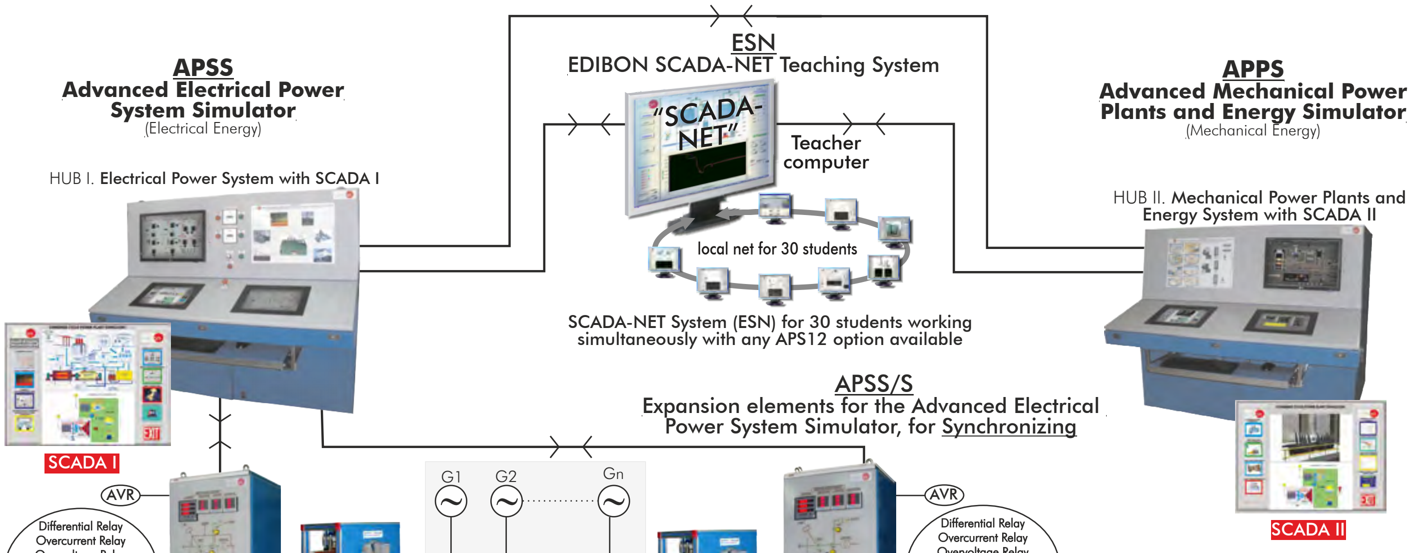
edibon

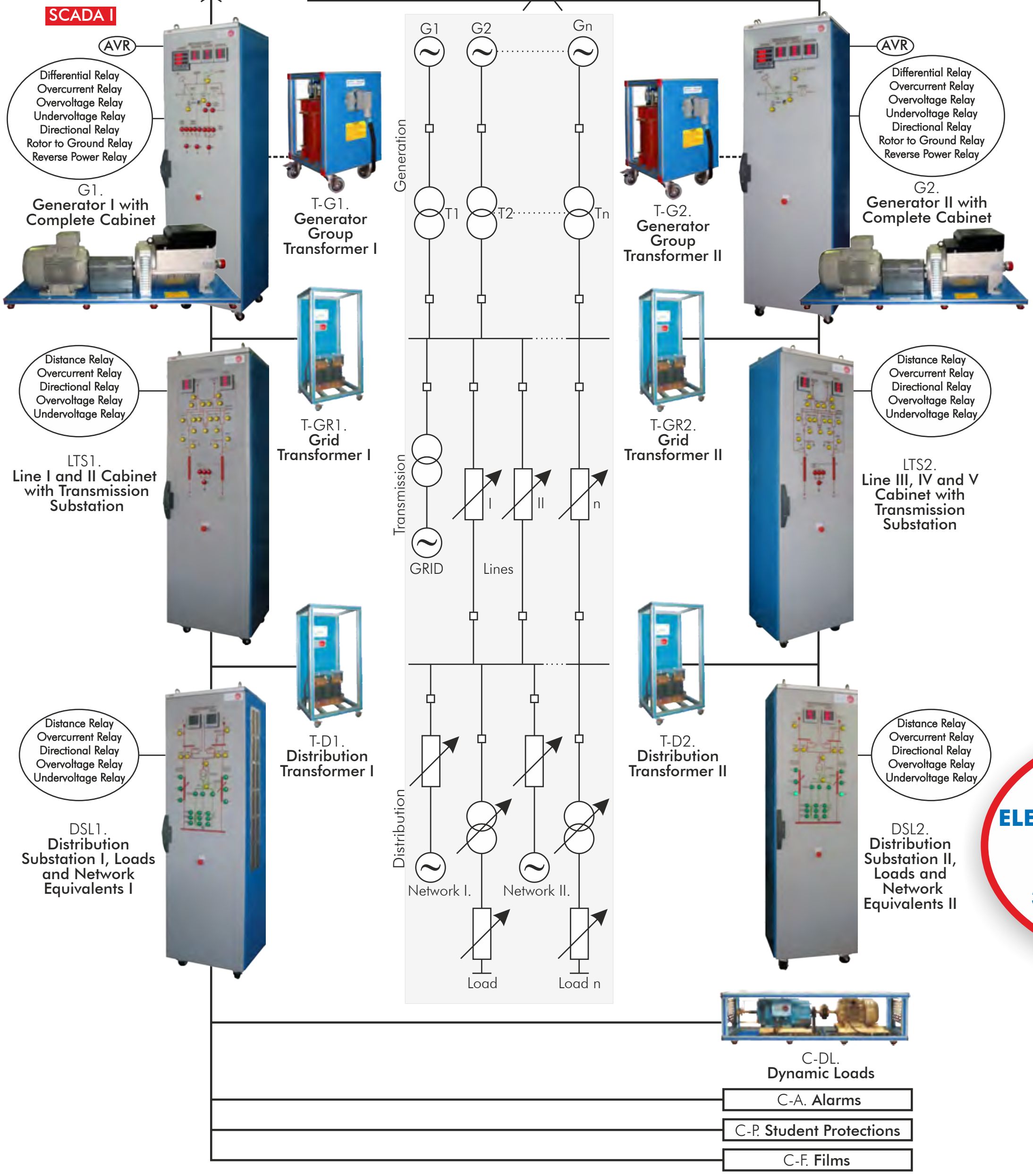
Technical Teaching Equipment

Advanced Smart Grid Trainer and Power Systems Simulator

(Generation, Transformation, Transport, Distribution and Consumption)

APS12





Available Power Plants and Energy Systems Simulation Softwares:

Conventionals

- PPE/CC. **Combined Cycle Power Plant.**
- PPE/NU. **Nuclear Power Plant.**
- PPE/FD. **Diesel Fuel Power Plant.**
- PPE/FF. **Fossil Fuel (coals) Power Plant.**
- PPE/GA. **Gas Power Plant.**

Renewables

- PPE/HY. **Hydroelectric Power Plant.**
- PPE/WP. **Wind Powered Power Plant.**
- PPE/FV. **Photovoltaic Power Plant.**
- PPE/HE. **Heliothermic Power Plant.**
- PPE/BM. **Biomass Power Plant.**
- PPE/FC. **Fuel Cells Power Plant.**
- PPE/GT. **Geothermal Power Plant.**

UNIQUE!

ELECTRICAL AND MECHANICAL POWER PLANTS

30 STUDENTS WORKING SIMULTANEOUSLY

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ISO 9000: Quality Management (for Design, Manufacturing, Commercialization and After-sales service)

European Union Certificate (total safety)

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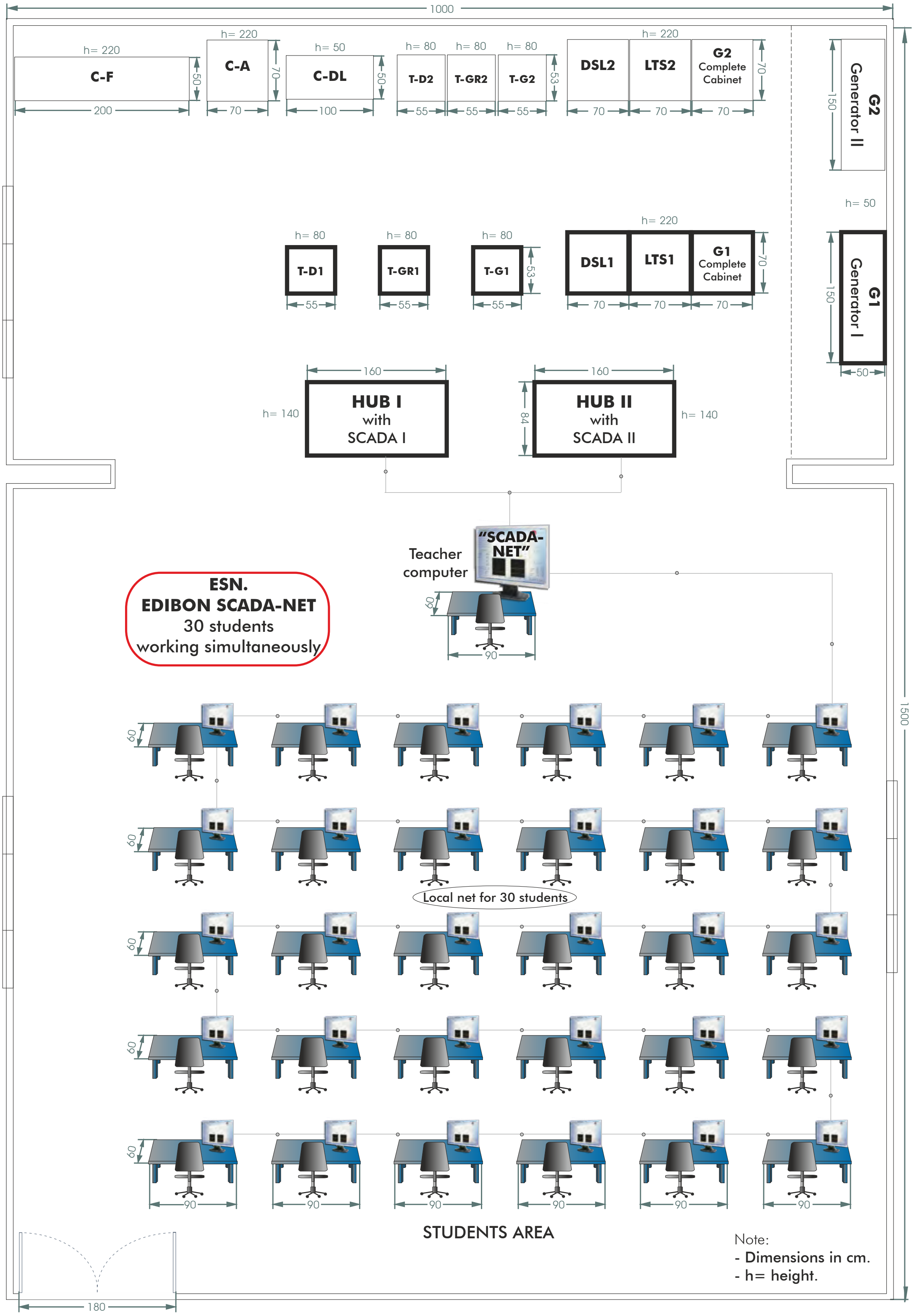
APS12 **Complete system layout**



<u>APSS. Advanced Electrical Power System Simulator:</u>

- **HUB I.** Electrical Power System with SCADA I.
- **G1.** Generator I with Complete Cabinet, including AVR, with synchronization system.
- **T-G1.** Generator Group Transformer I.
- **T-GR1.** Grid Transformer I.
- **LTS1.** Line I and II Cabinet with Transmission Substation.
- **DSL1.** Distribution Substation I, Loads and Network Equivalents I.
- **T-D1.** Distribution Transformer I.

Complements:

- **C-DL.** Dynamic Loads.
- **C-A.** Alarms Cabinet.
- **C-P.** Methacrilate student protections for safety measurements.
- **C-F.** Specific Power Plant films with 3 screens and projector.

<u>APPS. Advanced Mechanical Power Plants and Energy Simulator:</u>

- **HUB II.** Mechanical Power Plants and Energy System with SCADA II.

Available Power Plants and Energy Systems Simulation Softwares:

- **PPE/CC.** Combined Cycle Power Plant.
- **PPE/NU.** Nuclear Power Plant.
- **PPE/FD.** Diesel Fuel Power Plant.
- **PPE/FF.** Fossil Fuel (coals) Power Plant.
- **PPE/GA.** Gas Power Plant.
- **PPE/HY.** Hydroelectric Power Plant.
- **PPE/WP.** Wind Powered Power Plant.
- **PPE/FV.** Photovoltaic Power Plant.
- **PPE/HE.** Heliothermic Power Plant.
- **PPE/BM.** Biomass Power Plant.
- **PPE/FC.** Fuel Cells Power Plant.
- **PPE/GT.** Geothermal Power Plant.

<u>APSS/S. Expansion elements for the Advanced Electrical Power System Simulator, for **Synchronizing and Area Interconnection**:</u>

- **G2.** Generator II with Complete Cabinet, including AVR, with synchronization system.
- **T-G2.** Generator Group Transformer II.
- **T-GR2.** Grid Transformer II.
- **LTS2.** Line III, IV and V Cabinet with Transmission Substation.
- **C-DL.** Dynamic Loads.
- **DSL2.** Distribution Substation II, Loads and Network Equivalents II.
- **T-D2.** Distribution Transformer II.

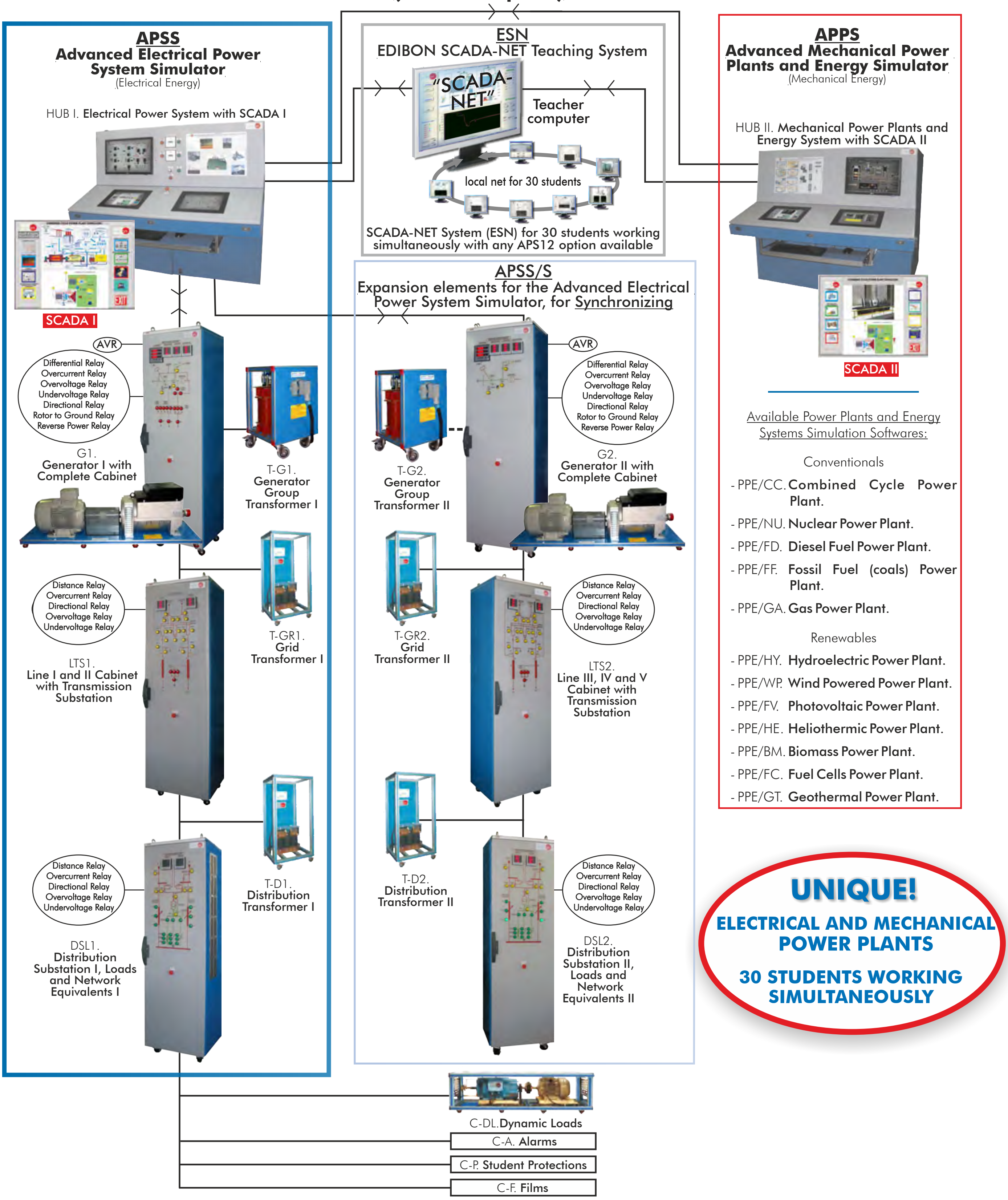
<u>ESN. EDIBON SCADA-NET Teaching System</u>

*IMPORTANT: **Synchronization possibilities:** 1) Two Electrical Power Systems synchronism.
2) Two Electrical Power Systems plus two Mechanical Power Plants synchronism.

APS12. **Advanced Smart Grid Trainer and Power Systems Simulator**

Global Description

(Four main parts)



APS12. Advanced Smart Grid Trainer and Power Systems Simulator with 12 Real Power Plants Softwares options (APSS + APPS + ANY of 12 plants + APSS/S + SCADA-NET).

The EDIBON "APS12" are TWO MAIN SYSTEMS IN ONE, the Advanced Electrical Power System Simulator (APSS), plus the Advanced Mechanical Power Plants and Energy Simulator (APPS) that includes 12 Power Plants Simulation options as, Combined Cycle, Hydroelectric, etc. Additionally Synchronization and SCADA-NET (ESN) is available too.

APSS. Advanced Electrical Power System Simulator. (Electrical Energy, with one or two generators)

APPS. Advanced Mechanical Power Plants and Energy Simulator. (Mechanical Energy with 12 Power Plants softwares available)

APSS/S. Expansion elements for the Advanced Electrical Power System Simulator for Synchronizing and Area Interconnection. (Electrical Synchronization and/or Mechanical Synchronization)

ESN. EDIBON SCADA-NET Teaching System.

The "APS12" is totally modular.

With only HUB I it is possible to run some experiments and it is possible to add more experiments by adding more other modules.

DESCRIPTION

a) General description:

The APS12. Advanced Smart Grid Trainer and Power Systems Simulator is a complete system with perhaps all possibilities for teaching Energy from the raw energy source to the energy comsuption at low and high technical and vocational level, for 30 students simultaneously.

This complete system can be divided in four main group of modules:

APSS. **Advanced Electrical Power System Simulator.**

APPS. **Advanced Mechanical Power Plants and Energy Simulator.**

APSS/S. **Expansion elements for the Advanced Electrical Power System Simulator, for Synchronizing and Area Interconnection.**

ESN. **EDIBON SCADA-NET Teaching System.**

Each group of modules contains:

APSS. Advanced Electrical Power System Simulator:

- **HUB I.** Electrical Power System with SCADA I.
- **G1.** Generator I with Complete Cabinet, including AVR, with synchronization system.
- **T-G1.** Generator Group Transformer I.
- **T-GR1.** Grid Transformer I.
- **LTS1.** Line I and II Cabinet with Transmission Substation.
- **DSL1.** Distribution Substation I, Loads and Network Equivalents I.
- **T-D1.** Distribution Transformer I.

Optional Complements:

- **C-DL.**Dynamic Loads.
- **C-A.** Alarms Cabinet.
- **C-P.** Methacrilate student protections for safety measurements.
- **C-F.** Specific Power Plant films with 3 screens and projector.

* Important: HUB I is the minimum requirement.

APPS. Advanced Mechanical Power Plants and Energy Simulator:

- **HUB II.** Mechanical Power Plant and Energy System with SCADA II.

Available Power Plants and Energy Systems Simulation Softwares:

- **PPE/CC.** Combined Cycle Power Plant.
- **PPE/NU.** Nuclear Power Plant.
- **PPE/FD.** Diesel Fuel Power Plant.
- **PPE/FF.** Fossil Fuel (coals) Power Plant.
- **PPE/GA.** Gas Power Plant.
- **PPE/HY.** Hydroelectric Power Plant.
- **PPE/WP.** Wind Powered Power Plant.
- **PPE/FV.** Photovoltaic Power Plant.
- **PPE/HE.** Heliothermic Power Plant.
- **PPE/BM.** Biomass Power Plant.
- **PPE/FC.** Fuel Cells Power Plant.
- **PPE/GT.** Geothermal Power Plant.

