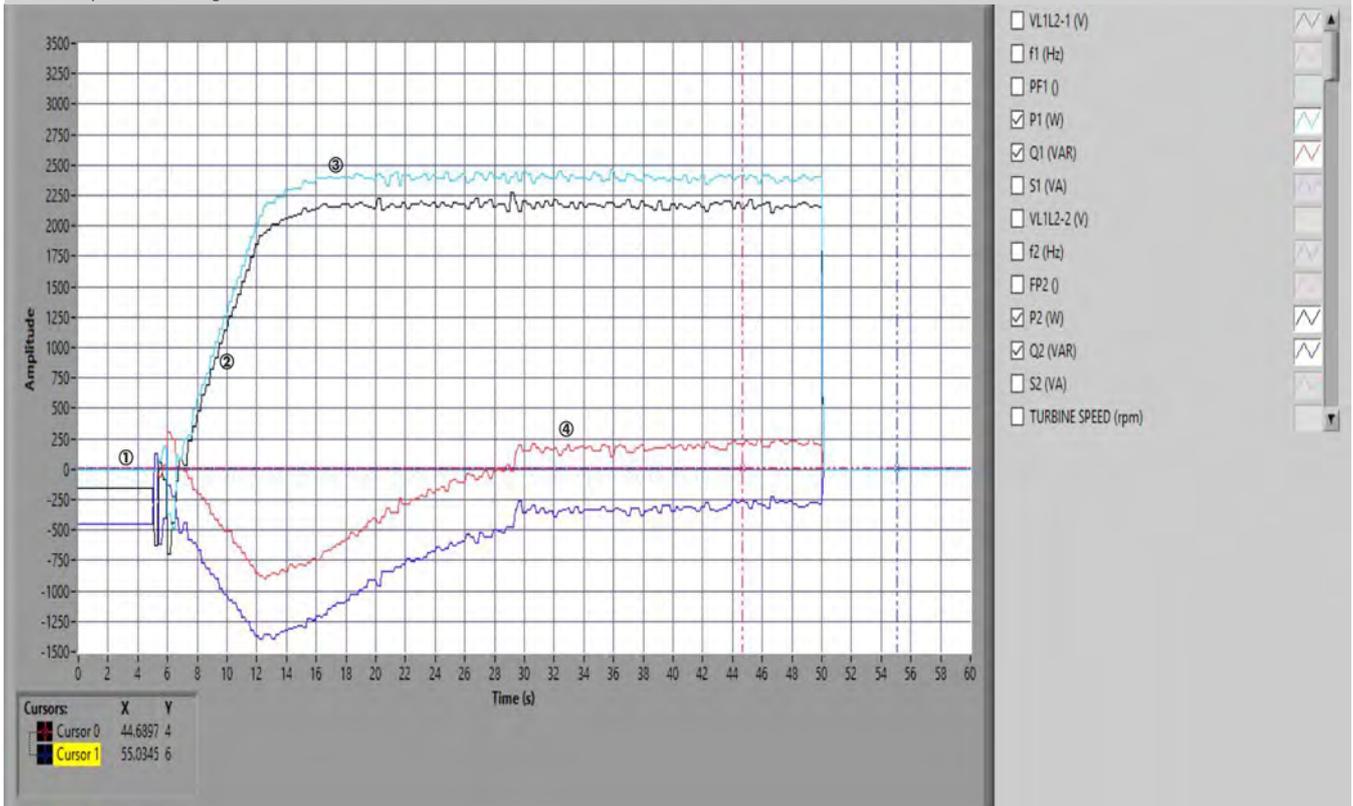
① Generation of active power in permanent regimen in parallel with the grid.

② Generator loading ramp.

③ Reactive power wave during synchronization and loading of generator.

④ Coupling of the generator with the grid.