APSS/S. Expansion elements for the Advanced Electrical Power System Simulator, for Synchronizing and Area Interconnection:

- **G2.** Generator II with Complete Cabinet, including AVR, with synchronization system.
- **T-G2.** Generator Group Transformer II.
- **T-GR2.** Grid Transformer II.
- **LTS2.** Line III, IV and V Cabinet with Transmission Substation.
- **C-DL.** Dynamic Loads.
- **DSL2.** Distribution Substation II, Loads and Network Equivalents II.
- **T-D2.** Distribution Transformer II.

ESN. EDIBON SCADA-NET Teaching System.

B) Description of any module:

APSS. Advanced Electrical Power System Simulator:

- **HUB I. Electrical Power System with SCADA I:**

This is the heart of the complete system and always is required.

This module contains the furniture, the computer, a SCADA I Software and all connection facilities for function not only with the rest of the APSS modules but any other module of the complete system APS12.

Main supplying combinations are HUB I with G1. Generator I with Complete Cabinet, including AVR, with synchronization system; and/or LTS1. Line I and II Cabinet with Transmission Substation and/or DSL1. Distribution Substation I, Loads and Network Equivalents I.

Second supplying combinations will be additionally: HUB II with one or several Power Plants and Energy Systems Softwares (12 options).

Other supplying combinations could be the ESN. EDIBON SCADA-NET Teaching System and/or the APSS/S. Expansion elements for the

Continue...

Advanced Electrical Power System Simulator, for Synchronizing, even the optional modules as: C-DL. Dynamic Loads and/or C-A. Alarms Cabinet and/or C-P. Methacrilate student protections for safety measurements and/or C-F. Specific Power Plant films with 3 screens and proyector.

For more information see HUB I Description and Possibilities.

- **G1. Generator I with Complete Cabinet, including AVR, with synchronization system:**

  This module generates and control electrically the generator by using similar elements as is used in a real Power Plant, but only the electrical part. In case of a real power plant has to be simulated then HUB II plus any of the 12 Power Plants and Energy Systems Simulation Softwares are required.

  This module can work with HUB I. Electrical Power System with SCADA I and additionally with LTS1. Line I and II Cabinet with Transmission Substation and DSL1. Distribution Substation I, Loads and Network Equivalents I.

  For more details see G1 specifications.

- **LTS1. Line I and II Cabinet with Transmission Substation.**

  This cabinet contains two lines and the transmission substation plus the proper relays, allowing to run experiments related with lines and substations.

  This module work together with HUB I and additionally with modules G1 and/or DSL1.

  For more details see LTS1 specifications.

- **DSL1. Distribution Substation I, Loads and Network Equivalents I.**

  This cabinet contains the distribution substation, loads and network equivalents allowing to run the exercises related with, working together with HUB I and additionally with modules LTS1 and/or G1.

APPS. Advanced Mechanical Power Plants and Energy Simulator:

Logically the more convenient group of modules to initiate are the complete APSS. Advanced Electrical Power System Simulator, but the second more important is the APPS. Advanced Mechanical Power Plants and Energy Simulator.

The APPS. Advanced Mechanical Power Plants and Energy Simulator includes at least the HUB II plus one of the 12 available Power Plants and Energy System Simulation Softwares.

By using the APPS. Advanced Mechanical Power Plants and Energy Simulator with one of the 12 Plants in combination with the APSS. Advanced Electrical Power System Simulator will allow to combine the Electrical and Mechanical system.

Example if we use APSS + APPS with PPE/CC Combined Cycle Power Plant Software then we work as a real Combined Cycle Power Plant since we use the raw material (gas) and we consume the energy.

As all the mathematical models are included in APPS, we can change the conditions in the comsuption and see the mechanical reaction in the Power Plant and viceverse. In other words by using APSS + APPS we combine and work doing the proper exercises as a complete system.

If you use the APPS with PPE/HY software, then the APSS will work as a Power System and Hydroelectric Power Plant. This means that by using only one APSS and 12 Power Plants and Energy System Simulation Softwares, the APSS can work as 12 different power systems and power plants.

For more details see APPS. Advanced Mechanical Power Plants and Energy Simulator specifications, and the proper specifications about all softwares available as:

- **PPE/CC.** Combined Cycle Power Plant.
- **PPE/NU.** Nuclear Power Plant.
- **PPE/FD.** Diesel Fuel Power Plant.
- **PPE/FF.** Fossil Fuel (coals) Power Plant.
- **PPE/GA.** Gas Power Plant.
- **PPE/HY.** Hydroelectric Power Plant.
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- **PPE/BM.** Biomass Power Plant.
- **PPE/FC.** Fuel Cells Power Plant.
- **PPE/GT.** Geothermal Power Plant.

APSS/S. Expansion elements for the Advanced Electrical Power System Simulator for Synchronizing and Area Interconnection:

The APSS/S group of modules allow to do exercises related with synchronization and area interconnection.

It is possible to synchronize only the generators G1 and G2, even G1 + LTS1 + DSL1 can be synchronized with G2 + LTS2 + DSL2.

In case of using two Power Plants and Energy Systems in HUB II example PPE/CC. Combined Cycle Power Plant and PPE/NU. Nuclear Power Plant we are synchronizing really TWO COMPLETE POWER PLANTS.

For more details see all modules specifications.

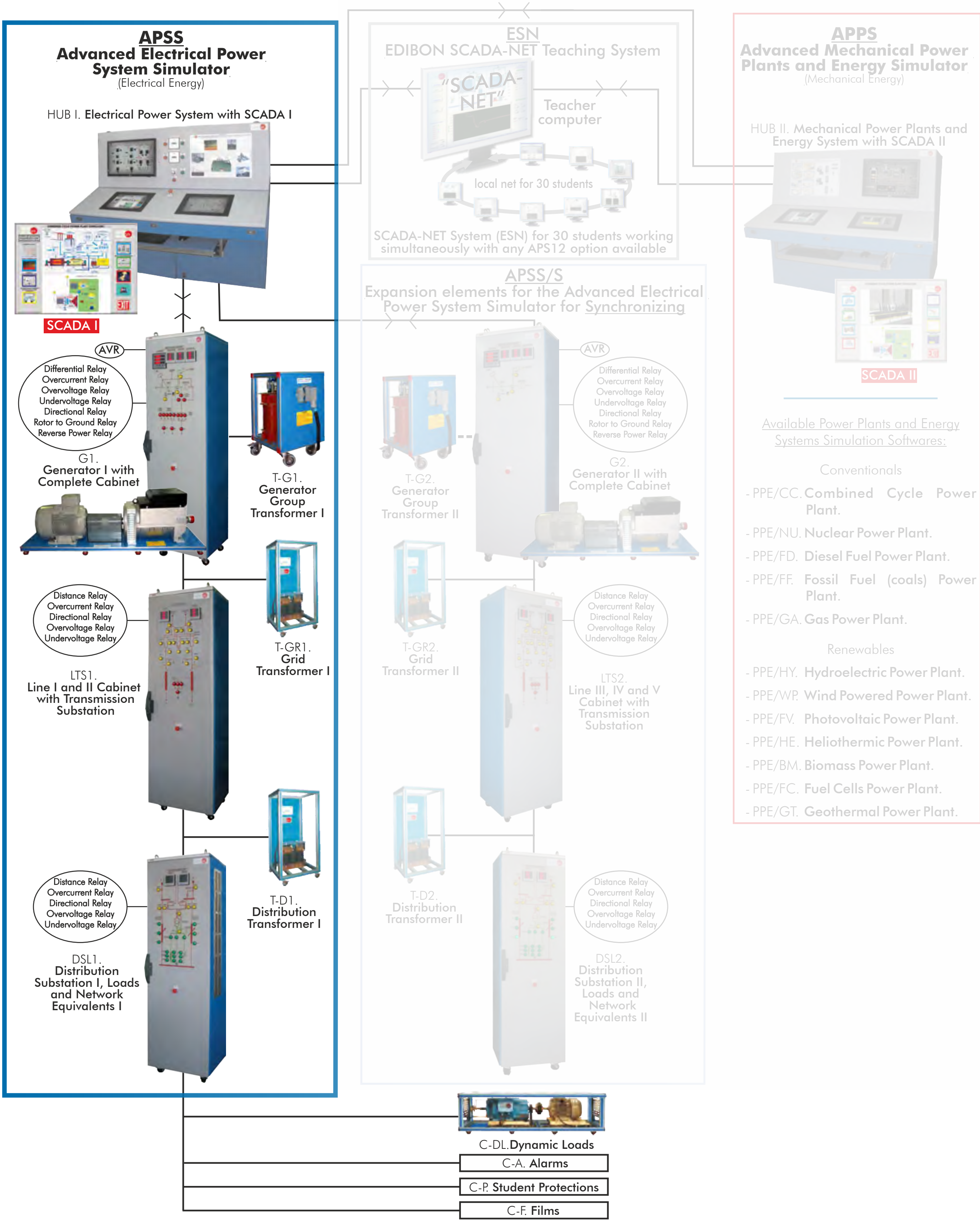
ESN. EDIBON SCADA-NET Teaching System:

The ESN will allow the teacher to work with 30 students simultaneously, allowing any student to run the complete system, but under the teacher supervision.

The ESN not only allows may students to work with the system but the teacher efficiency increares drastically.

By using the ESN the teacher can have full guarantee that any student to understand fully what he is explain. The ESN is considered as top importance complement for clear, quick and full students/workers understanding.

For more details see ESN specifications.



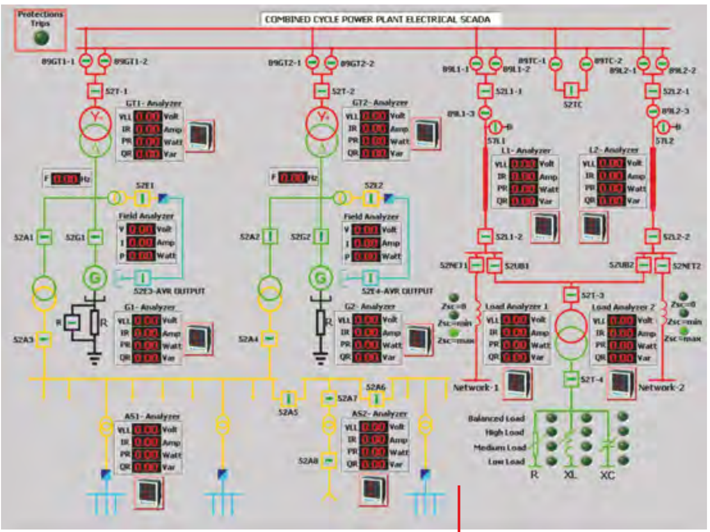
APSS. Advanced Electrical Power System Simulator, includes:

- **HUB I.** Electrical Power System with SCADA I:
  Electrical Control Desk (main unit with two touch screens and one computer screen).
  SCADA I. Allocated in Computer Control and Data Adquisition Unit HUB I.
- **G1.** Generator I with Complete Cabinet.
- **T-G1.** Generator Group Transformer I.
- **T-GR1.** Grid Transformer I.
- **LTS1.** Line I and II Cabinet with Transmission Substation.
- **DSL1.** Distribution Substation I, Loads and Network Equivalents I.
- **T-D1.** Distribution Transformer I.

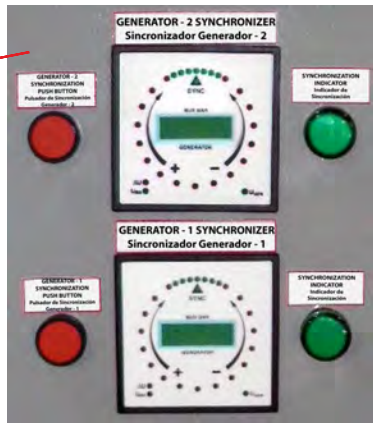
Optional Complements:

- **C-DL.** Dynamic Loads.
- **C-A.** Alarms Cabinet.
- **C-P.** Methacrilate student protections for safety measurements.
- **C-F.** Specific Power Plant films with 3 screens and projector.

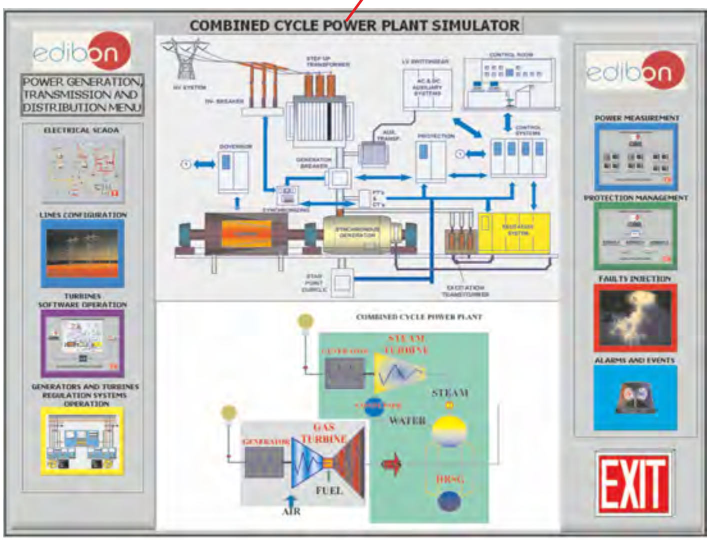
HUB I. **Electrical Power System with SCADA I**



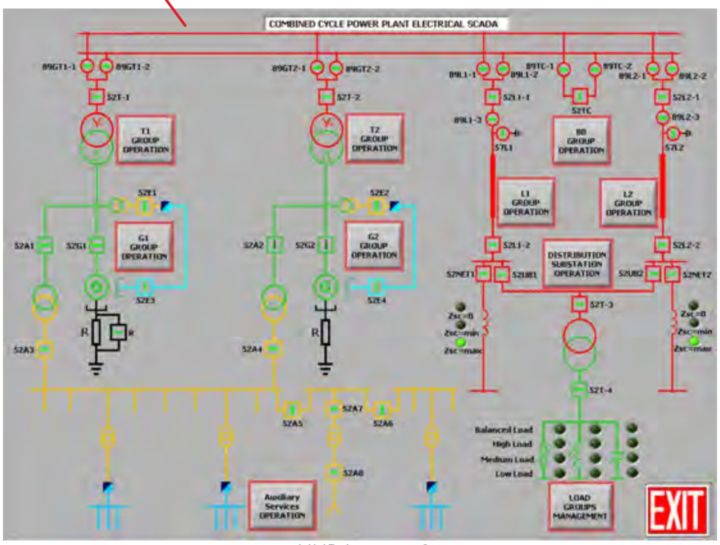
HUB I screen 3



Synchronising devices



HUB I screen 1



HUB I screen 2

DESCRIPTION AND POSSIBILITIES

It includes an Electrical Control Desk with two touch screens and one normal screen with their computer and SCADA I system.
A SCADA I System with computer control, electronics and the proper software package for controlling all the parameters involved in any module of the system. All functions are done and controlled by SCADA I.
The computer placed in the Electrical Control Desk is equipped with a PCI cards that manages the RS485/232 communication links between the SCADA I system and control, protection, measurement devices of power simulator, AVR and Vector Inverters.
All the communication signals are distributed in six communication links. Each connector communicates the PCI cards with one external RS485 bus.
This HUB I will allow:

1) Procedure for starting and stopping the electrical part of the Power System.
2) Real time control, measurement and protection for generation, transformation, transport, distribution and consumption.
3) Open Control.
4) Multicontrol.
5) To give the information received from the Mechanical Power Plants and Energy System with SCADA II (HUB II) and to transfer to all the other modules.
6) To receive and process all information from all modules and to exchange the proper information with the Mechanical Power Plant and Energy System with SCADA II (HUB II).

Continue ...

SCADA I is an industry-standard supervisory control and data acquisition (SCADA) software for realistic experience of power system control.

For use with APSS Simulator to increase students´ understanding of power systems.

It can connect to multiple generation systems for remote control and supervision of local generation and distributed generation.

It includes alarms and logs data for detailed analysis of APSS during stable and transient operation.

It communicates with programmable logic controllers (PLCs), power analyzers, numerical protection relays, automatic voltage regulators and prime-mover simulation device of the Power System Simulator to control and collect information from the power system.

Includes high performance computer with integrated communication interface to exchange information with all devices.

Remotely controls the generator and prime-mover of the Electrical Power System Simulator in different power system operation control methods (frequency control, voltage control, active power control, reactive power control, power factor control, generators load exchange).

The SCADA I connects to Electrical Power System Simulator (APSS) to train students in supervision and control of power systems.

The package includes industrial-standard SCADA software, a computer and communications hardware.

EDIBON supplies the software already installed on the high performance computer. The software does several jobs, including remote control and data display and logging. It includes programs written by EDIBON to match experiments which students have done directly with the Power System Simulator. The software´s on-screen display or ´user interface´shows real-time data and mimics the circuit-breakers (opening and closing). It also mimics the adjustment of the loads and any faults applied by the user. Other screens give details about the settings and data collected at each protection relay or instrument on the simulator.

Students select the correct screen for the experiment they want to perform. They then use the computer to close circuit-breakers, set and adjust any loads and connect the grid supply (or start the generator) by means of touch screens, in others words, they configure the topology of Power System Simulator.

The generators synchronization can be performed in manual and automatic mode with the help of SCADA I.

Students can use the software to log data from the simulator and analyse it, compare conditions before and after faults, and see the effects of faults. They can use this information to predict power system problems and change the power system protection to prevent future problems.

The software includes the experiments already given with the Advanced Electrical Power System Simulator (APSS).

The experiments include:

- Generator characteristics and performance.
- Transformers.
- Transmission, distribution and consumption.
- Power system protection.
- Power system operation and control in different modes.
- Power flow control.
- etc.

SCADA I allows the control and supervision of the operations related to the generation, transformation, transmission and distribution of the electrical energy made by the APSS simulator.

Through a sophisticated human-machine interface, executed in the high performance computer, it is possible to monitor and control a lot of events and alarms as well as analyse, display and control the information acquired from all Programmable Logic Controllers (PLCs), Automatic Voltage Regulators (AVRs), power analyzers, protection relays and prime mover simulation device.

SCADA I system is connected to the PLCs communication networks, network analyzers, protection relays and the rest of the units of the APSS. Simulator, through high-speed physical buses RS485, allowing the data acquisition and control in real time from all the elements of the APSS. Simulator. The acquired data are stored for their future analysis or they are directly sent to screens connected to the computer as a visual information.

The objective of the SCADA I developed architecture is centralising and automating all the control tasks, monitoring, protection and data acquisition of the APSS. Simulator is operated similar to local or central load dispatch center of Real Electrical Power System.

The equipments connected to the SCADA I make one or some of the following functions:

1.- Respond to the commands of the control computer, in order to close or open all the circuit breaker contacts, power isolator, power disconnector and the rest of the equipments that conform the topology of the Electrical Power System Simulator.
2.- Transmit to SCADA the ON/OFF state of the electrical equipment that conform the Simulated Electrical Power System.
3.- Vary all the set points of the controlled parameters, for example, the frequency control, active power, reactive power, power factor and voltage control set point.
4.- Measurement and management of all the acquired electrical parameters in different nodes and points of the simulated power system.
5.- Protection of the electrical circuits and the equipments that conform the APSS. Simulator.

SCADA I allows making a control, supervision and data acquisition in a centralised and remote way, simulating a central generation dispatch center.

With help of SCADA I, students can observe the real time state of the electrical equipment of the APSS by means of graphical and state screens.

With SCADA I, the operator of the electrical power system can monitor its state and consequently, it can act and make decisions about how to operate in different conditions. For example, when there is a sound or visual alarm, the operator can see what is happening in a SCADA screen, because the monitoring system includes an alarm sequences and events list of all the equipment operation, recordered throughout the practice period and can done, reports about a determined operation or about the complete practice.

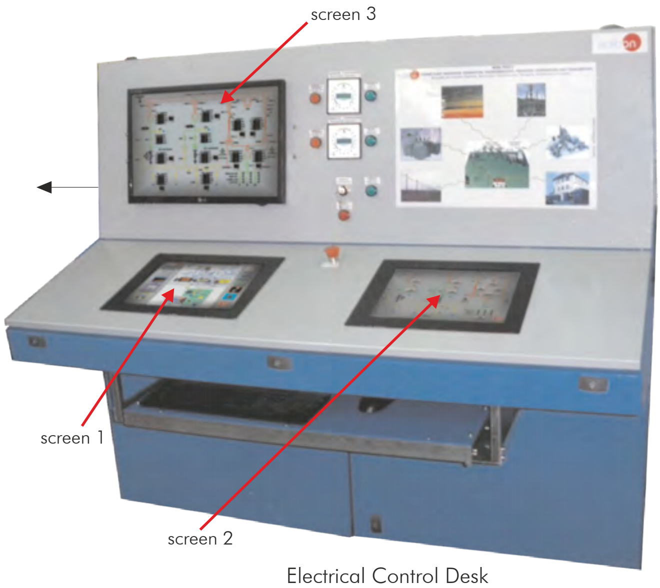
Another SCADA I facility is that it allows visualise in a central way all the instrumentation of the APSS. Simulator through several screens with digital and analogical virtual instruments.