This picture shows the generation/demand of active power while the injection of a fault and the stopping of the machine after this fault.
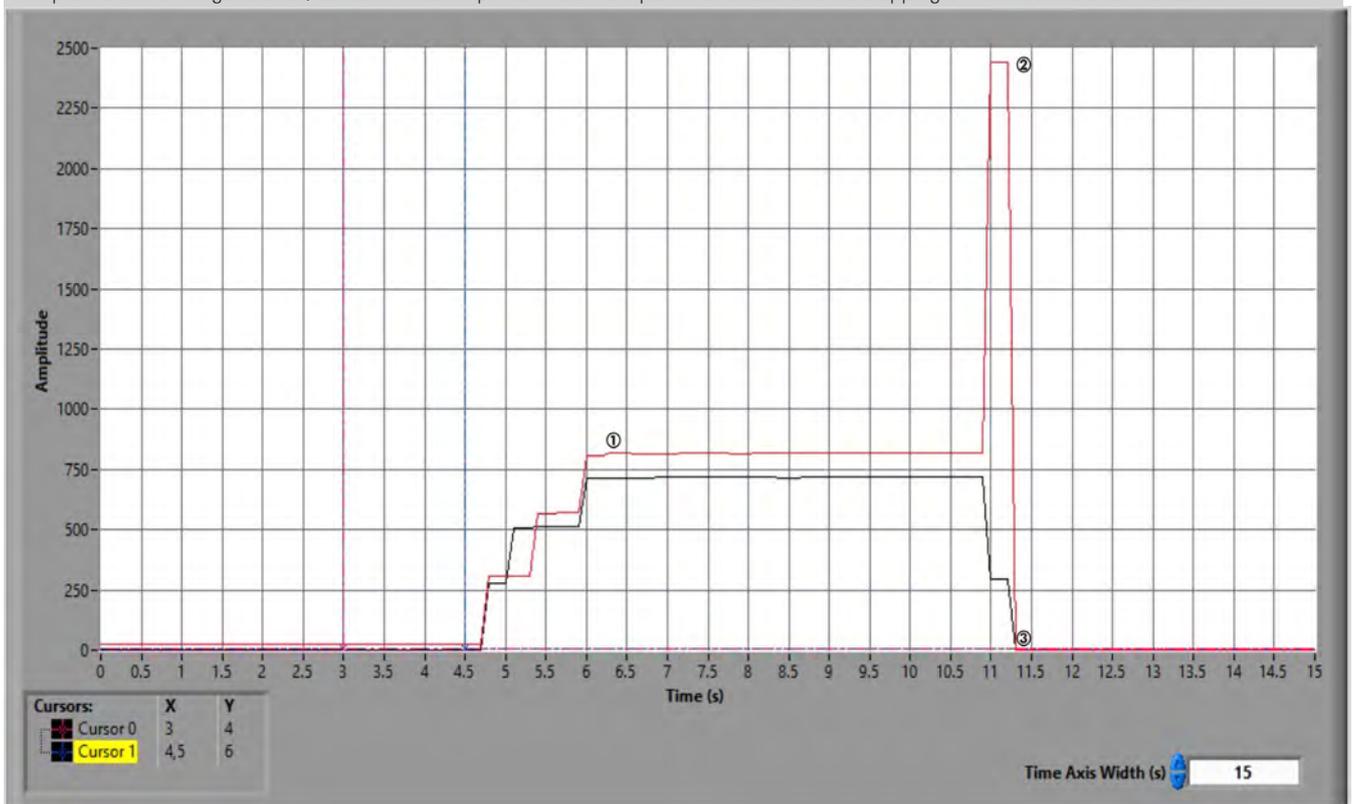
① Active power consumption.

② Fault overcurrent.

③ Turning off the generator.

Screen of the Simulator of the Plant's Power of Wind Energy
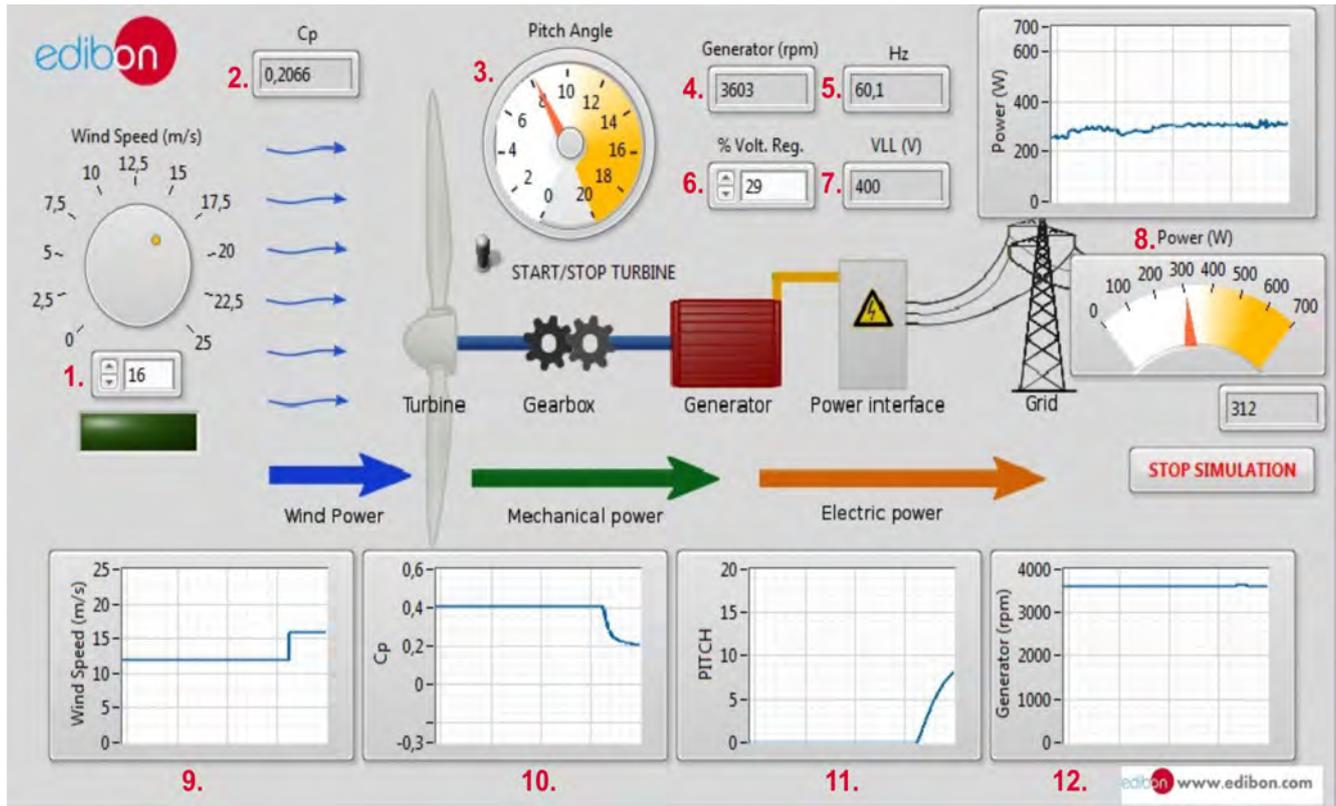
1. Wind speed.
2. Power coefficient.
3. Pitch Angle.
4. Generator rotational speed.
5. Generator frequency.
6. Voltage regulator.
7. Generator output voltage.
8. Power graph and meter.
9. Wind speed graph.
10. Power coefficient graph.
11. Pitch angle graph.
12. Generator rotational speed graph.