In the APSS. Simulator, several multifunctional and numeric protection relays are used, because the study of the electrical protections is an essential point for a electrical power system.

The protection relays include measurement, communication and programmable logic possibilities to do functions of monitoring and control of the equipment that are protecting. Thanks to these facilities, the protection functions are incorporated and managed from SCADA I, making the teaching of this subject easier in a automated and centralised way, because the students can communicate with each protection relay and managed it remotely.

HUB I. **Electrical Power System with SCADA I**

SPECIFICATIONS



Electrical Control Desk

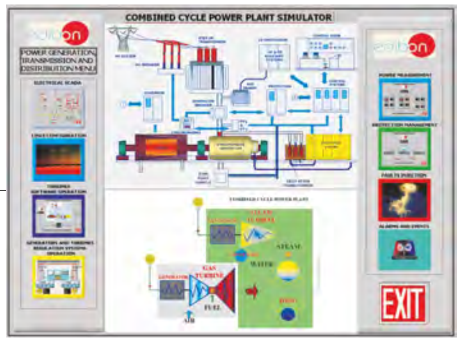
Electrical Control Desk, including:

- Two touch screens.
- One normal screen.
- General emergency stop switch.
- General emergency stop indicator.
- Security key indicator.
- Security key switch.
- Generator manual synchronization push button.
- Generator synchronizer device.
- Generator manual synchronization indicator.
- Computer (PC).
- Security keys for synchronization and fault insertion are included.
- Programmable logic controller (PLC) with 42 I/O signals and RS-485 communication interface.
- Magneto-thermal switches.
- Connectors of 6 and 24 pins.
- 4 ports RS232-RS485 Converter.
- SCADA I system with computer control electronics and the proper software package for controlling the units of the system and to exchange information with HUB II Power Plant Energy System and SCADA II. All functions are done and controlled by SCADA I.

SCADA I Screens distribution:

a) **HUB I screen 1. Main menu touch screen display**:

This screen appears in the left bottom display on Electrical Control Desk and from this screen it's possible to navigate and explore others operation screens that conform the Electrical SCADA I of the power simulator.

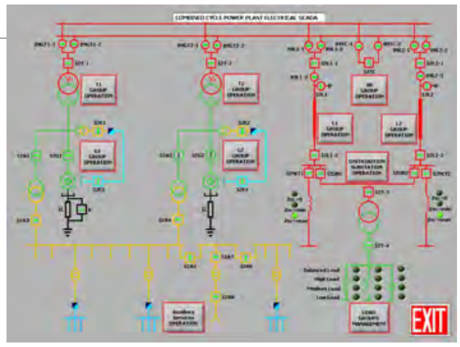


a) HUB I screen 1

b) **HUB I screen 2. Operational touch screen display:**

Elements of the operational touch screen display:

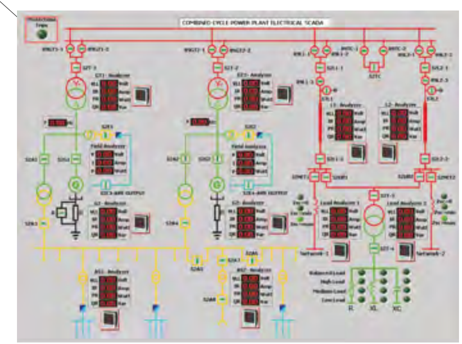
- Electrical SCADA I operation screen.
- Power lines configuration screen.
- Prime Mover Configuration software screen.
- Generation Systems Controls operation screen.
- Power measurement management software screen.
- Electrical Protection system operation screen.
- Faults injection management screen.
- Alarm and events management screen.



b) HUB I screen 2

c) **HUB I screen 3. General State Diagrams screen display:**

This screen shows the one line diagram we are working on and other auxiliary screens.


c) HUB I screen 3

SCADA I Software functions:

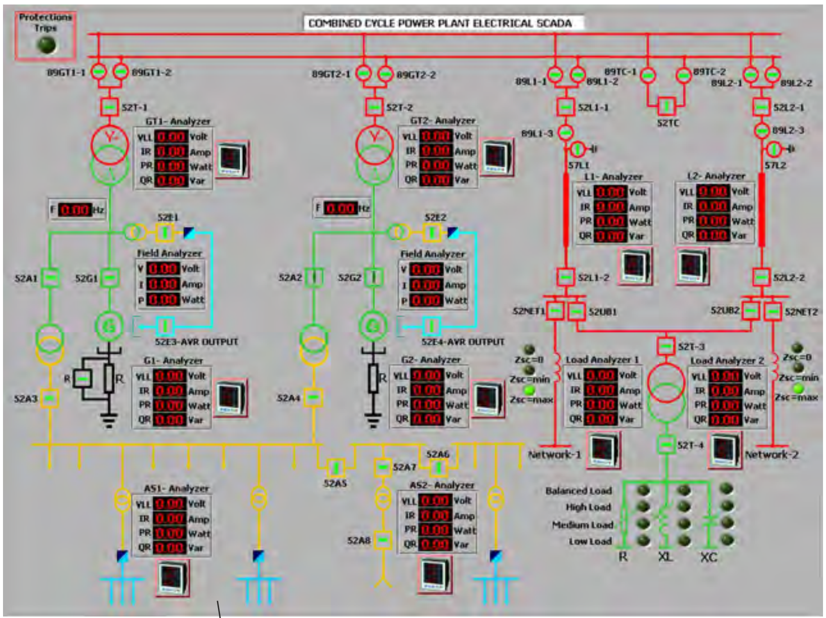
- To send the closing and opening commands to simulate circuit breaker and isolators of the power system including Power station, substations, lines, loads and network equivalents connections.
- To adjust manually and automatically the voltage and frequency of the generators when they work isolated from the network or synchronize with the network.
- Measurement and management of all electrical parameters of generation, transmission and distribution units.
- To manage the protection system and fault injection to study the protection system performance on the generation, transmission and distribution units.
- To train students in Electrical SCADA operation.
- Simplify the study of Power System Operation and Control, power flow study, stability studies, etc.

DIMENSIONS & WEIGHT

- Dimensions: 160 x 84 x 140 cm. approx. - Weight: 150 Kg. approx.

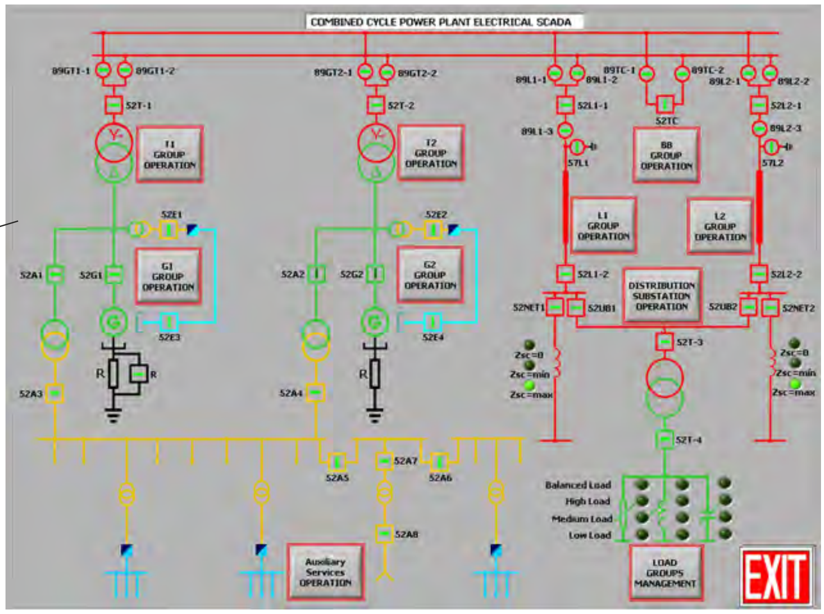
HUB I. **Electrical Power System with SCADA I** (Example of Combined Cycle)

Main Screens



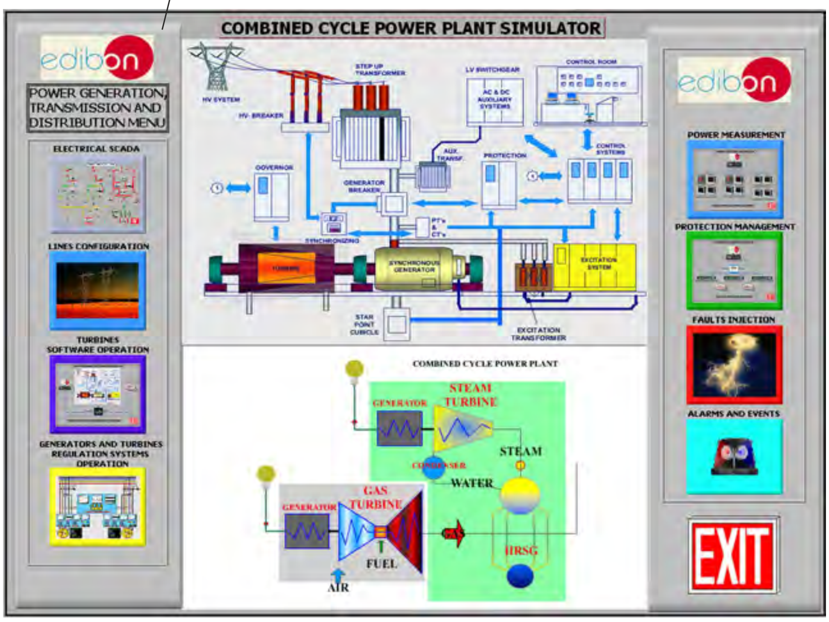
HUB I screen 3
(Power plant simulator one line diagram management screen)

Screen possibilities, see next pages



HUB I screen 2
(Electrical SCADA operation screen)

Screen possibilities, see next pages



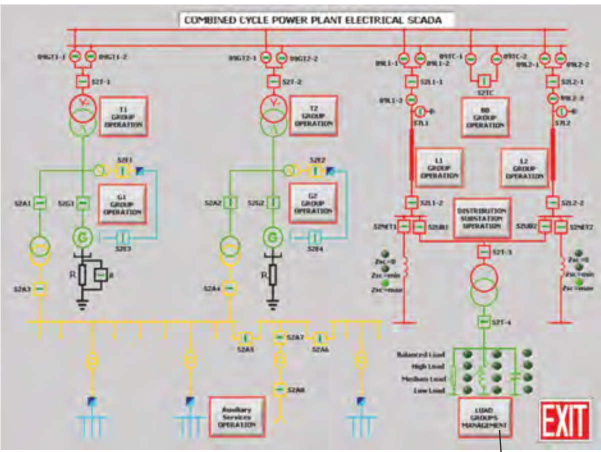
HUB I screen 1
(Main menu screen)

Screen possibilities, see next pages

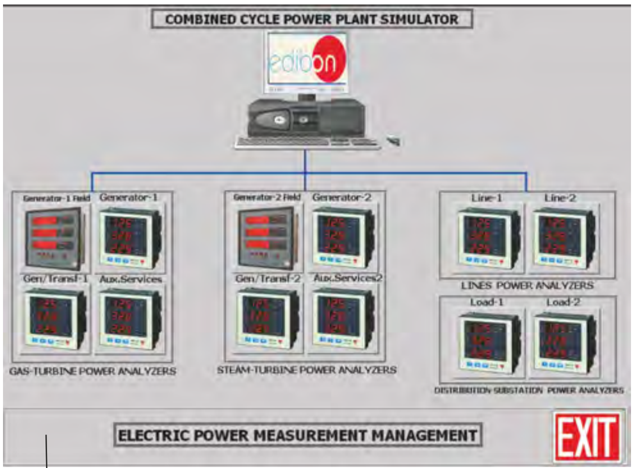
Continue ...

HUB I. **Electrical Power System with SCADA I** (Example of Combined Cycle)

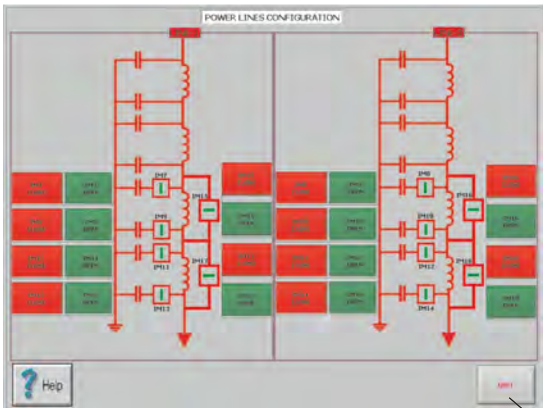
HUB I **screen 1** Possibilities



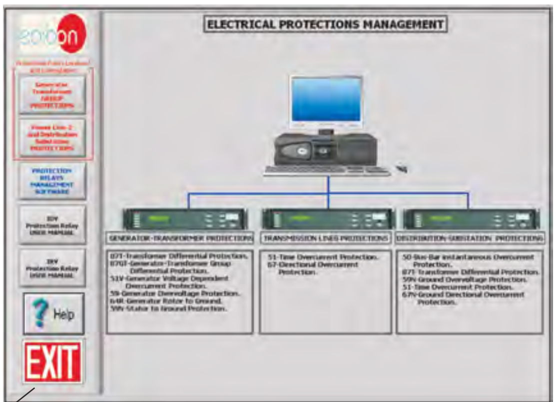
HUB I screen 1.1. **Electrical SCADA operation screen**



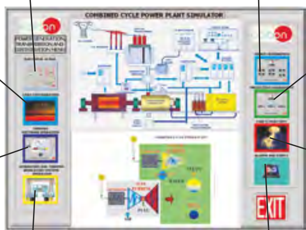
HUB I screen 1.5. **Power Measurement Management software screen**



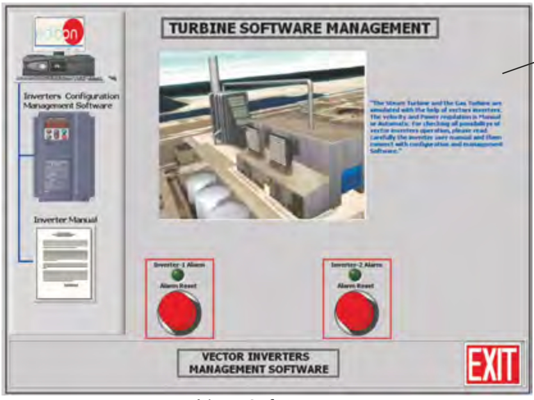
HUB I screen 1.2. **Power Lines switchgears group operation screen**



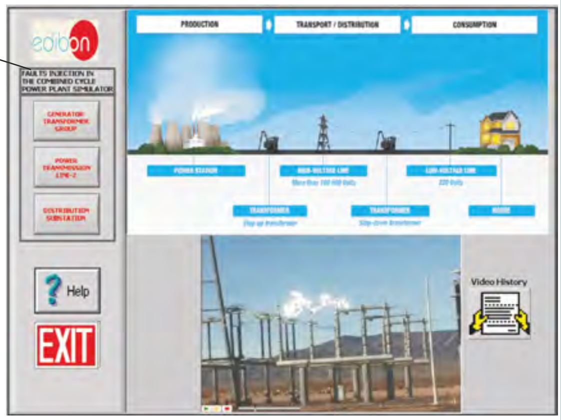
HUB I screen 1.6. **Electrical Protections System operation screen**



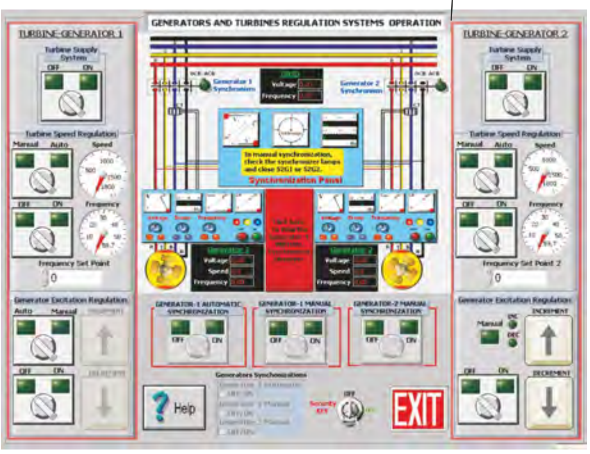
HUB I screen 1
(screen possibilities)



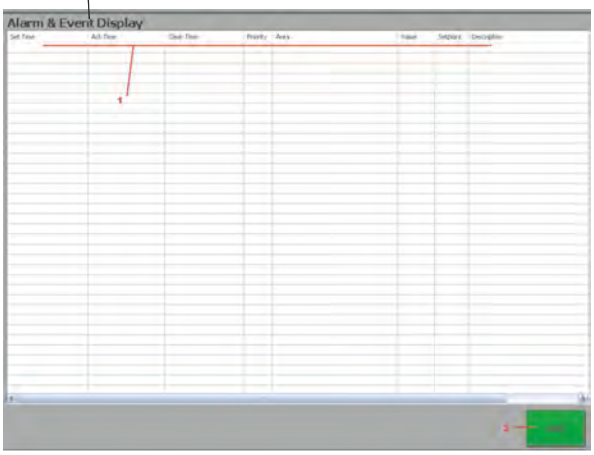
HUB I screen 1.3. **Turbines Software Management screen**



HUB I screen 1.7. **Faults Injection Management screen**



HUB I screen 1.4. **Generation Systems Operation screen**

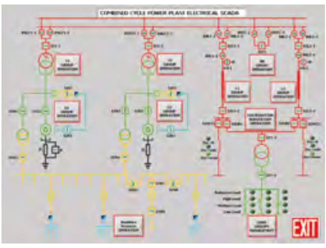


HUB I screen 1.8. **Alarms and Events Management screen**

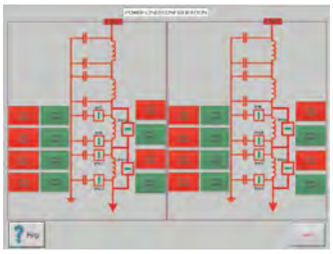
Continue ...

HUB I. **Electrical Power System with SCADA I** (Example of Combined Cycle)

HUB I screen 1.1 to 1.4 some Possibilities

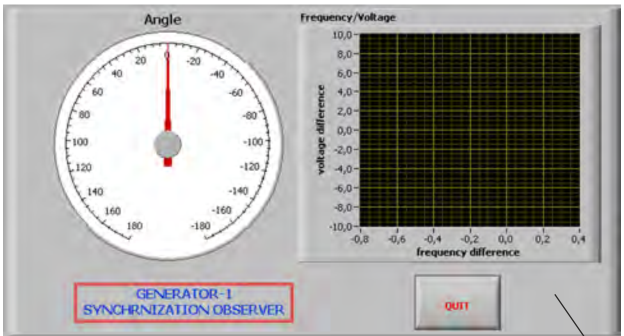


HUB I screen 1.1. **Electrical SCADA operation screen**

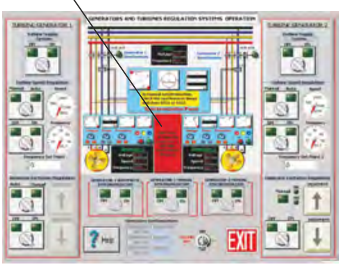


HUB I screen 1.2. **Power Lines switchgears group operation screen**

HUB I screen 1.3. **Turbines Software Management screen**



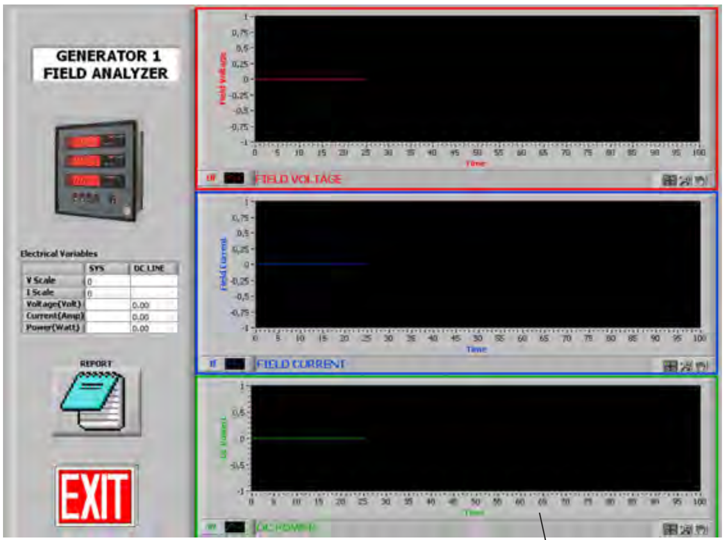
HUB I screen 1.4.1. **Generator virtual synchronization observer**



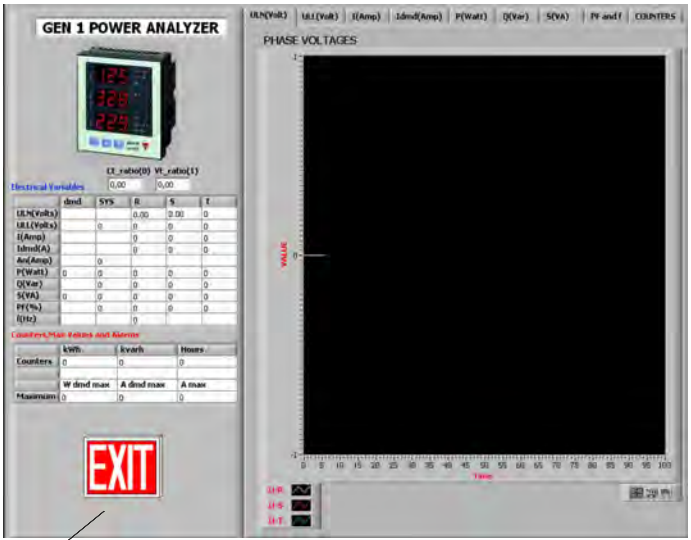
HUB I screen 1.4. **Generation Systems Operation screen**

Continue ...

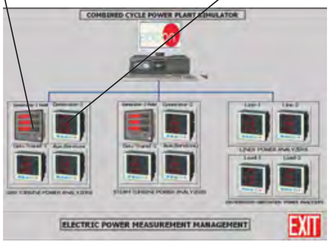
HUB I screen 1.5 and 1.6 some Possibilities



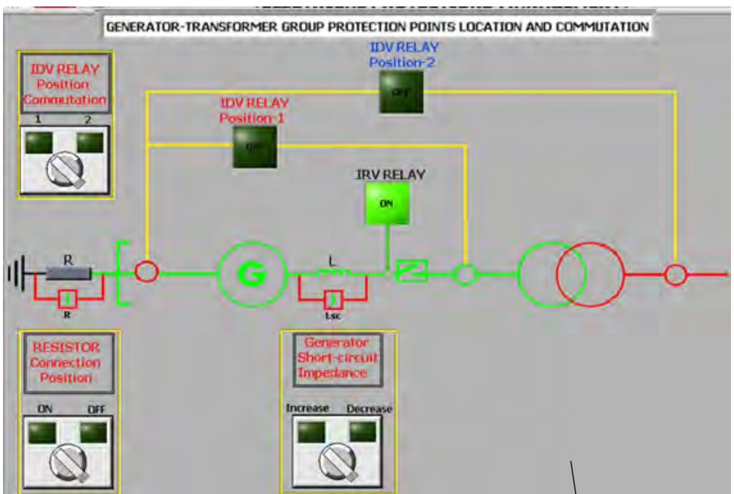
HUB I screen 1.5.1. **Generator field excitation power analyzer sub-screen**



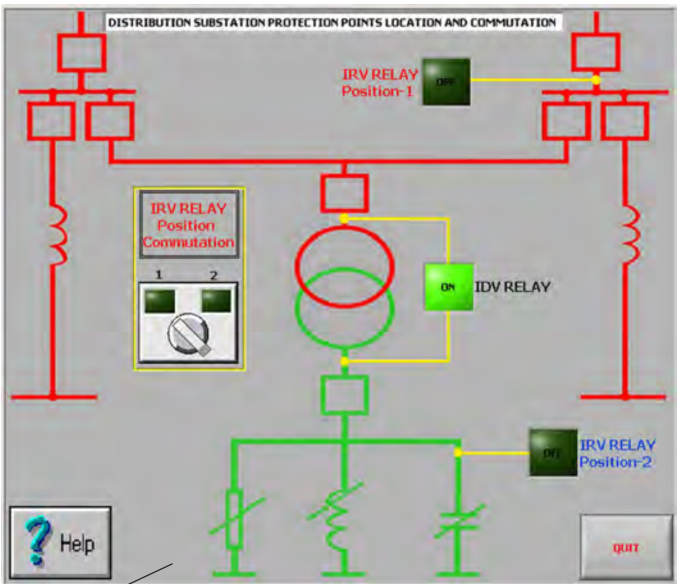
HUB I screen 1.5.2. **Generator power analyzer sub-screen**



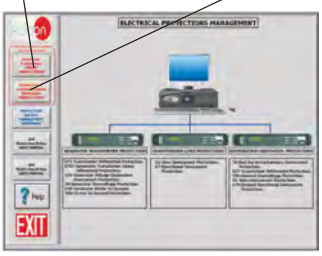
HUB I screen 1.5. **Power Measurement Management software screen**



HUB I screen 1.6.1. **Generator transformer group protections points configuration sub-screen**



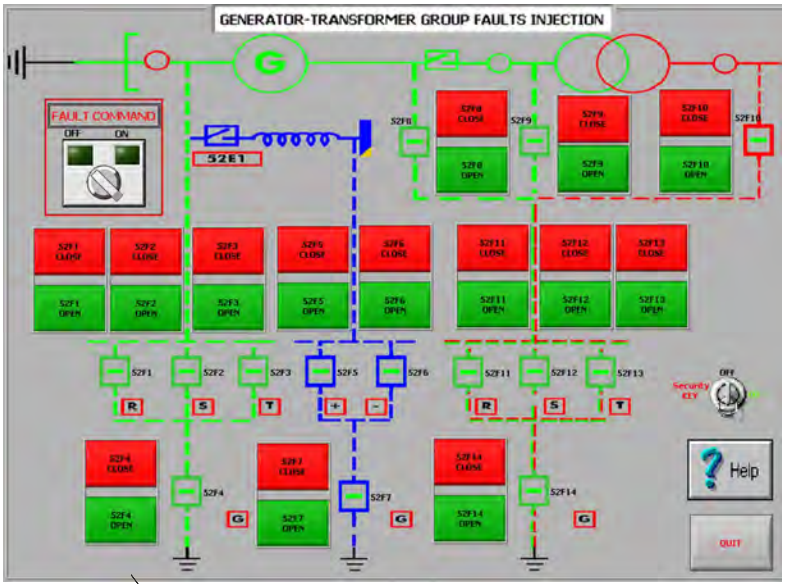
HUB I screen 1.6.2. **Line 2 and Distribution Substation protections points configuration sub-screen**



HUB I screen 1.6. **Electrical Protections System operation screen**

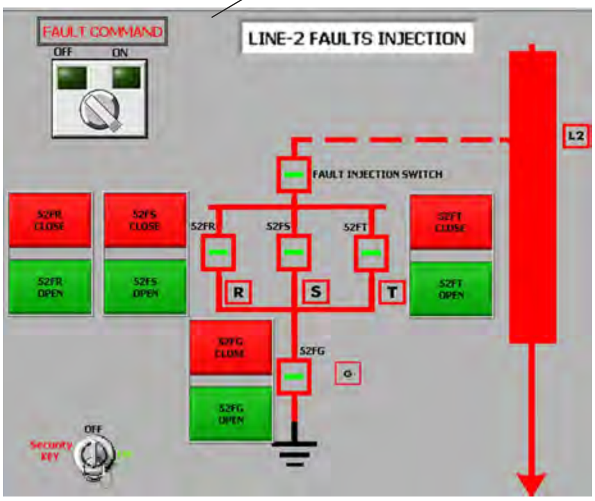
Continue ...

HUB I screen 1.7 and 1.8 some Possibilities

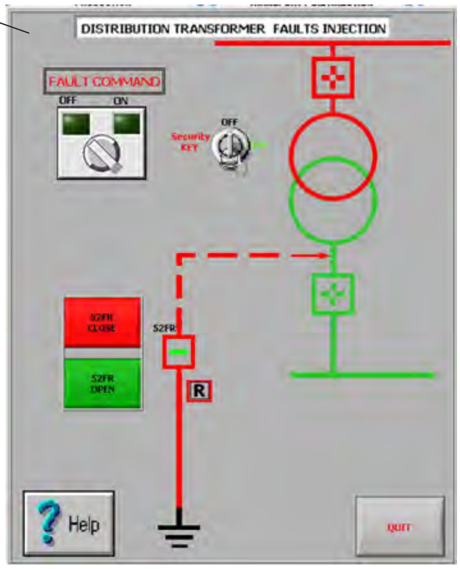


HUB I screen 1.7.1. **Generator-Transformer group fault injection management sub-screen**

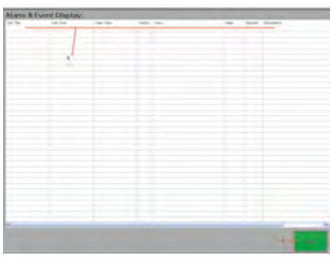
HUB I screen 1.7. **Faults Injection Management screen**



HUB I screen 1.7.2. **Line 2 fault injection management sub-screen**



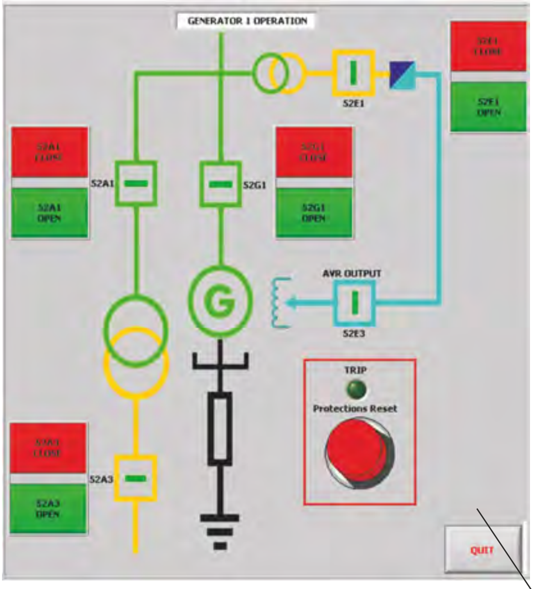
HUB I screen 1.7.3. **Distribution substation fault injection management sub-screen**



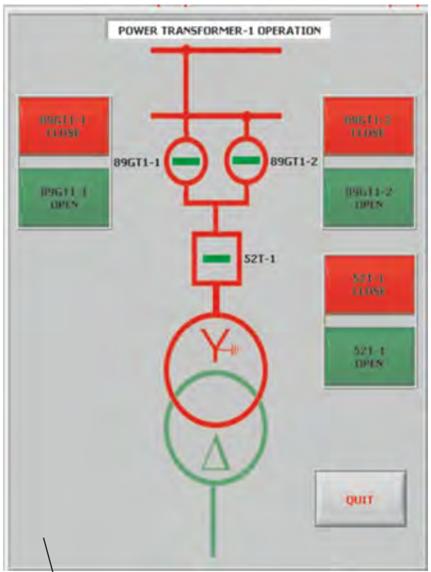
HUB I screen 1.8. **Alarms and Events Management screen**

Continue ...

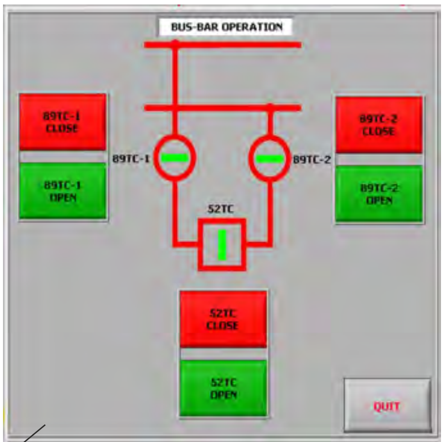
HUB I **screen 2** Some Possibilities



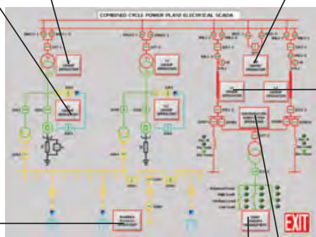
HUB I screen 2.1. **Generator-1 switchgears group operation sub-screen**



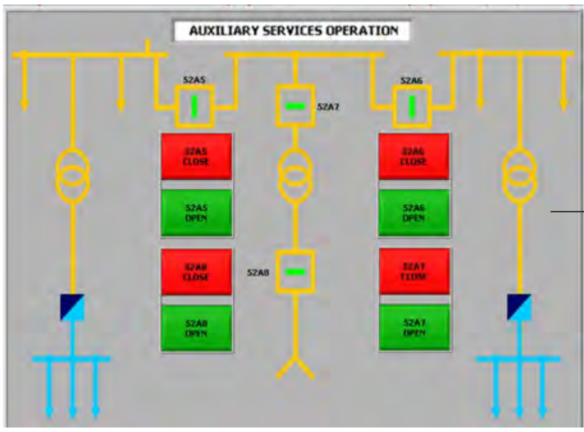
HUB I screen 2.2. **Power Transformer-1 switchgears group operation sub-system**



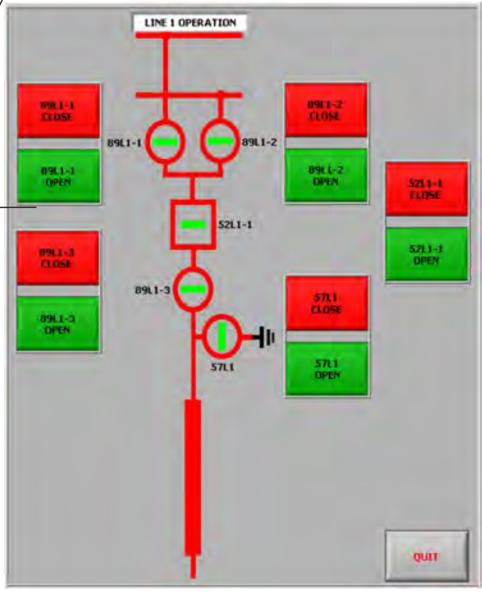
HUB I screen 2.3. **Bus-Bar interconnection switchgears group operation sub-screen**



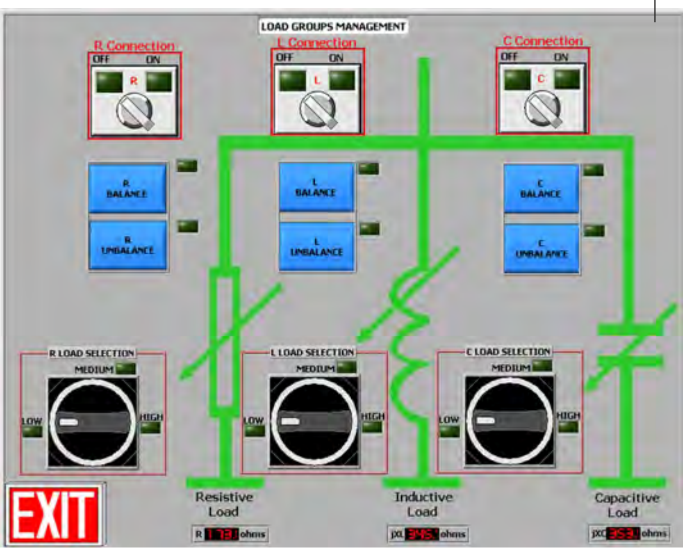
HUB I screen 2
(Electrical SCADA operation screen)
(screen possibilities)



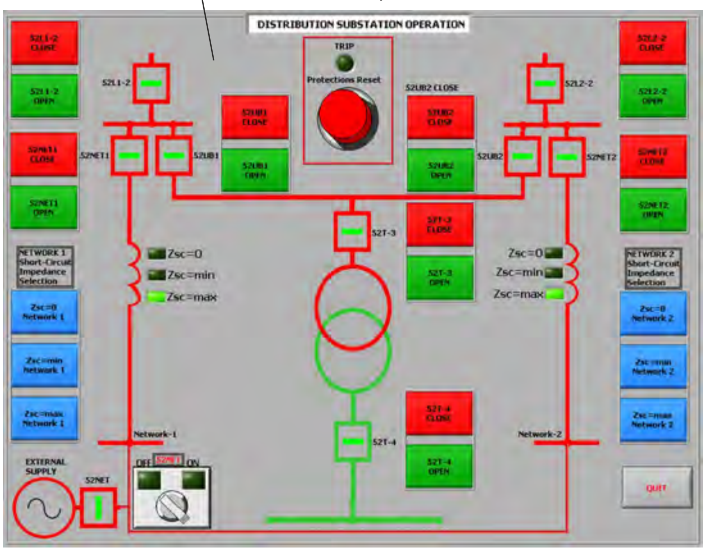
HUB I screen 2.4. **Auxiliary services switchgears group operation sub-screen**



HUB I screen 2.5. **Power Line-1 switchgears group operation sub-screen**



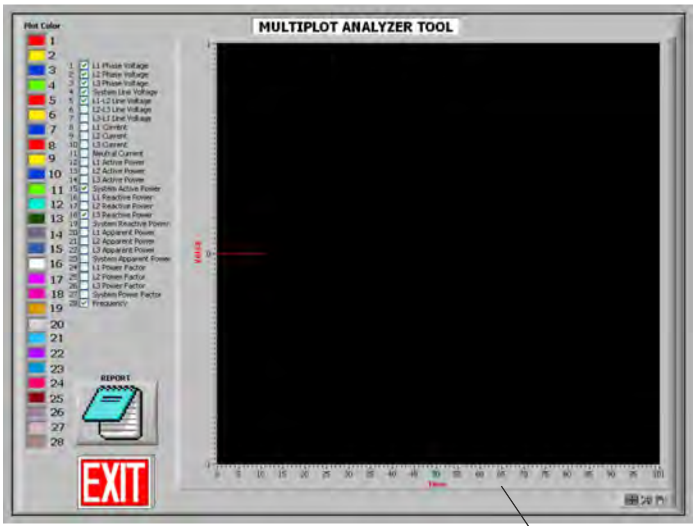
HUB I screen 2.6. **Loads switchgears group operation sub-screen**



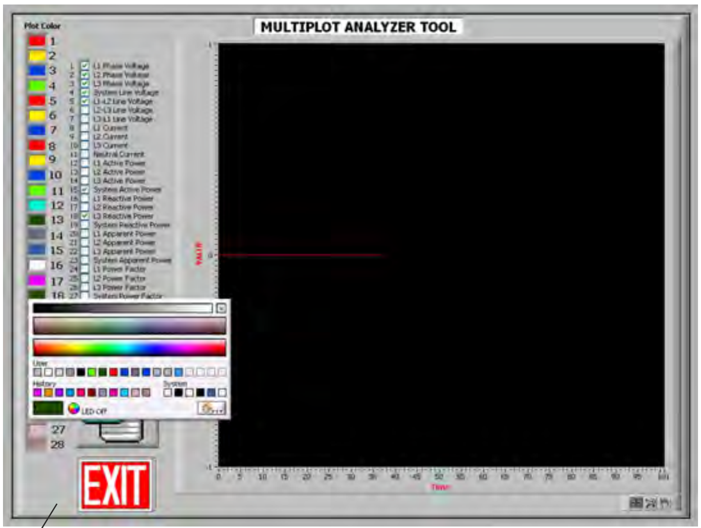
HUB I screen 2.7. **Distribution Substation switchgears group operation sub-screen**

Continue ...

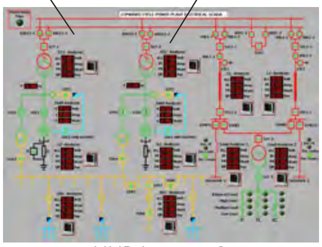
HUB I **screen 3** Some Possibilities



HUB I screen 3.1



HUB I screen 3.2



HUB I screen 3
(Power plant simulator one line diagram management screen)

(screen possibilities)

G1. **Generator I with Complete Cabinet**, including AVR (Automatic Voltage Regulator), with Synchronization System, Protection Relays and Power Analyzers

Inner view

SPECIFICATIONS

Generator:
- Base plate in painted steel and anodized aluminium structure.
- Generator:
  Three-phase synchronous generator: 7KVA, 230/400Vac, 1500 r.p.m., Cos φ: 0.8 , with brush excitation system.
- Motor prime mover:
  Three-phase squirrel cage motor, 7KW, 1500 r.p.m., 400 Vac, 50Hz, Cos φ: 0.86 , driven by a vector controlled multifunction inverter with RS-485 interface.
- Shaft encoder.
- Semiflex coupling.

Etc.