Simulator screen of the Biomass Energy Power Plant
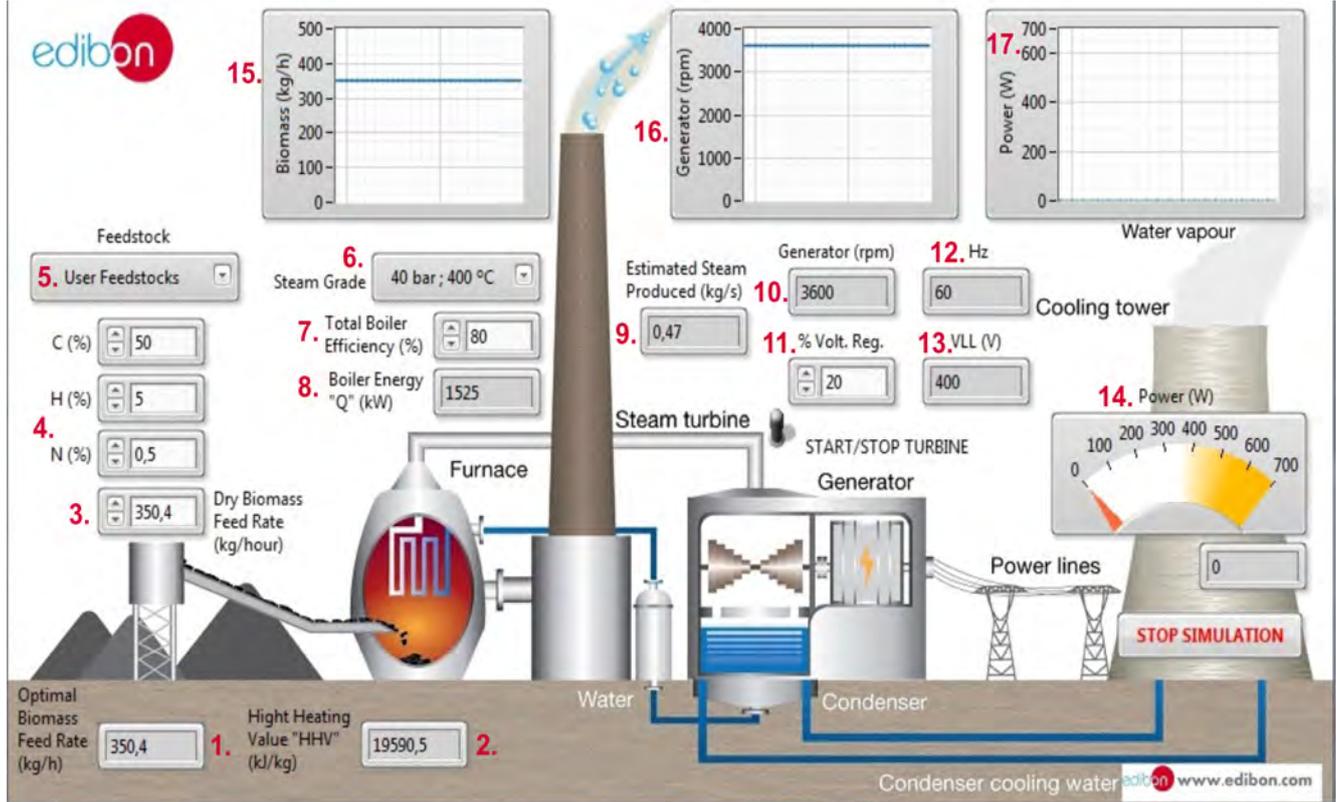
1. Optimum biomass mass flow.
2. Introduced biomass mass flow.
3. Biomass Higher Heating Value.
4. Biomass composition.
5. Biomass compound selector.
6. Vapor pressure and temperature.
7. Boiler efficiency.
8. Boiler heating power.
9. Estimated produced steam.
10. Generator rotational speed.
11. Generator frequency.
12. Voltage regulator.
13. Generator output voltage.
14. Power meter.
15. Biomass mass flow graph.
16. Generator rotational speed graph.
17. Power graph.

Simulator screen of the Geothermal Energy Power Plant
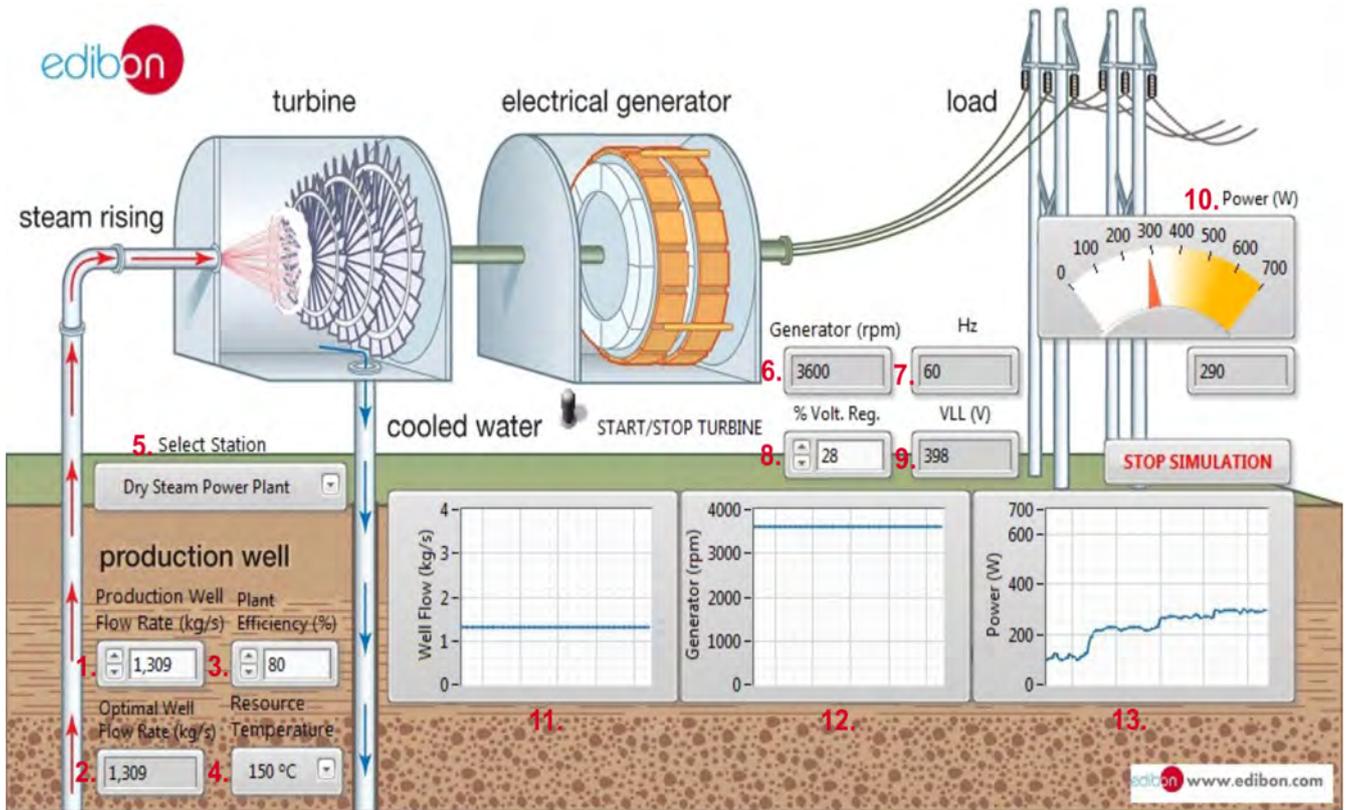
1. Introduced water or vapour mass flux.
2. Optimun water or vapour mass flux.
3. Plant efficiency.
4. Resource temeprature.
5. Type of geothermal plant selector.
6. Generator rotational speed.
7. Generator frequency.
8. Voltage regulator.
9. Generator output voltage.
10. Power meter.
11. Water or vapour mass flow graph.
12. Generator rotational speed graph .
13. Power graph.

Additionally to the main items (1, 2, 3 and 4) described, we can offer, as optional, other items from 5 to 7.

All these items try to give more possibilities for:

a) Technical and Vocational Education configuration. (ICAI)

b) Multipost Expansions options. (Mini ESN and ESN)

a) Technical and Vocational Education configuration

⑤ **AEL-EPP/ICAI. Interactive Computer Aided Instruction Software System.**

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.