Cabinet:
- Metallic cubicle, with wheels.
- Front panel diagram.
- Inductances for simulating the transient and sub-transient state of the generator.
- Power supply.
- Current transformers. Voltage transformers.
- Vector inverter with automatic frequency load controller (AFLC).
- Automatic/manual voltage regulator (AVR) and automatic/manual synchronization device.
- Magneto-thermal switches.
- Connectors.
- Power energy analyzers with RS-485 communication interface:
  Voltage: Range 20-500 Vrms. Prec.: ±0.5%. Phase to phase-Phase to neutral. Current: Range 0.02-5 Arms. Prec.: ±0.5%.
  Frequency: Range 48 to 62 Hz. ±0.1Hz. Power: Active, Reactive and Apparent. Range 0.01 to 9900 kW. Prec.: ±1%.
  Power Factor: Power Factor for each phase and average. Range -0.1 to + 0.1. Prec.: ±1%.
- Digital protection relays with RS-485 communication interface.
- Differential Relay.
- Overcurrent Relay.
- Overvoltage Relay. Undervoltage Relay.
- Directional Relay.
- Generator Rotor to Ground Relay.
- Generator Reverse Power Flow Relay.
- Programable logic controller (PLC) with 42 I/O signals and RS-485 interfaces for generation system topology configuration.
- Contactors.
- Power switches and fault state indicators in the front panel.
- Emergency switch included.
- Back-up generation protection devices.

Etc.

DIMENSIONS & WEIGHT

Generator:
- Dimensions: 150 x 50 x 50 cm. approx.
- Weight: 150 Kg. approx.

Cabinet:
- Dimensions: 70 x 70 x 220 cm. approx.
- Weight: 100 Kg. approx.

Transformers

SPECIFICATIONS

T-G1. **Generator Group Transformer I:**

- Three-phase power transformer, 5KVA, Dy11 connection, with multi- tapped primary and secondary windings.
- Anodized aluminium structure and panels in painted steel.
- It includes wheels for mobility.

T-GR1. **Grid Transformer I:**

- Three-phase power transformer with connection group Dy11, 5kVA , with multi- tapped secondary.

T-D1. **Distribution Transformer I:**

- Three-phase transformer, 2kVA, phaser group Yd1, with multi-tapped primary.

DIMENSIONS & WEIGHT

Each transformer:

- Dimensions: 55 x 53 x 80 cm. approx.
- Weight: 30 Kg. approx.

LTS1. **Line I and II Cabinet with Transmission Substation**

Front side

Inner

SPECIFICATIONS

- Metallic cubicle, with wheels.
- Front panel diagram.
- Inductances and capacitors for lines parameters simulation.
- Voltage transformers.
- Current transformers.
- Magneto-thermal switches.
- Connectors.
- Contactors.
- It includes tapping points for changing the length of lines and the configuration of PI or T line loss profiling, and fault injection with the help of PLC control device.
- Digital protection relay with RS-485 communication interface.
- Distance Relay.
- Overcurrent Relay.
- Directional Relay.
- Overvoltage Relay.
- Undervoltage Relay.
- Power meter analyzers with RS-485 communication interface:
  Voltage: Range 20-500 Vrms. Prec.: ±0.5%. Phase to phase-Phase to neutral. Current: Range 0.02-5 Arms. Prec.: ±0.5%.
  Frequency: Range 48 to 62 Hz. ±0.1Hz. Power: Active, Reactive and Apparent. Range 0.01 to 9900 kW. Prec.: ±1%.
  Power Factor: Power Factor for each phase and average. Range -0.1 to + 0.1. Prec.: ±1%.
- Programmable logic controller (PLC) with 42 I/O signals for controlling and state estimation of all line elements and fault injection switches.
- State indicator lamps in the front panel.
- Emergency switch included.
- Etc.

DIMENSIONS & WEIGHT

- Dimensions: 70 x 70 x 220 cm. approx.
- Weight: 100 Kg. approx.

DSL1. **Distribution Substation I, Loads and Network Equivalents I**

Front side

Inner

SPECIFICATIONS

- Metallic cubicle, with wheels.
- Front panel diagram.
- Inductances, capacitors, resistors and active load modules for load simulation.
- Contactors.
- Power meter analyzers with RS-485 communication interface:
  Voltage: Range 20-500 Vrms. Prec.: ±0.5%. Phase to phase-Phase to neutral. Current: Range 0.02-5 Arms. Prec.: ±0.5%.
  Frequency: Range 48 to 62 Hz. ±0.1Hz. Power: Active, Reactive and Apparent. Range 0.01 to 9900 kW. Prec.: ±1%.
  Power Factor: Power Factor for each phase and average. Range -0.1 to + 0.1. Prec.: ±1%.
- Voltage transformers.
- Digital protection relays with RS-485 communication interface.
- Directional Relay.
- Differential Relay.
- Overcurrent Relay.
- Overvoltage Relay.
- Undervoltage Relay.
- Dissipator fan.
- Connectors.
- Magneto-thermal circuit breaker.
- It includes tapping points for charging load topology configuration and fault injection with the help of PLC control device.
- Programmable logic controller (PLC) with 42 I/O signals for controlling, state estimation of all distribution substation elements and load configuration and fault injection.
- Back-up protection for external network connection.
- Etc.

DIMENSIONS & WEIGHT

- Dimensions: 70 x 70 x 220 cm. approx.
- Weight: 100 Kg. approx.

EXERCICES AND PRACTICAL POSSIBILITIES

Some practical possibilities among many others:

With APSS (Advanced Electrical Power System Simulator):

1.- Mechanical Power Plant Simulator Components recognition and operation introduction.

2.- Study of Unit-1 feeding isolated loads through Line-1 with automatic frequency control and voltage adjustment at remote distribution substation busbars.

3.- Study of Unit-1 feeding isolated loads through Line-2 with automatic frequency control and voltage adjustment at remote distribution substation busbars.

4.- Study of Unit-1 feeding isolated loads through Line-1 and Line-2 with automatic frequency control and voltage adjustment at remote distribution substation busbars.

5.- Study of Unit-1 feeding isolated loads through Line-2 with automatic frequency control and voltage adjustment at transmission substation busbars.

6.- Study of Unit-1 feeding isolated loads through Line-2 with automatic frequency control and without voltage control.

7.- Study of Unit-1 connected to the network through Line-1 with different network equivalent reactances, operating at constant active power and variable field current.

8.- Study of Unit-1 connected to the network through Line-2 with different network equivalent reactances, operating at constant active power and variable field current.

9.- Study of Unit-1 connected to the network through Line-1 and Line-2 with different network equivalent reactances, operating at constant active power and variable field current.

10.- Study of Unit-1 connected to the network through Line-1 with different network equivalent reactances, operating at variable active power and constant field current.

11.- Study of Unit-1 connected to the network through Line-2 with different network equivalent reactances, operating at variable active power and constant field current.

12.- Study of Unit-1 connected to the network through Line-1 and Line-2 with different network equivalent reactances, operating at variable active power and constant field current.

13.- Study of Load Flow when Unit-1 is connected through Lines 1 and Line 2 to the network with different network equivalent reactances.

14.- Verification of the automatic frequency-load control operation under small disturbances of Unit-1 feeding isolated loads through Line-1.

15.- Verification of the automatic frequency-load control operation under small disturbances of Unit-1 feeding isolated loads through Line-2.

16.- Verification of the automatic frequency-load control operation under small disturbances of Unit-1 feeding isolated loads through Line-1 and Line-2.

17.- Study of Unit-1 connected to the network through Line-1, operating on different modes: base load program, fixed load program and regulating load program.

18.- Study of Unit-1 connected to the network through Line-2, operating on different modes: base load program, fixed load program and regulating load program.

19.- Study of Unit-1 connected to the network through Line-1 and Line-2, operating on different modes: base load program, fixed load program and regulating load program.

20.- Verification of the automatic voltage control (AVR) operation under small disturbances of Unit-1 feeding isolated loads through Line-1.

21.- Verification of the automatic voltage control (AVR) operation under small disturbances of Unit-1 feeding isolated loads through Line-2.

22.- Verification of the automatic voltage control (AVR) operation under small disturbances of Unit-1 feeding isolated loads through Line-1 and Line-2.

23.- Verification of Generator Rotor to Ground Protection functionality.

24.- Verification of Generator Differential Protection functionality.

25.- Power Plant and Power System Power Switches Interlocks Analysis.

26.- Auxiliary Services Operation in the Power Plant Diagram.

APPS
Advanced Mechanical Power Plants and Energy Simulator
(Mechanical Energy)

HUB II. **Mechanical Power Plants and Energy System with SCADA II**

Available Power Plants and Energy Systems Simulation Softwares:

Conventionals

- PPE/CC. **Combined Cycle Power Plant.**
- PPE/NU. **Nuclear Power Plant.**
- PPE/FD. **Diesel Fuel Power Plant.**
- PPE/FF. **Fossil Fuel (coals) Power Plant.**
- PPE/GA. **Gas Power Plant.**

Renewables

- PPE/HY. **Hydroelectric Power Plant.**
- PPE/WP. **Wind Powered Power Plant.**
- PPE/FV. **Photovoltaic Power Plant.**
- PPE/HE. **Heliothermic Power Plant.**
- PPE/BM. **Biomass Power Plant.**
- PPE/FC. **Fuel Cells Power Plant.**
- PPE/GT. **Geothermal Power Plant.**

APPS. Advanced Mechanical Power Plants and Energy Simulator, includes:

-**HUB II.** Power Plant Energy System with SCADA II:

Energy Control Desk (main unit with two touch screens and one computer screen).

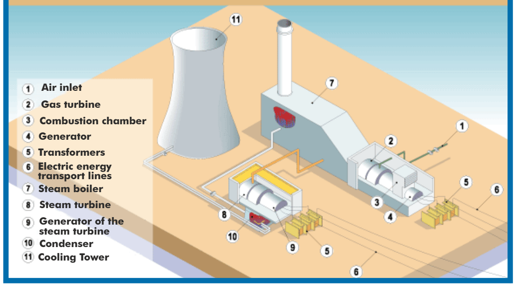
SCADA II. Allocated in Computer Control and Data Adquisition Unit HUB II.

Available Power Plants and Energy Systems Simulation Softwares:

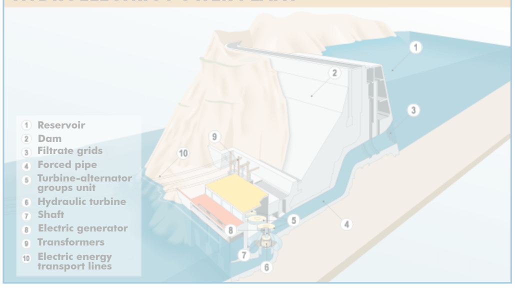
- **PPE/CC.** Combined Cycle Power Plant.
- **PPE/NU.** Nuclear Power Plant.
- **PPE/FD.** Diesel Fuel Power Plant.
- **PPE/FF.** Fossil Fuel (coals) Power Plant.
- **PPE/GA.** Gas Power Plant.
- **PPE/HY.** Hydroelectric Power Plant.
- **PPE/WP.** Wind Powered Power Plant.
- **PPE/FV.** Photovoltaic Power Plant.
- **PPE/HE.** Heliothermic Power Plant.
- **PPE/BM.** Biomass Power Plant.
- **PPE/FC.** Fuel Cells Power Plant.
- **PPE/GT.** Geothermal Power Plant.

Available Power Plants:

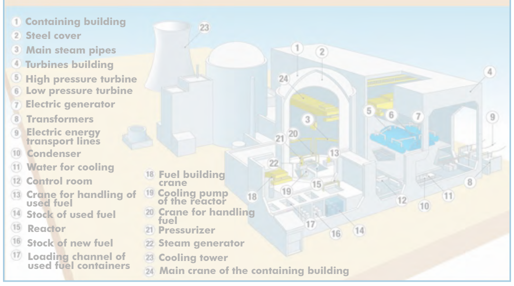
COMBINED CYCLE POWER PLANT



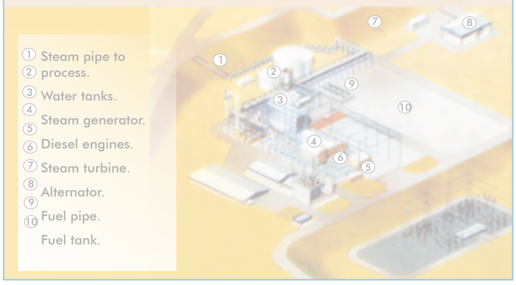
HYDROELECTRIC POWER PLANT



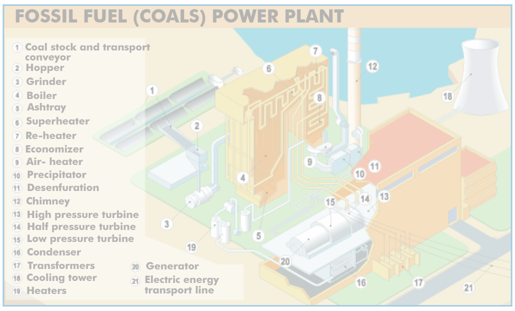
NUCLEAR POWER PLANT



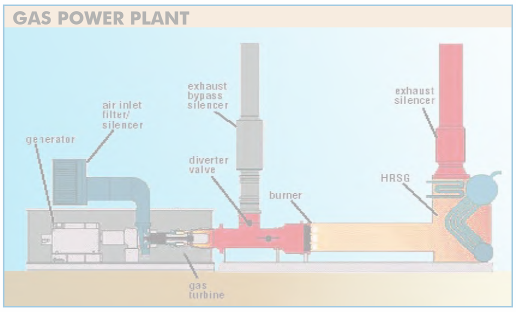
DIESEL FUEL POWER PLANT



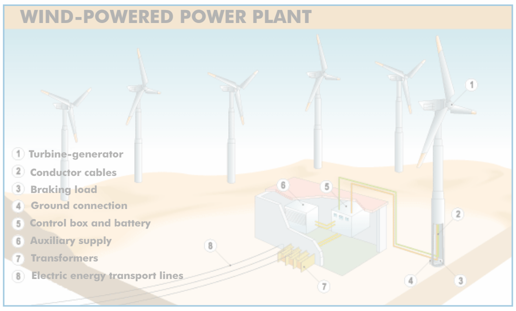
FOSSIL FUEL (COALS) POWER PLANT



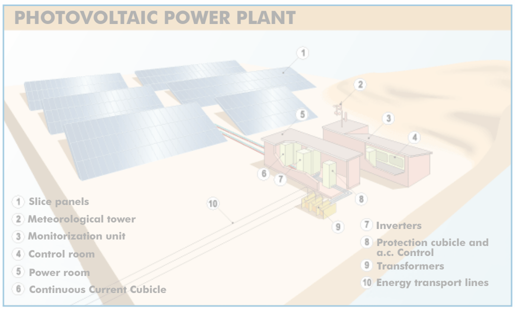
GAS POWER PLANT



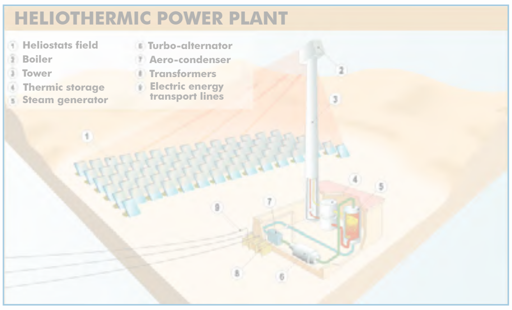
WIND-POWERED POWER PLANT



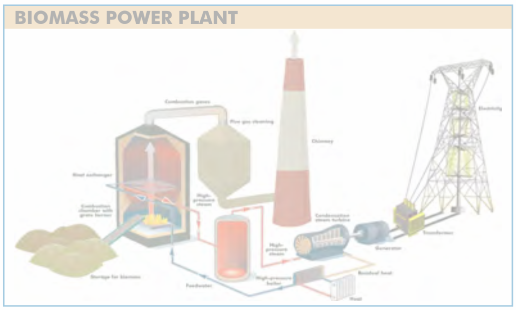
PHOTOVOLTAIC POWER PLANT



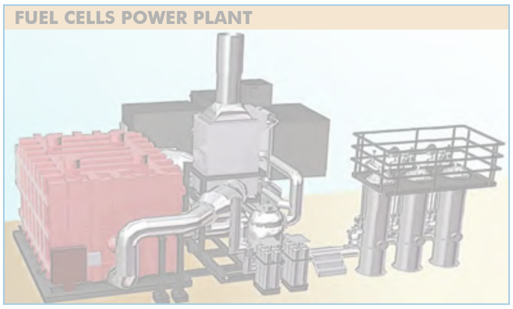
HELIOTHERMIC POWER PLANT



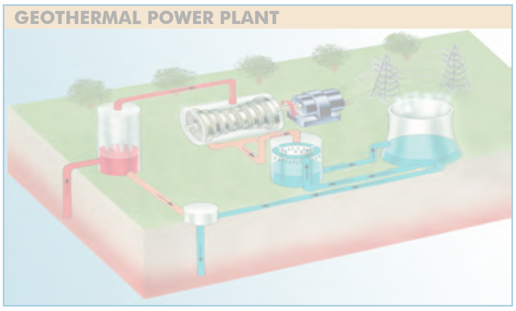
BIOMASS POWER PLANT



FUEL CELLS POWER PLANT

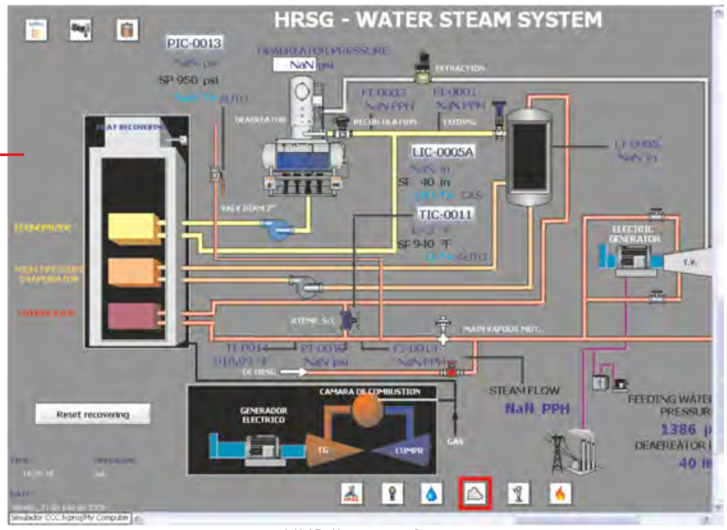


GEOTHERMAL POWER PLANT

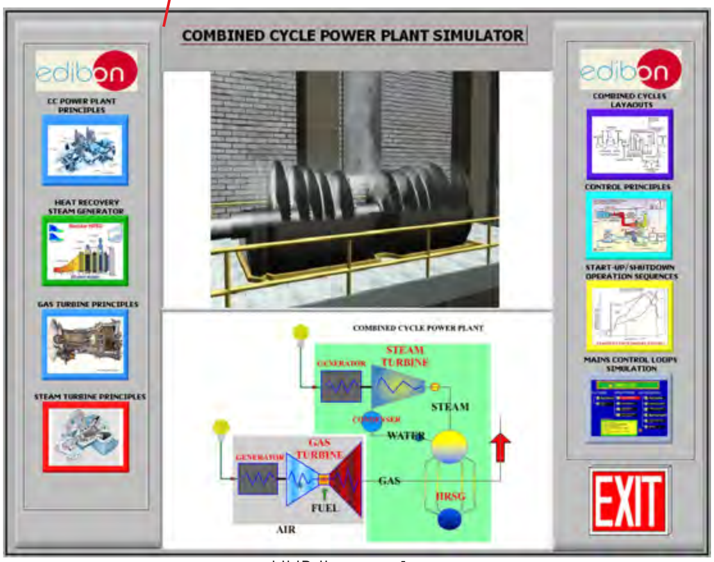


NOTE: Any of the 12 options available required HUB II. Mechanical Power Plants and Energy System with SCADA II.

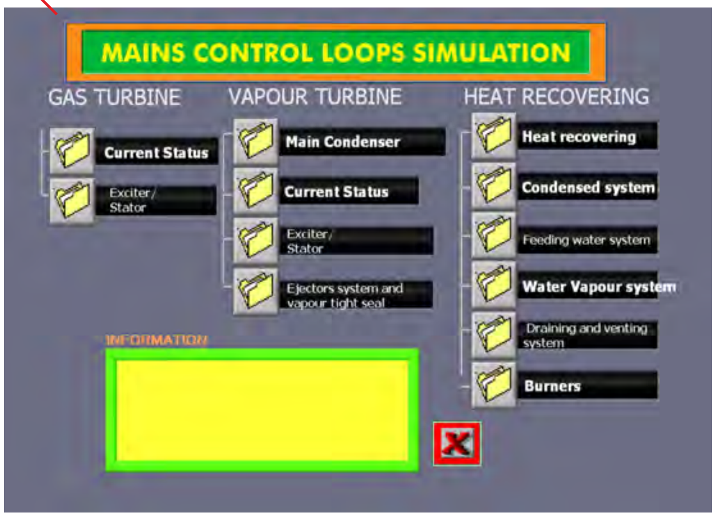
HUB II. **Mechanical Power Plants and Energy System with SCADA II**



HUB II screen 3



HUB II screen 1



HUB II screen 2

GENERAL DESCRIPTION

It includes an Energy Control desk with two touch screens and one normal screen and computer; a SCADA II system with computer control electronics and the proper operation software package.

The main function of this system is the control and simulation of Mathematical Model representing the Primary Energy Conversion and the second one is the interaction data exchange with the HUB I. Electrical Power System and SCADA I.

This desk will accept any of the following Power Plants and Energy Systems Simulation Softwares Packages:

- PPE/CC. Combined Cycle Power Plant.
- PPE/NU. Nuclear Power Plant.
- PPE/FD. Diesel Fuel Power Plant.
- PPE/FF. Fossil Fuel (coals) Power Plant.
- PPE/GA. Gas Power Plant.
- PPE/HY. Hydroelectric and Power Plant.
- PPE/WP. Wind Powered Power Plant.
- PPE/FV. Photovoltaic Power Plant.
- PPE/HE. Heliothermic Power Plant.
- PPE/BM. Biomass Power Plant.
- PPE/FC. Fuel Cells Power Plant.
- PPE/GT. Geothermal Power Plant.

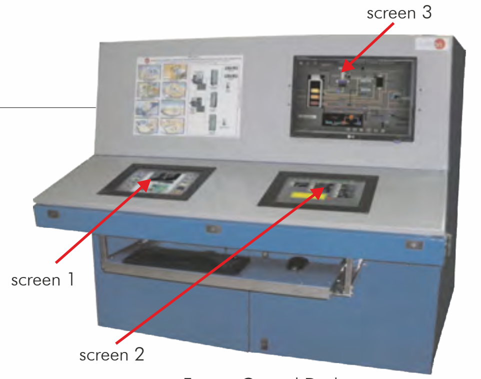
Any of these sofware packages describes the simulation of the energy and electromechanical conversion part of the simulator.

Main components of any of these software packages:

a) Simulation of the main control loops of the primary mover from the power system operation point of view.
b) Procedure for starting and stopping the real Power Plant.
c) Dynamic interaction between students and real control loops simulation.
d) Students can change dynamically the control loops set points and operation parameters.
e) To receive a theoretical background on the Power Plant operation and control.
f) Open control, multicontrol and real time control.

HUB II. **Mechanical Power Plants and Energy System with SCADA II**

SPECIFICATIONS



Energy Control Desk

<u>Energy Control Desk</u>, including:

-Two touch screens.
-One normal screen.
-Computer (PC).
-Power cables and communication cable.
-Magneto-thermal switches.
-SCADA II system with computer control electronics and the proper operation software package.
-Communication interface with HUB I.
Etc.

<u>SCADA II</u> **Screens distribution:**

a) HUB II screen 1. Main menu touch screen display (screen 1): This screen appears in the left bottom display on Energy Control Desk and from this screen it is possible to navigate and explore others operation screens that conform the power plant processes control and operation simulation.

When you push a button on this screen, an operational screen appears in the right bottom touch screen (screen 2) display.

Elements of the main menu screen:

a.1) Power Plant General Principles.

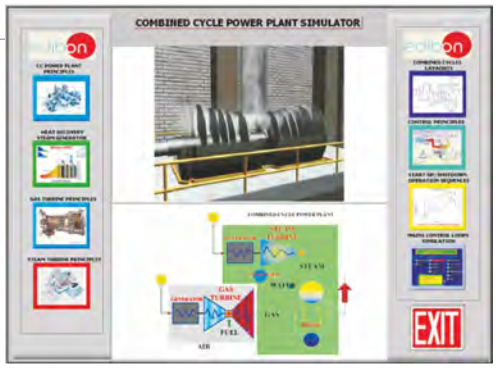
This screen works like power point slider document and the objective is to introduce you to the principles of power plant operation. Front this menu screen you can access all elements of the power plant, and take a theoretical background about the principles of operation individually and in conjunction.

a.2) Primary Mover Principles of Operation.

This screen works like power point slider document and the objective is to introduce you to the principles of primary mover. You can take a theoretical background about the principles of energy conversion from the primary mover to electrical energy, what kind of element participate in that conversion and how to control and operate these elements.

a.3) Power Plant General Layouts.

This screen works like power point slider document and the objective is to introduce you to the Power Plant individual and generals control and operation layouts. You can take a theoretical background about how to interpret different primary mover control layouts.



a) HUB II screen 1

a.4) Power Plant Control Principles.

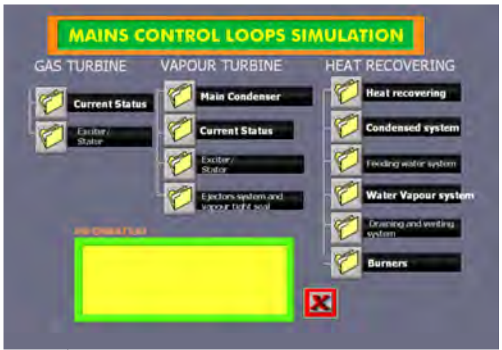
This screen works like power point slider document and the objective is to introduce you to the control principles of the power plant. You can take a theoretical background about the differerent control loops in this type of power plant by mean of description of what variables are measured and controlled.

a.5) Power Plant Start-Up and Shutdowns Operation Sequences.

This screen works like power point slider document and the objective is to training you on the general sequences that any power plant operator must be follow to Start and shutdown a power plant.

a.6) Mains Power Plant Control Loops Simulation.

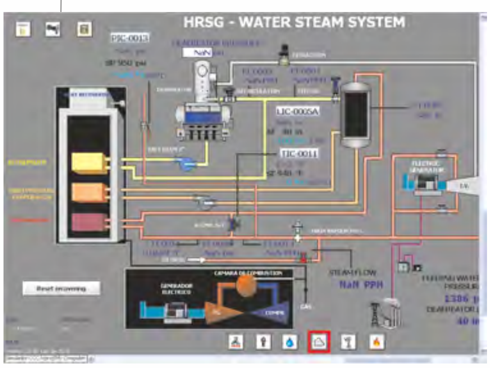
This screen shows the real time simulation of mathematical model of the primary mover as part of the power system and the objective is to explain in detail the simulation of the mains control loops of the Power Plant and how these control loops interact between then and with the real time electrical power system. You can analyse the frequency-load control, voltage-reactive power control, etc.



b) HUB II screen 2

b) HUB II screen 2. Operational touch display (screen 2): This screen will indicate information at second level related to any one of the elements of main menu screen.

c) HUB II screen 3. General state diagram screen display (screen 3): This screen will indicate the particular diagram we are working on at any time and any selection.



c) HUB II screen 3

<u>SCADA II</u> **Software description:**

<u>Introduction:</u>

The MECHANICAL POWER PLANT SIMULATOR is a simulation and control system software developed taking into account the experience related to Power Plants.

In this system are different configuration and management levels that allow the teacher to design and execute different practices related with the power plant processes control and operation.

<u>Technical requirements:</u>

The MECHANICAL POWER PLANT SIMULATOR is prepared to work with a minimum resolution of 1024x768. If you work with a smaller resolution, some controls may not be visualised in the screen.

<u>Hardware configuration:</u>

The computer placed in the Energy Control Desk is equipped with all elements necessary for achieve a real time simulation of the power plant main processes.

<u>Software start:</u>

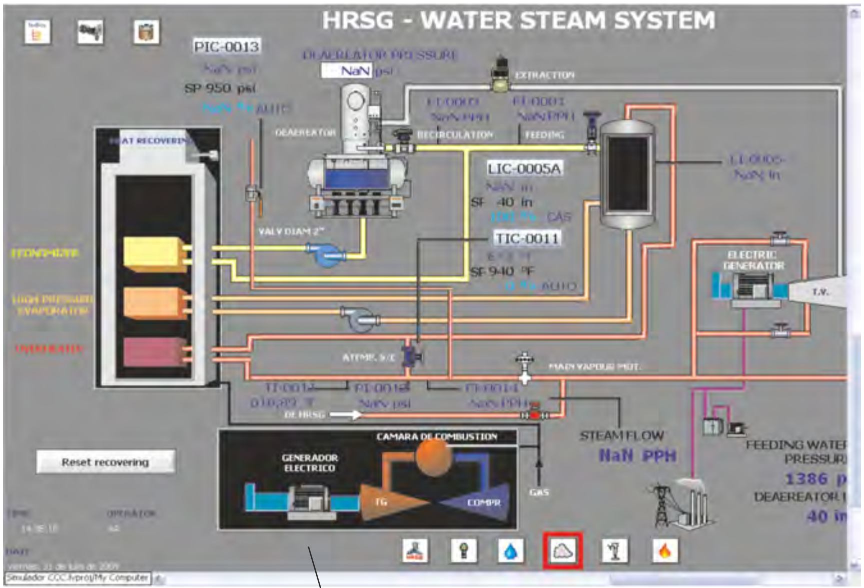
The software describes the simulation of the energy and electromechanical conversion part of the simulator. It will be launched from Windows Desktop, appearing as three screens in the corresponding displays. If a new start is needed, the program will appear on Windows Desktop.

DIMENSIONS & WEIGHT

- Dimensions: 160 x 84 x 140 cm. approx.
- Weight: 100 Kg. approx.

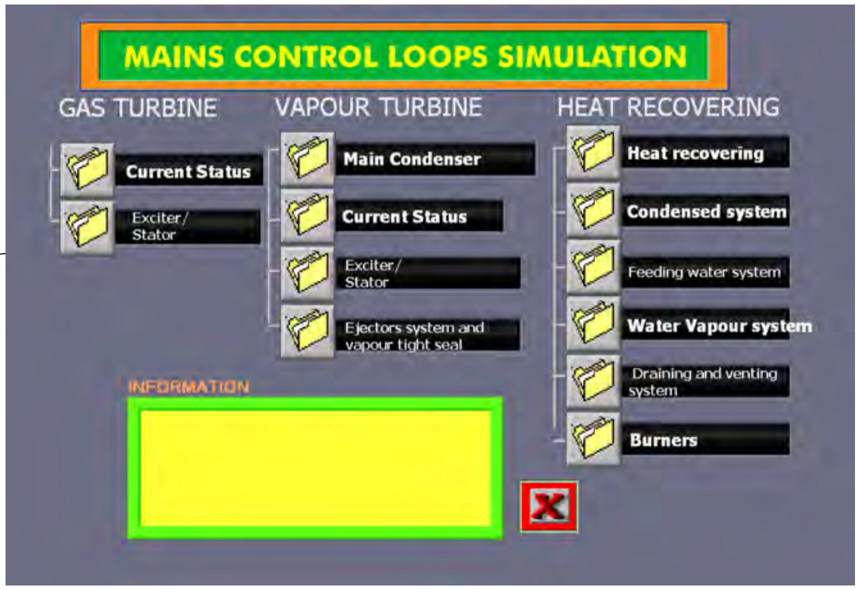
HUB II. **Mechanical Power Plants and Energy System with SCADA II** (Example of Combined Cycle)

Main Screens



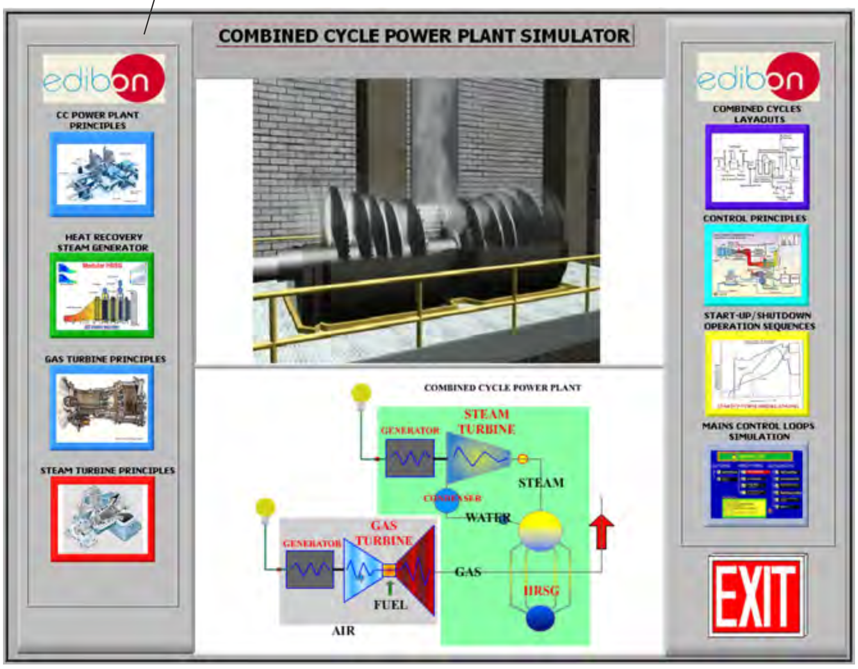
HUB II screen 3
(General state Power Plant diagram)

Screen possibilities, see next pages



HUB II screen 2
(Mains Power Plant Control Loops Simulation)

Screen possibilities, see next pages



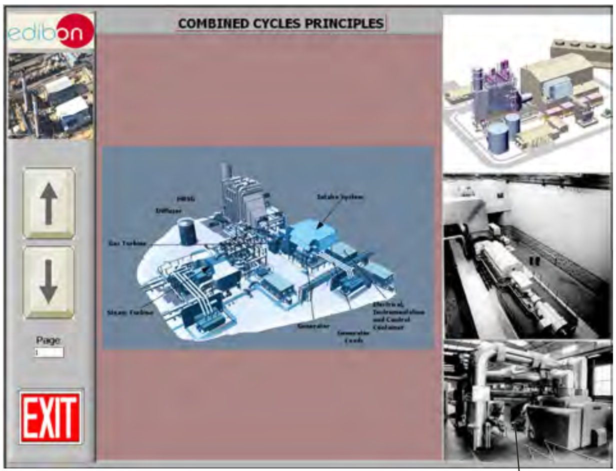
HUB II screen 1
(Main menu screen)

Screen possibilities, see next pages

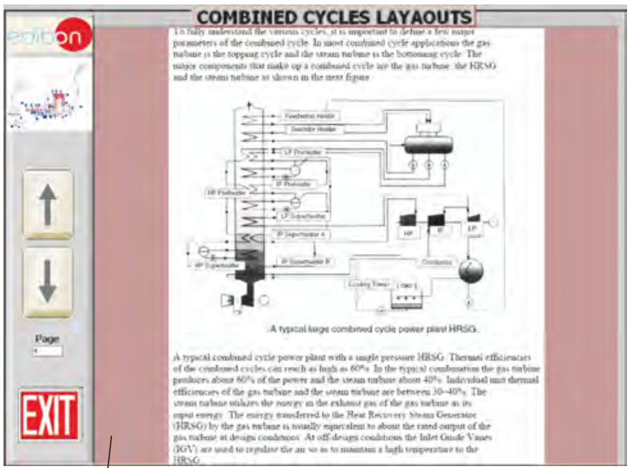
Continue ...

HUB II. **Mechanical Power Plants and Energy System with SCADA II** (Example of Combined Cycle)

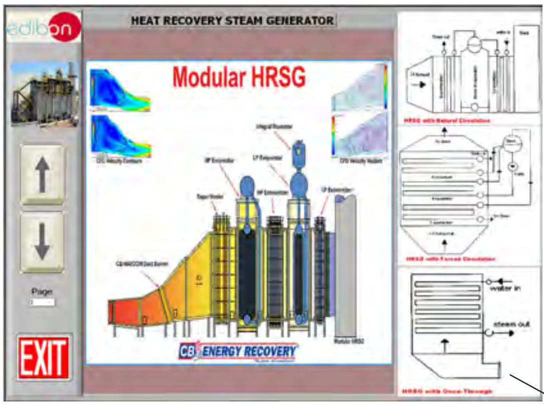
HUB II **screen 1** Possibilities



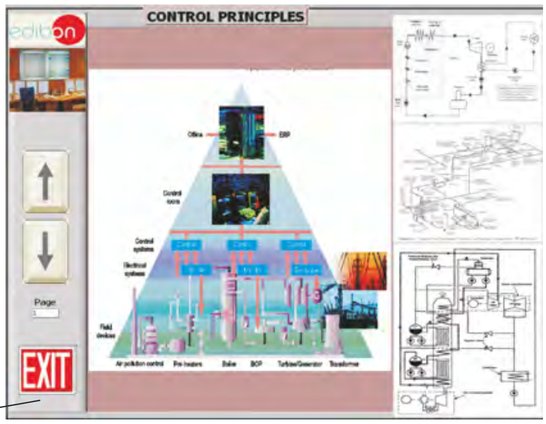
HUB II screen 1.1. **Combined Cycle Power Plant Principles screen**



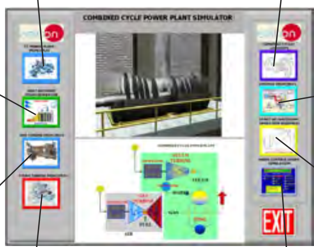
HUB II screen 1.5. **Combined Cycles Power Layouts screen**



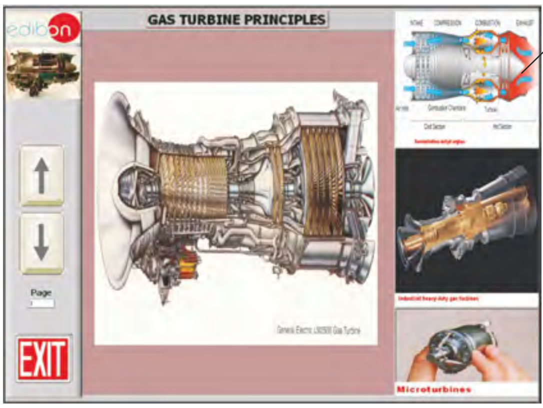
HUB II screen 1.2. **Heat Recovery Steam Generator Principles screen**



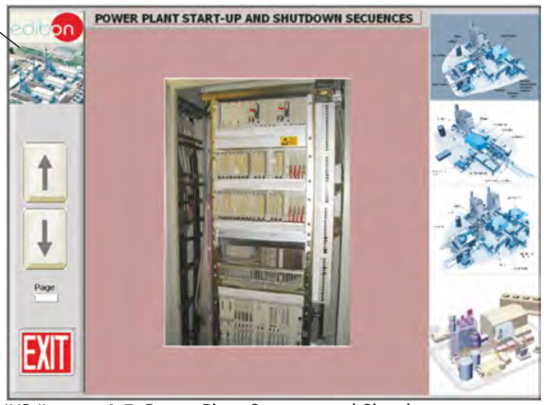
HUB II screen 1.6. **Control Principles screen**



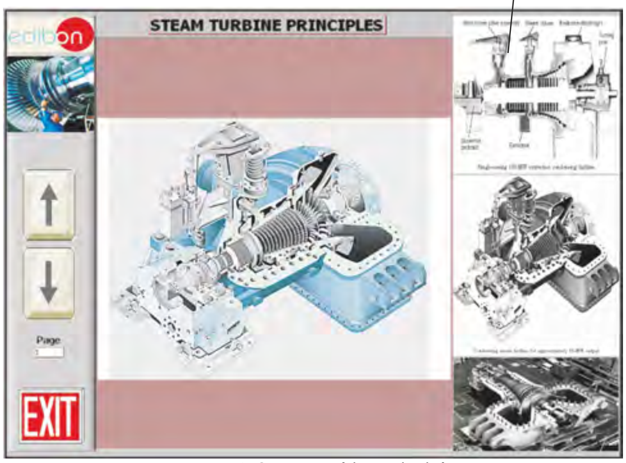
HUB II screen 1
(screen possibilities)



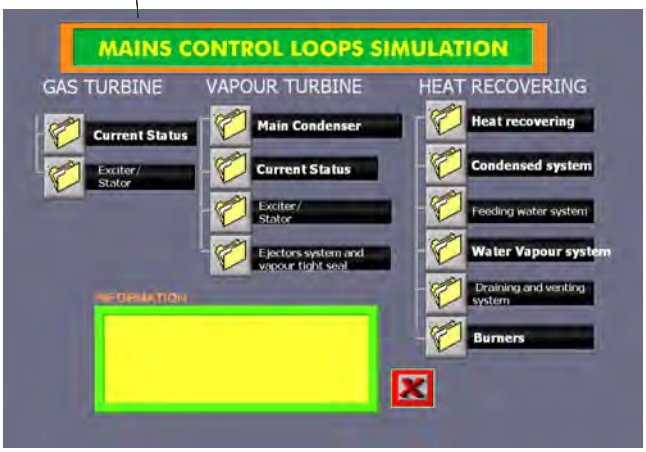
HUB II screen 1.3. **Gas Turbine Principles screen**



HUB II screen 1.7. **Power Plant Start-up and Shutdown sequences screen**



HUB II screen 1.4. **Steam Turbine Principles screen**

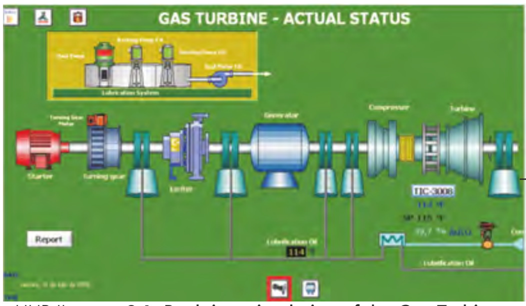


HUB II screen 1.8. **Mains Power Plant Control Loops Simulation screen (selection menu)**

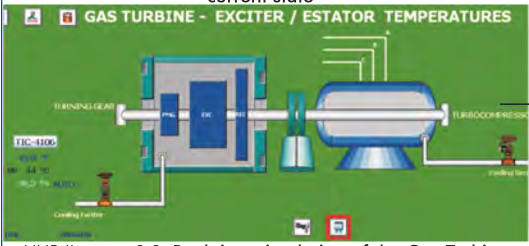
Continue ...