This software is optional and can be used additionally to items (1 to 4).

- 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.**

- 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

Instructor Software
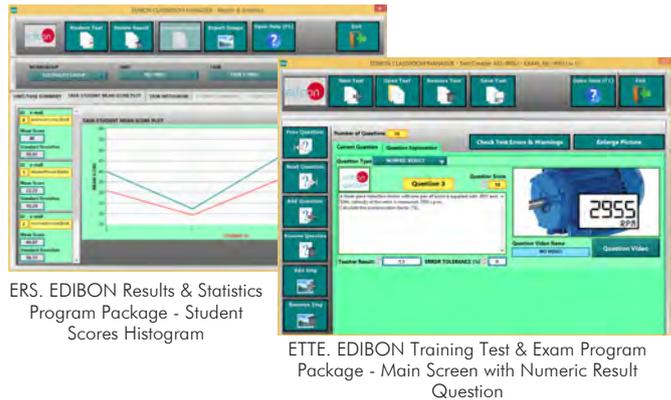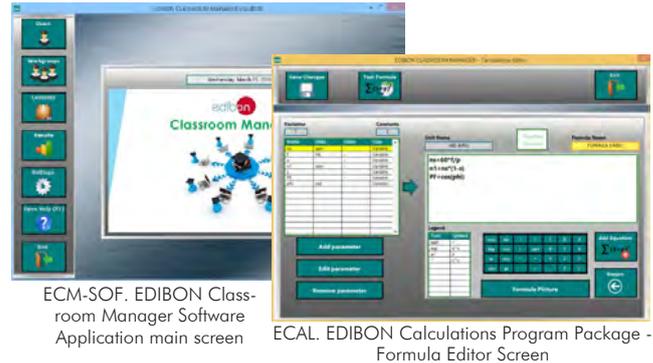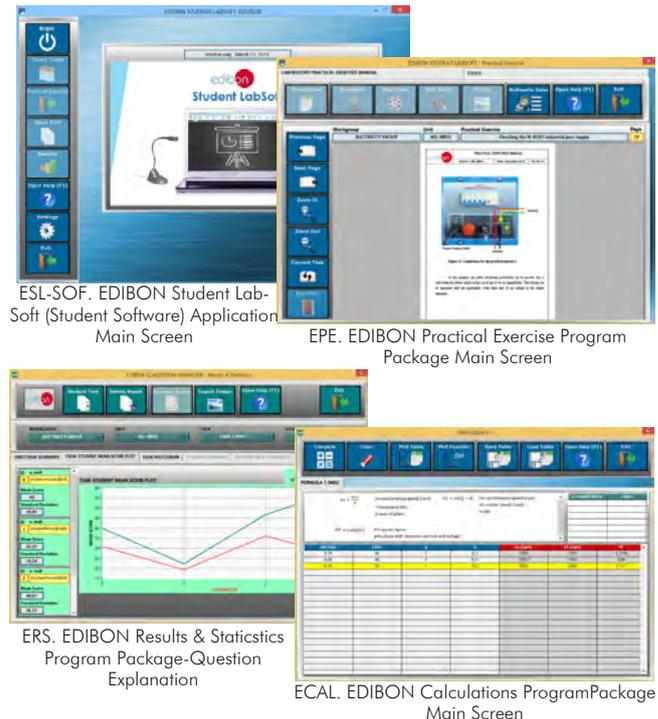
ECM-SOF. EDIBON Classroom Manager Software Application main screen

ECAL. EDIBON Calculations Program Package - Formula Editor Screen

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

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

Student Software

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

EPE. EDIBON Practical Exercise Program Package Main Screen

ERS. EDIBON Results & Staticstics Program Package-Question Explanation

ECAL. EDIBON Calculations ProgramPackage Main Screen

⑥ **Mini ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.**

Mini ESN. EDIBON Mini Scada-Net System allows up to 30 students to work with a Teaching Unit in any laboratory, simultaneously.

It is useful for both, Higher Education and/or Technical and Vocational Education.

The Mini ESN system consists of the adaptation of any EDIBON computer controlled unit with SCADA integrated in a local network.

This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit. Then, the number of possible users who can work with the same unit is higher than in an usual way of working (usually only one).

Main characteristics:

- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA, connected in a local net.
- Open Control + Multicontrol + Real Time Control + Multi Student Post.
- Instructor controls and explains to all students at the same time.
- Any user/student can work doing "real time" control/multicontrol and visualisation.
- Instructor can see in the computer what any user/student is doing in the unit.
- Continuous communication between the instructor and all the users/students connected.

Main advantages:

- It allows an easier and quicker understanding.
- This system allows you can save time and cost.
- Future expansions with more EDIBON Units.

For more information see **Mini ESN** catalogue. Click on the following link:

www.edibon.com/products/catalogues/en/Mini-ESN.pdf

Mini ESN.
EDIBON Mini Scada-Net System

1 UNIT= up to 30 STUDENTS can work simultaneously

Energy Power Plants Application, with SCADA (AEL-EPP)

Software for:
- Computer Control
- Data Acquisition
- Data Management

Instructors Central Computer

Mini Scada-Net Software

LOCAL NET FOR 30 STUDENTS

**OPEN CONTROL
+
MULTICONTROL
+
REAL TIME CONTROL**

Note: The Mini ESN system can be used with any EDIBON computer controlled unit

⑦ **ESN. EDIBON Scada-Net System.**

This unit can be integrated, in the future, into a Complete Laboratory with many Units and many Students.

www.edibon.com/en/files/expansion/ESN/catalog
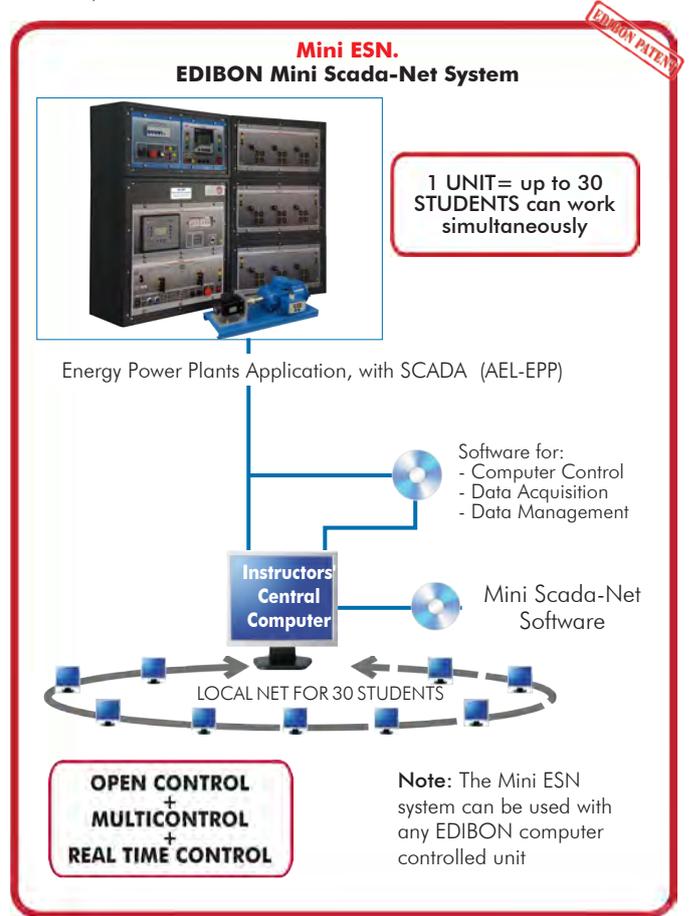
Main items (always included in the supply)

Minimum supply always includes:

① **Unit: AEL-EPP. Energy Power Plants Application.**

② **AEL-EPP/CCSOF. Computer Control + Data Acquisition + Data Management Software.**

③ **Cables and Accessories**, for normal operation.

④ **Manuals.**

*IMPORTANT: Under AEL-EPP we always supply all the elements for immediate running as 1, 2, 3 and 4.

Optional items (supplied under specific order)

a) Technical and Vocational configuration

⑤ AEL-EPP/ICAI. Interactive Computer Aided Instruction Software System.

b) Multipost Expansions options

⑥ Mini ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units..

⑦ ESN. EDIBON Scada-Net System.

① **AEL-EPP. Unit.**

The AEL-EPP application includes the following elements:

- **N-ALI01. Industrial Main Power Supply.**
  Supply voltage: 400 VAC, 3PH+N+G.
  ON-OFF removable key.
  Output voltage connections:
    Three-Phase + Neutral: 400 VAC.
    Single-Phase: 230 VAC.
  Three-Phase supply hose with IP44 3PN+E 32A 400V connecting plug.
  Differential magnetothermal, 4 poles, 25A, 300mA AC 6KA.

- **N-PSUB2. Power Generation Substation Module 2.**
  Supply voltage: 400 VAC, 3PH+N+G
  ON/OFF switch.
  Power and signals connection:
    Auxiliary connection.
    Three-phase turbine supply hose with IP44 3PN+E 32A 400V connecting plug.
    Three-phase generator supply hose with IP44 3PN+E 32A 400V connecting plug.
  Three switches to choose between the different modes:
    Local and remote control mode.
    Manual and automatic speed control.
    Manual and automatic excitation control
  Three control switches to:
    Start and stop the turbine.
    Give permission to synchronize the generator with the grid.
    Give permission to close 52NET circuit breaker.
  Two potentiometers to regulate:
    Turbine speed.
    Generator excitation.
  Emergency stop button.
  Two circuit breakers for synchronization and stand-alone operations.
  Different terminals to measure.
  Ethernet connection: RJ45 communication port for SCADA remote control.