HUB II. **Mechanical Power Plants and Energy System with SCADA II** (Example of Combined Cycle)

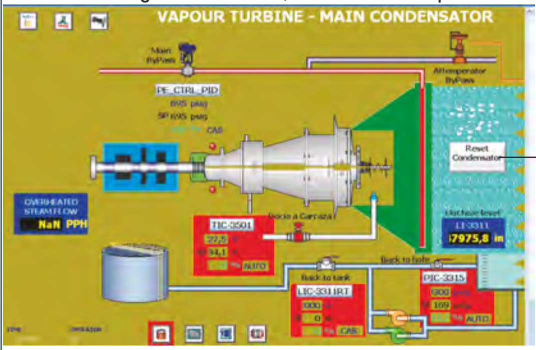
HUB II **screen 2** Possibilities



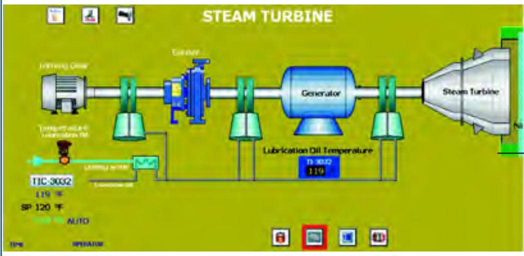
HUB II screen 2.1. **Real time simulation of the Gas Turbine current state**



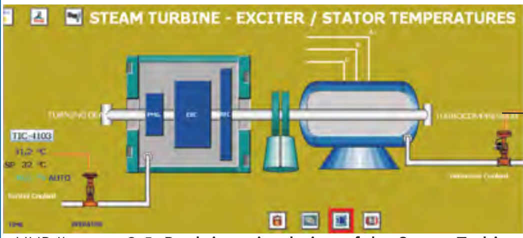
HUB II screen 2.2. **Real time simulation of the Gas Turbine electric generator exciter/stator control loops**



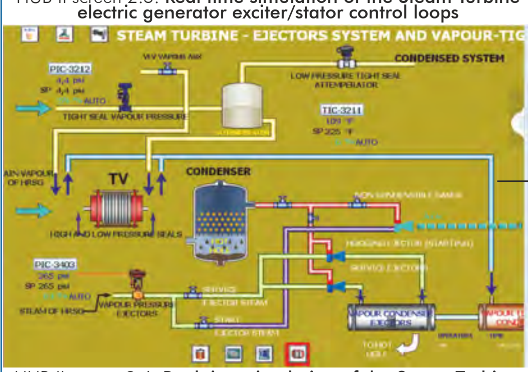
HUB II screen 2.3. **Real time simulation of the Steam Turbine Main Condenser control loops**



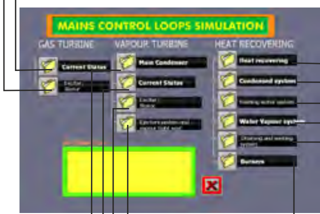
HUB II screen 2.4. **Real time simulation of the Steam Turbine Main current state**



HUB II screen 2.5. **Real time simulation of the Steam Turbine electric generator exciter/stator control loops**

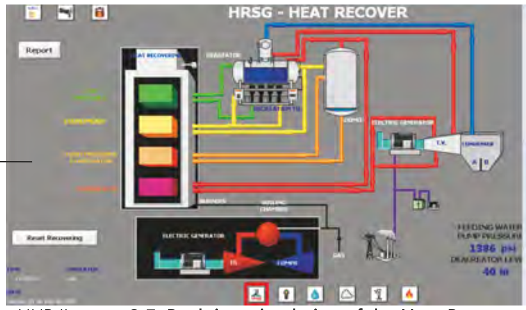


HUB II screen 2.6. **Real time simulation of the Steam Turbine ejectors system and steam tight seal control loops**

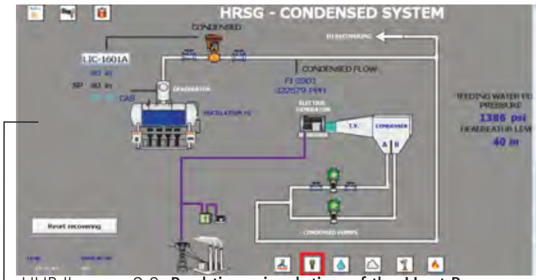


HUB II screen 2
(Mains Power Plant Control Loops Simulation)

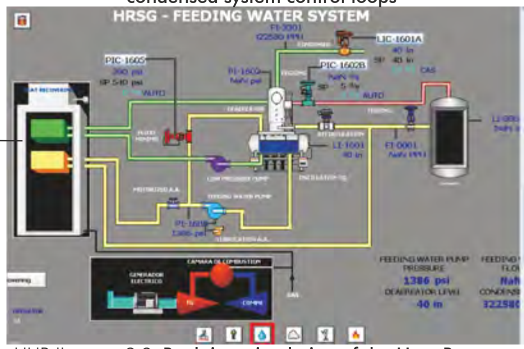
(screen possibilities)



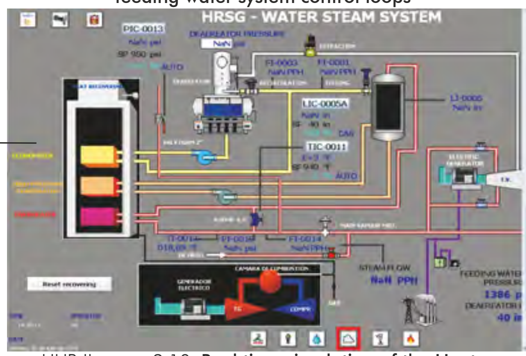
HUB II screen 2.7. **Real time simulation of the Heat Recovery current state**



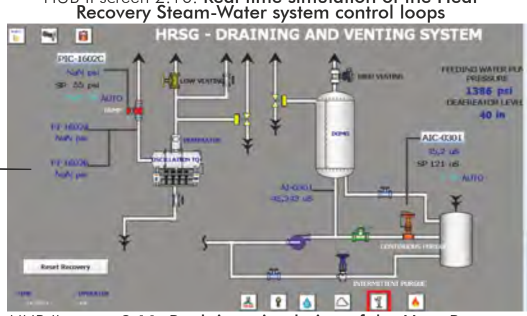
HUB II screen 2.8. **Real time simulation of the Heat Recovery condensed system control loops**



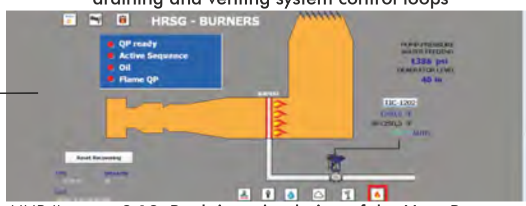
HUB II screen 2.9. **Real time simulation of the Heat Recovery feeding water system control loops**



HUB II screen 2.10. **Real time simulation of the Heat Recovery Steam-Water system control loops**



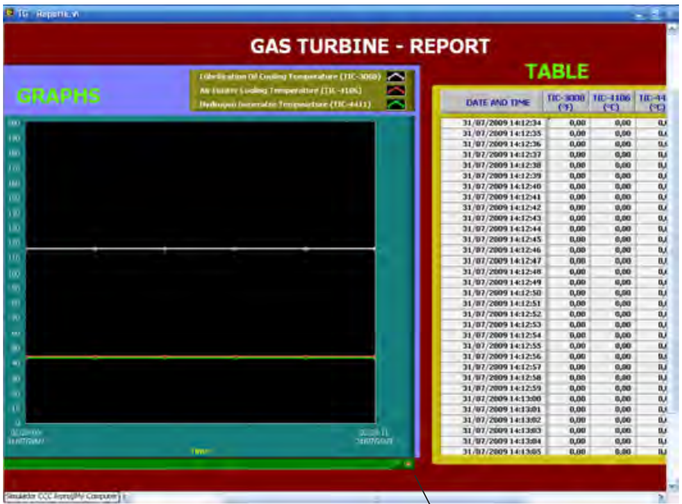
HUB II screen 2.11. **Real time simulation of the Heat Recovery draining and venting system control loops**



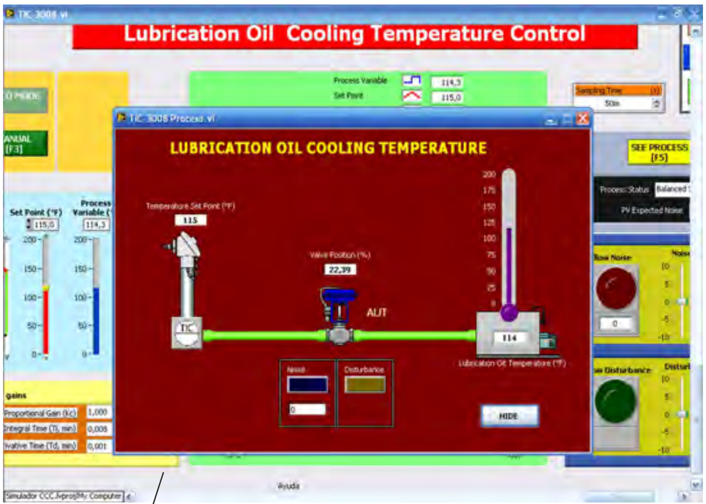
HUB II screen 2.12. **Real time simulation of the Heat Recovery burners control loops**

Continue ...

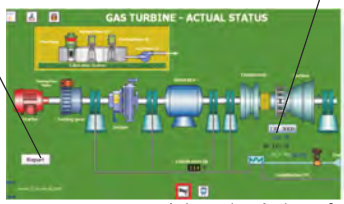
HUB II screen 2.1 and 2.2 some Possibilities



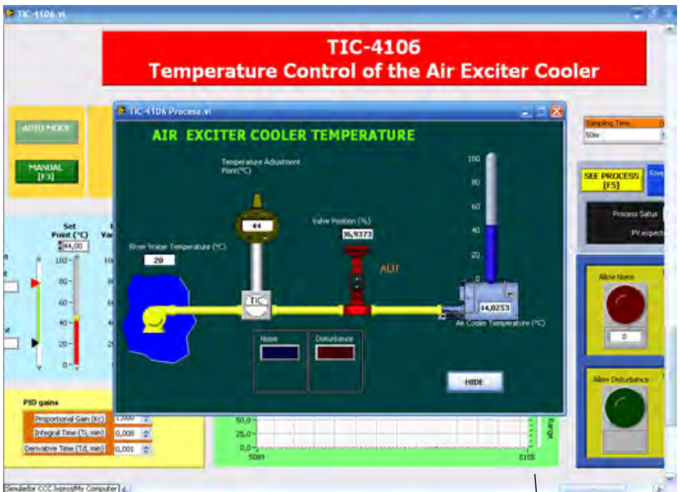
HUB II screen 2.1.1



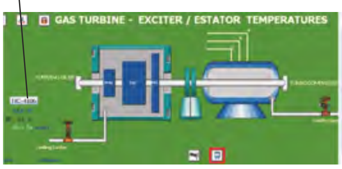
HUB II screen 2.1.2. **Real time simulation of the local control loop of lubrication oil cooling temperature (TIC-3008)**



HUB II screen 2.1. **Real time simulation of the Gas Turbine current state**



HUB II screen 2.2.1. **Real time simulation of the local control loop of air exciter cooler temperature (TIC-4106)**

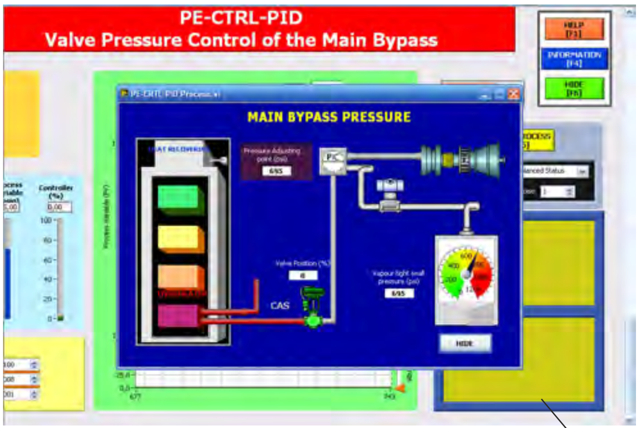


HUB II screen 2.2. **Real time simulation of the Gas Turbine electric generator exciter/stator control loops**

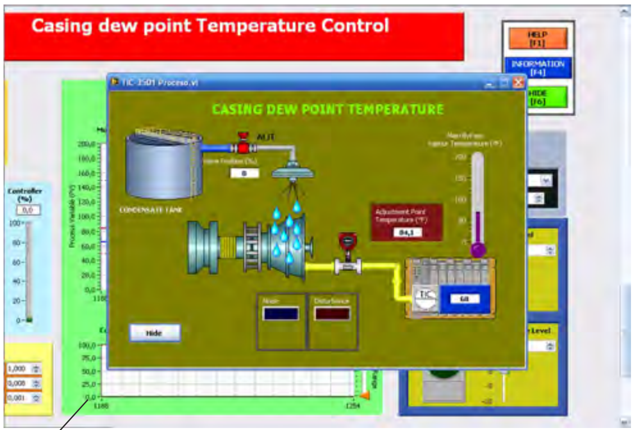
Continue ...

HUB II. **Mechanical Power Plants and Energy System with SCADA II** (Example of Combined Cycle)

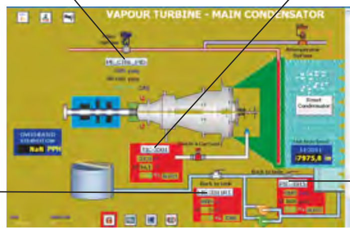
HUB II screen 2.3 and 2.4 some Possibilities



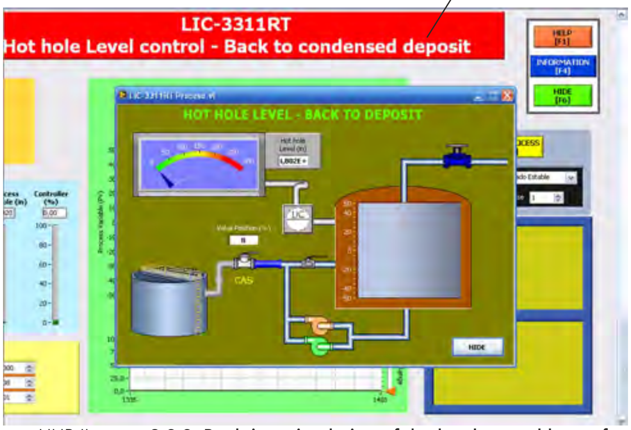
HUB II screen 2.3.1. **Real time simulation of the local control loop of main bypass pressure (PE-CTRL-PID)**



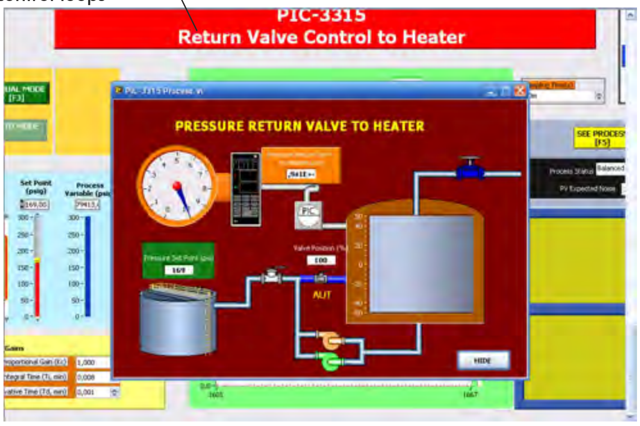
HUB II screen 2.3.2. **Real time simulation of the local control loop of casing dew point temperature (TIC-3105)**



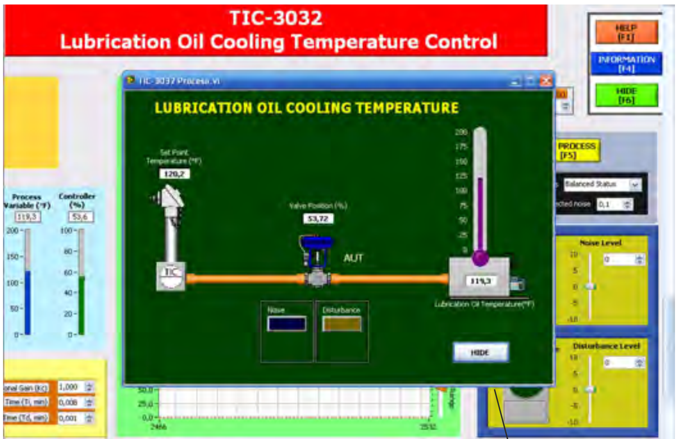
HUB II screen 2.3. **Real time simulation of the Steam Turbine Main Condenser control loops**



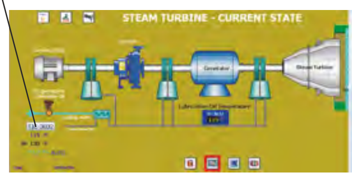
HUB II screen 2.3.3. **Real time simulation of the local control loop of hot hole level - back to condensed deposit (LIC-3311RT)**



HUB II screen 2.3.4. **Real time simulation of the local control loop of pressure return valve to heater (PIC-3315)**



HUB II screen 2.4.1. **Real time simulation of the local control loop of lubrication oil cooling temperature (TIC-3032)**

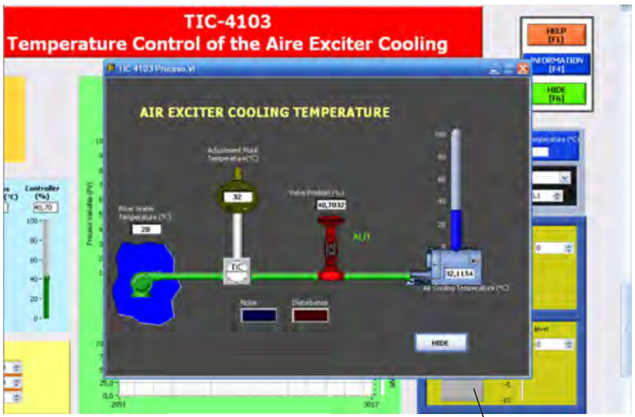


HUB II screen 2.4. **Real time simulation of the Steam Turbine Main current state**

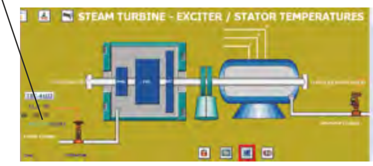
Continue ...