- **N-PPCM1. Control and Protection of Turbine-Generator Group Module 1.**
  Automatic speed and voltage controller (easygen):
    Enables to connect up to 16 electric generators in parallel-island with distribution of active and reactive load and start/stop in function of the load demand.
    Enables to connect a generator in parallel with the grid.
    Enables different switches control modes, such as opening, closing and synchronization.
    Analogical outputs to control voltage and frequency regulators.
    Three-phase measurement of the grid and the generator voltage.
    Three-phase measurement of the generator intensity and power.
    Single-phase measurement of the grid intensity.
  Protection system.
  Generator:
    Maximum/minimum voltage (59/27), maximum/minimum frequency (81O/U), voltage asymmetry, detection of dead busbars, overvoltage (32), load unbalance (46), negative sequence power/reduced power (32R/F), overcurrent by defined curve (50/51), inverse time overcurrent (IEC255), measured ground fault (50N/51N), phase rotation, switches faults.
  Network:
    Maximum/minimum voltage (59/27), maximum/minimum frequency (81O/U), vector jump, phase rotation.
  Six alarms:
    Alarm 1: Reverse power.
    Alarm 2: Overcurrent.
    Alarm 3: Over/undervoltage.
    Alarm 4: Inverse Time Overcurrent.
    Alarm 5: Over/under frequency.
    Alarm 6: Shutdown Alarms.
  Four operation signals:
    Ready for operation.
    Start request.
    Synchronization conditions.
    Permission for synchronization.
  Back-up protections:
    Current relay.
    Reverse Power relay.
  Ethernet connection: RJ45 communication port.

- **EMT6/1K. 1kW/1P Three-Phase Synchronous Generator.**
  Nominal power: 1000 VA.
  Power factor: 0.8.
  Nominal output voltage: 3x 400V AC.
  Frequency: 50/60 Hz.
  Speed: 3000 r.p.m.
  Nominal output current: 0.8 A.
  Nominal excitation current: 5 A.

- SERV01. AC Servomotor 1.
  Nominal power: 2000 W.
  Nominal voltage: 400V AC.
  Nominal speed: 3000 r.p.m.
  Nominal current: 5A.
- N-EALD. Network Analyzer Module with Data Acquisition.
  ON-OFF switch.
  Supply voltage: 400V AC.
  Input terminals: Input connection with the measurement point.
  Output terminals: Output connection with the measurement point.
  Digital outputs: Three digital outputs are used for pulses or alarms, or for combining both.
  RS-485 Communication port.
  Fuses: 3x10 A.
  Network Analyzer Display. It shows:
    Active, reactive and apparent power.
    Active, reactive and apparent energies.
    Lines and phase currents.
    Line and phase voltages.
    Frequencies.
    Power Factor.
Required elements:
- N-REFT/3C. 3x300 W Three-Phase Configurable Resistors Module.
    Configurable Star and Delta connections.
    Three banks with three three-phase resistors of 1600 Ω.
    Nominal voltage: 400V AC.
    Nominal power: 3 x (3 x 300) W.
  - N-INDT/3C. 3x300 VAr Three-Phase Configurable Inductances Module.
    Configurable Star and Delta connection.
    Three banks with three three-phase inductances of 5 H.
    Nominal voltage: 400V AC.
    Nominal power: 3 x (3x300) VAr.
  - N-CAR19T/3C. 3x300 VAr Three-Phase Configurable Capacitors Module.
    Configurable Star and Delta connection.
    Three banks with three three-phase capacitors of 2 μF.
    Nominal voltage: 400V AC.
    Nominal power: 3 x (3 x 300) VAr.
- AEL-PC. Touch Screen and Computer.
    Touch Screen:
      Energy efficiency class: A.
      Screen diagonal: 68.6 cm (27 inch (s)).
      Power consumption (operating): 26 watts.
      Annual energy consumption: 38 kWh.
      Power consumption (standby / off) 0.49 watts.
      Screen resolution: 1920 x 1080 pixels.
    Computer:
      Processor Number: Intel Core i7-6600U Processor (4M Cache, up to 3,40 GHz).
      Cache: 4 MB Intel Smart Cache.
      Clock speed: 2.6 GHz.
      # Of Cores/# of Threads: 2/4.
      Max. TDP/Power: 15 W.
      Memory Types: DDR4-2133, LPDDDR3-1866, DDR3L-1600.
      Graphics: Intel HD Graphics 530.
      Slot for PCI Express.
- All necessary cables to realize the practical exercises are included.
The complete unit includes as well:
  Advanced Real-Time SCADA.
  Open Control + Multicontrol + Real-Time Control.
  Specialized EDIBON Control Software based on LabVIEW.
  Projector and/or electronic whiteboard compatibility allows the unit to be explained and demonstrated to an entire class at one time.
  Capable of doing applied research, real industrial simulation, training courses, etc.
  Remote operation and control by the user and remote control for EDIBON technical support, are always included.
  Totally safe, utilizing 4 safety systems (Mechanical, Electrical, Electronic & Software).
  Designed and manufactured under several quality standards.
  Optional ICAI software to create, edit and carry out practical exercises, tests, exams, calculations, etc. Apart from monitoring user's knowledge and progress reached.
  This unit has been designed for future expansion and integration. A common expansion is the EDIBON Scada-Net (ESN) System which enables multiple students to simultaneously operate many units in a network.

② **AEL-EPP/CCSOF. Computer Control +Data Acquisition+Data Management Software:**

The three softwares are part of the SCADA system.

Compatible with the industry standards.

Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters.

Management, processing, comparison and storage of data.

It allows the registration of the alarms state and the graphic representation in real time.

Open software, allowing the teacher to modify texts, instructions. Teacher's and student's passwords to facilitate the teacher's control on the student, and allowing the access to different work levels.

This unit allows the 30 students of the classroom to visualize simultaneously all the results and the manipulation of the unit, during the process, by using a projector or an electronic whiteboard.

③ **Cables and Accessories**, for normal operation.

④ **Manuals:**

This unit is supplied with 7 manuals: Required Services, Assembly and Installation, Control Software, Starting-up, Safety, Maintenance & Practices Manuals.

Exercises and Practical Possibilities to be done with the Main Items

Operations with electrical generator and governor:

1.- Generator island grid operations.

2.- Generator parallel grid operations.

3.- Generator manual voltage regulation operations.

4.- Generator manual frequency regulation operations.

5.- Study of synchronous generator power factor regulation.

6.- Studying of turbine regulation (frequency control) in island mode.

7.- Study of turbine regulation (frequency control) in parallel grid mode.

8.- Study of excitation/voltage regulation in island mode.

9.- Study of excitation/voltage regulation in parallel grid mode.

10.- Analysis of active and reactive power control.

11.- Automatic control of active power.

12.- Automatic control of reactive power.

Particular practical exercises related to power plants:

Wind Powered Power Plant Simulator.

13.- Demonstration the working principles of mechanism of wind powered power plant simulator.

14.- Manual wind flow control.

Biomass Power Plant Simulator.

15.- Demonstration the working principles of mechanism of biomass power plant simulator.

16.- Manual biomass control.

Geothermal Power Plant Simulator.

17.- Demonstration the working principles of mechanism of biomass power plant simulator.

18.- Manual water flow control.

Heliothermic Solar Power Plant Simulator.

19.- Demonstration the working principles of mechanism of Heliothermic Solar Power Plant Simulator.

20.- Solar irradiation manual control.

Hydroelectric Power Plants Simulator.

21.- Demonstration of the operation principles of hydroelectric power plants mechanisms.

22.- Manual control of the turbine components.

Gas Power Plants Simulator.

23.- Demonstration of the operation principles of gas power plants mechanisms.

24.- Manual control of the fuel mass flux in the combustion chamber.

Other possibilities to be done with this unit:

25.- Many students view results simultaneously.

To view all results in real time in the classroom by means of a projector or an electronic whiteboard.

26.- The Computer Control System with SCADA allows a real industrial simulation.

27.- This unit is totally safe as uses mechanical, electrical and electronic, and software safety devices.

28.- This unit can be used for doing applied research.

29.- This unit can be used for giving training courses to Industries even to other Technical Education Institutions.

- Several other exercises can be done and designed by the user.

<u>a) Technical and Vocational Education configuration</u>

⑤ **AEL-EPP/ICAI. Interactive Computer Aided Instruction Software System.**

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.

- 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.

- 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.

<u>b) Multipost Expansions options</u>

⑥ **Mini ESN. EDIBON Mini Scada-Net System for being used with EDIBON Teaching Units.**

MINI ESN. EDIBON Mini Scada-Net System allows up to 30 students to work with a Teaching Unit in any laboratory, simultaneously.

The MINI ESN system consists of the adaptation of any EDIBON Computer Controlled Unit with SCADA integrated in a local network.

This system allows to view/control the unit remotely, from any computer integrated in the local net (in the classroom), through the main computer connected to the unit.

Main characteristics:

- It allows up to 30 students to work simultaneously with the EDIBON Computer Controlled Unit with SCADA, connected in a local net.
- Open Control + Multicontrol + Real Time Control + Multi Student Post.
- Instructor controls and explains to all students at the same time.
- Any user/student can work doing "real time" control/multicontrol and visualisation.
- Instructor can see in the computer what any user/student is doing in the unit.
- Continuous communication between the instructor and all the users/students connected.

Main advantages:

- It allows an easier and quicker understanding.
- This system allows you can save time and cost.
- Future expansions with more EDIBON Units.

The system basically will consist of:

This system is used with a Computer Controlled Unit.

- Instructor's computer.
- Students' computers.
- Local Network.
- Unit-Control Interface adaptation.
- Unit Software adaptation.
- Webcam.
- MINI ESN Software to control the whole system.
- Cables and accessories required for a normal operation.

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

REPRESENTATIVE