HUB II. **Mechanical Power Plants and Energy System with SCADA II** (Example of Combined Cycle)

HUB II screen 2.5 and 2.6 some Possibilities

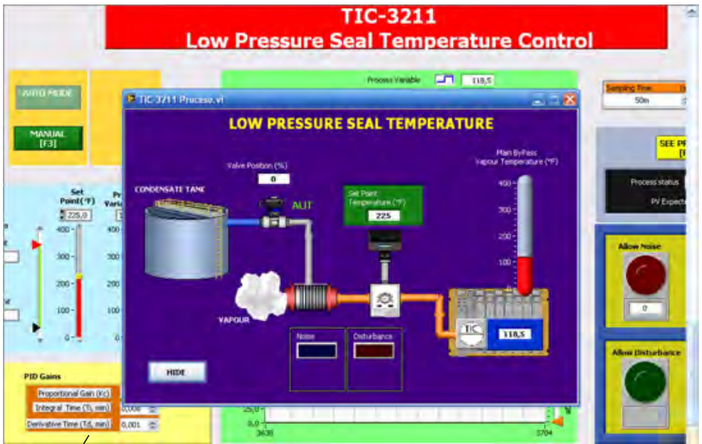


HUB II screen 2.5.1. **Real time simulation of the local control loop of air exciter cooling temperature (TIC-4103)**

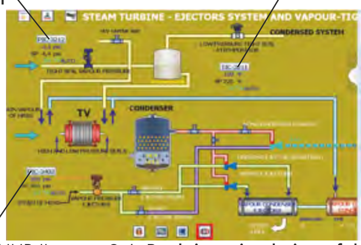


HUB II screen 2.5. **Real time simulation of the Steam Turbine electric generator exciter/stator control loops**

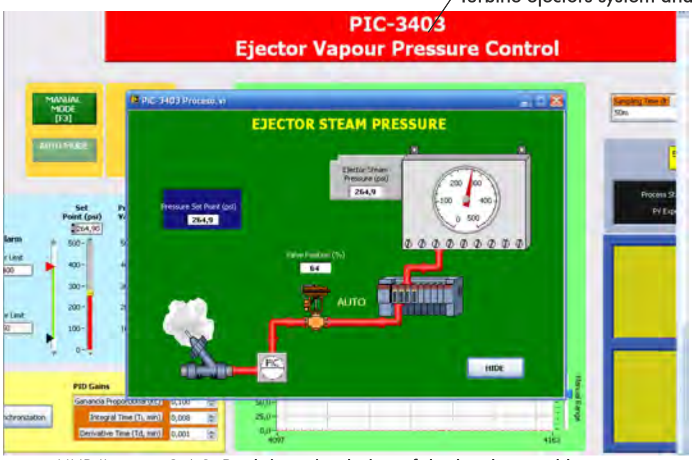
HUB II screen 2.6.1. **Real time simulation of the local control loop of seal steam pressure (PIC-3212)**



HUB II screen 2.6.2. **Real time simulation of the local control loop of low pressure seal temperature (TIC-3211)**



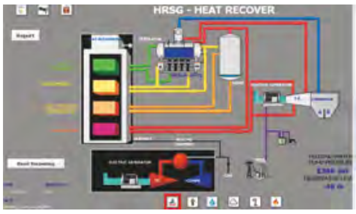
HUB II screen 2.6. **Real time simulation of the Steam Turbine ejectors system and steam tight seal control loops**



HUB II screen 2.6.3. **Real time simulation of the local control loop of ejector steam pressure (PIC-3403)**

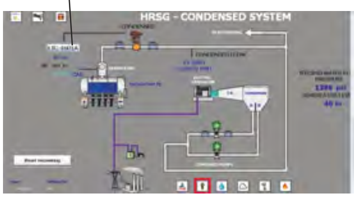
Continue ...

HUB II screen 2.7 and 2.8 some Possibilities



HUB II screen 2.7. **Real time simulation of the Heat Recovery current state**

HUB II screen 2.8.1. **Real time simulation of the local control loop of dearator level (LIC-1601A)**

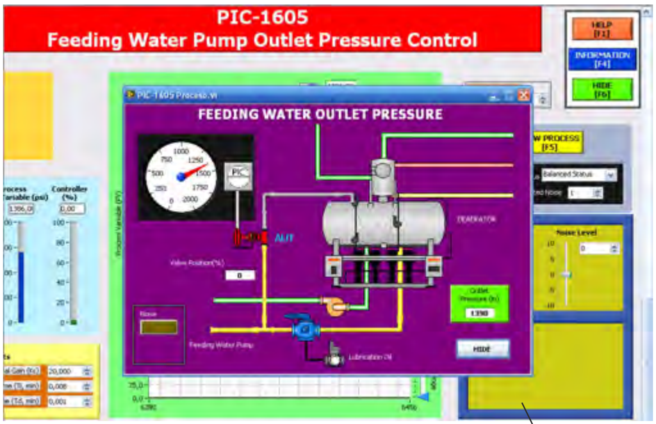


HUB II screen 2.8. **Real time simulation of the Heat Recovery condensed system control loops**

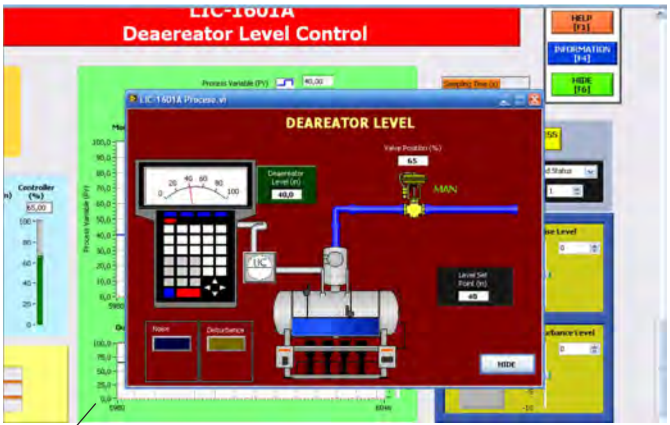
Continue ...

HUB II. **Mechanical Power Plants and Energy System with SCADA II** (Example of Combined Cycle)

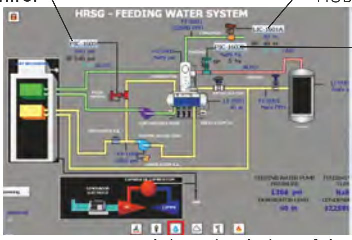
HUB II screen 2.9 and 2.10 some Possibilities



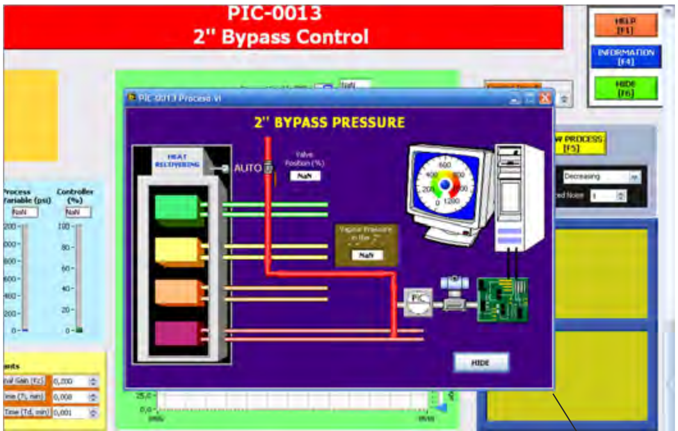
HUB II screen 2.9.1. **Real time simulation of the local control loop of feeding water outlet pressure (PIC-1605)**



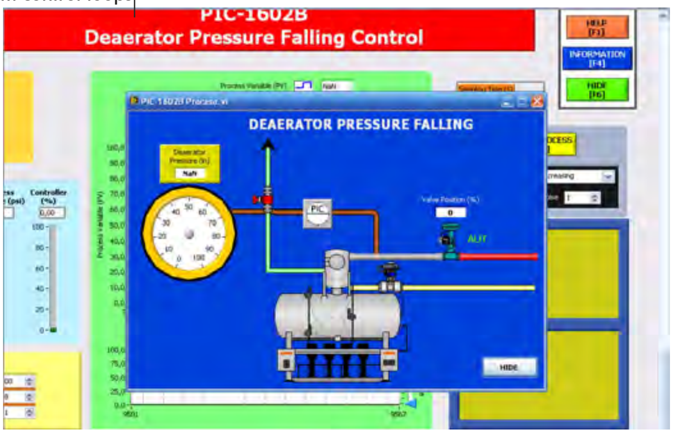
HUB II screen 2.9.2. **Real time simulation of the local control loop of deareator level (LIC-1601A)**



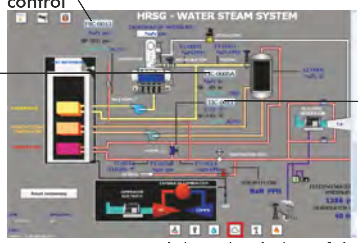
HUB II screen 2.9. **Real time simulation of the Heat Recovery feeding water system control loops**



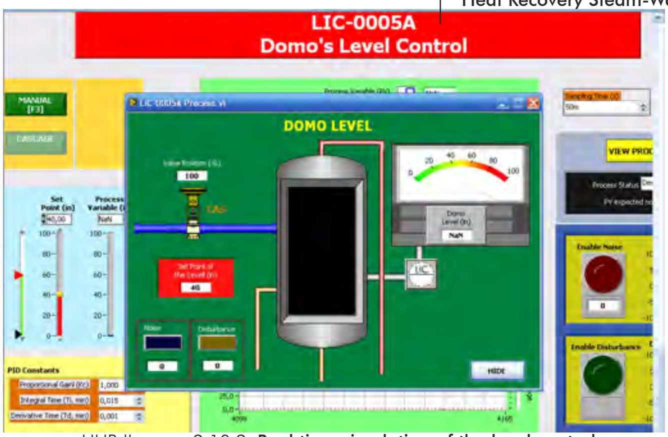
HUB II screen 2.10.1. **Real time simulation of the local control loop of bypass pressure (PIC-0013)**



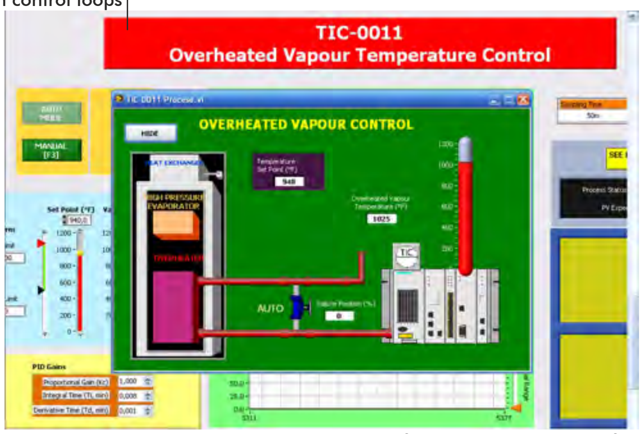
HUB II screen 2.9.3. **Real time simulation of the local control loop of deareator pressure falling (PIC-1602B)**



HUB II screen 2.10. **Real time simulation of the Heat Recovery Steam-Water system control loops**



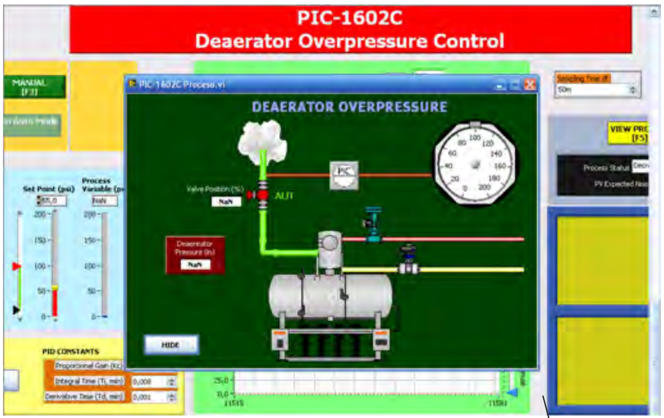
HUB II screen 2.10.2. **Real time simulation of the local control loop of domo level (LIC-0005A)**



HUB II screen 2.10.3. **Real time simulation of the local control loop of overheated vapour control (TIC-0011)**

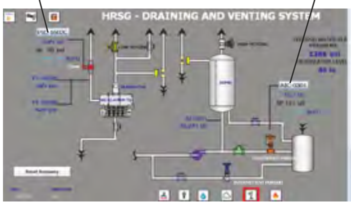
Continue ...

HUB II screen 2.11 and 2.12 some Possibilities

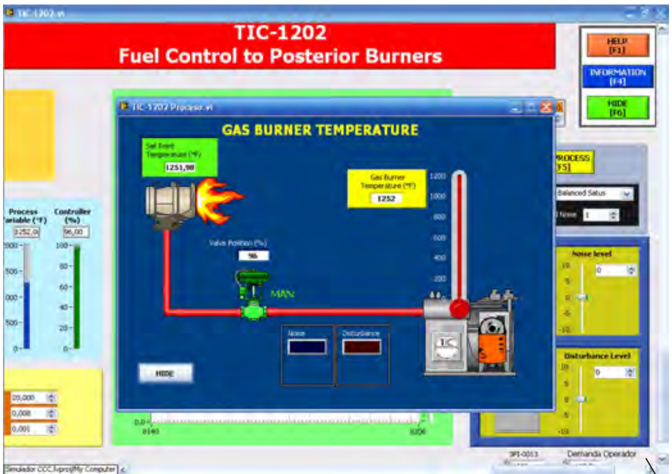


HUB II screen 2.11.1. **Real time simulation of the local control loop of deaerator overpressure (PIC-1602C)**

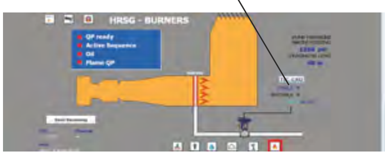
HUB II screen 2.11.2. **Real time simulation of the local control loop of domo's conductivity (AIC-0301)**



HUB II screen 2.11. **Real time simulation of the Heat Recovery draining and venting system control loops**



HUB II screen 2.12.1. **Real time simulation of the local control loop of gas burner temperature (TIC-1202)**



HUB II screen 2.12. **Real time simulation of the Heat Recovery burners control loops**

EXERCICES AND PRACTICAL POSSIBILITIES

Some practical possibilities among many others:

With **HUB II. Mechanical Power Plants and Energy System with SCADA II + PPE/CC. Combined Cycle Power Plant**:

1.- Combined Cycle Power Plant General Principles of Operation.

2.- Gas Turbine of the Combined Cycle Power Plant General Principles of Operation.

3.- Steam Turbine of the Combined Cycle Power Plant General Principles of Operation.

4.- Combined Cycle Power Plant General Control Layouts.

5.- Combined Cycle Power Plant Control and Instrumentation Principles.

6.- Introduction to Mechanical and Electrical System Simulation.

7.- Introduction to Combined Cycle Power Plant Block Diagram and Transfer Functions.

8.- Introduction to Proportional, Integral and Derivate (PID) Controllers used in Power Plant Control.

9.- Analysis of Proportional Controller.

10.- Analysis of Integral Controller.

11.- Analysis of Derivative Controller.

12.- Analysis of PID Controller.

13.- Analysis and Simulation of Gas Turbine Fuel System of the Combined Cycle Power Plant.

14.- Analysis and Simulation of Compressor-Turbine System of the Combined Cycle Power Plant.

15.- Analysis and Simulation of Gas Turbine Temperature Control of the Combined Cycle Power Plant.

16.- Analysis and Simulation of Gas Turbine Governor/Speed Control of the Combined Cycle Power Plant.

17.- Analysis and Simulation of Steam Turbine Governor/Speed Control of the Combined Cycle Power Plant.

18.- Analysis and Simulation of Gas Turbine Generator Excitation System of the Combined Cycle Power Plant.

19.- Analysis and Simulation of Steam Turbine Generator Excitation System of the Combined Cycle Power Plant.

20.- Analysis and Simulation of Gas Turbine Outer/Loop MW Control of the Combined Cycle Power Plant.

21.- Analysis and Simulation of Steam Turbine Outer/Loop MW Control of the Combined Cycle Power Plant.

22.- Analysis and Simulation of Gas Turbine Electrical Generator of the Combined Cycle Power Plant.

23.- Analysis and Simulation of Steam Turbine Electrical Generator of the Combined Cycle Power Plant.

24.- Analysis and Simulation of Gas Turbine Lubrication Oil Cooling Temperature Control of the Combined Cycle Power Plant.

25.- Analysis and Simulation of Gas Turbine Generator Exciter Cooler Temperature Control of the Combined Cycle Power Plant.

26.- Combined Cycle Power Plant Start-Up Procedure Analysis and Simulation.

27.- Combined Cycle Power Plant Start-Up execution with the real Hardware.

28.- Combined Cycle Power Plant Shut-Down Procedure Analysis and Simulation.

29.- Combined Cycle Power Plant Shut-Down execution with the real Hardware.

30.- Combined Cycle Power Plant Active Power Control in isolated mode of operation (two generators).

31.- Combined Cycle Power Plant Frequency Control in isolated mode of operation.

32.- Combined Cycle Power Plant Reactive Power Control in isolated mode of operation (two generators).

33.- Combined Cycle Power Plant Voltage Control in isolated mode of operation.

34.- Combined Cycle Power Plant Synchronization.

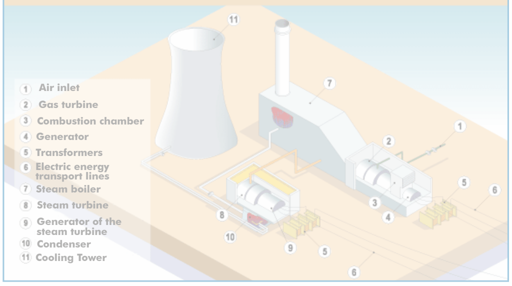
35.- Combined Cycle Power Plant Active Power Control when connected to the Grid.

36.- Combined Cycle Power Plant Reactive Power Control when connected to the Grid.

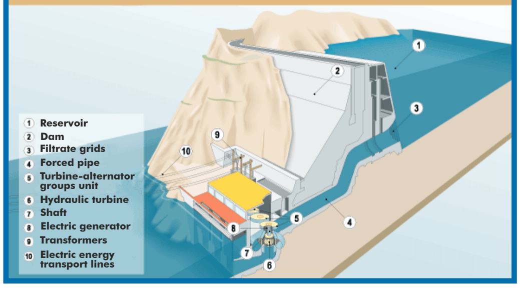
37.- Faults in Combined Cycle Power Plant Operation.

Available Power Plants:

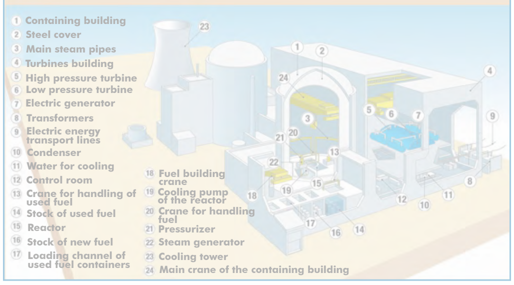
COMBINED CYCLE POWER PLANT



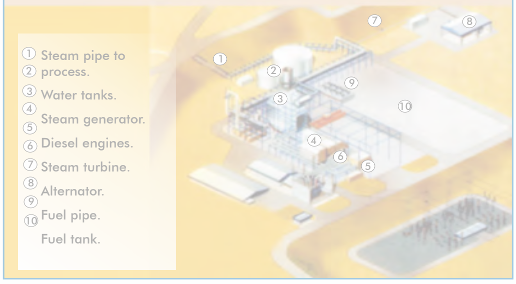
HYDROELECTRIC POWER PLANT



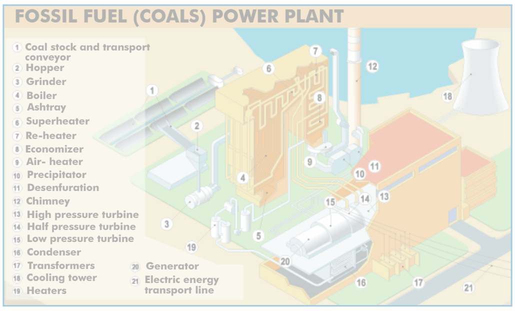
NUCLEAR POWER PLANT



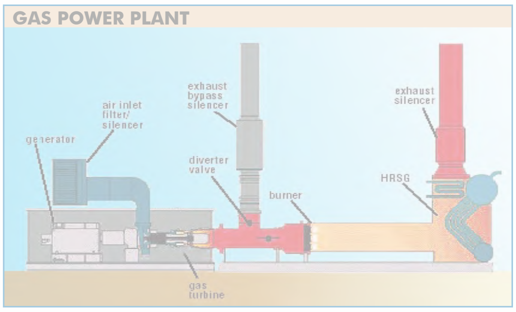
DIESEL FUEL POWER PLANT



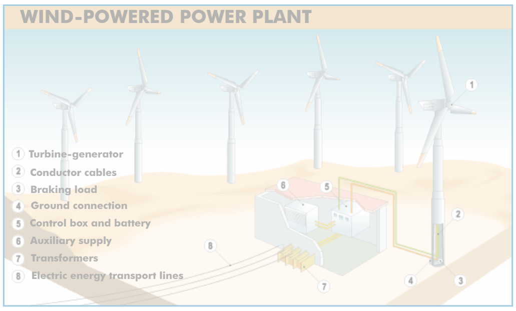
FOSSIL FUEL (COALS) POWER PLANT



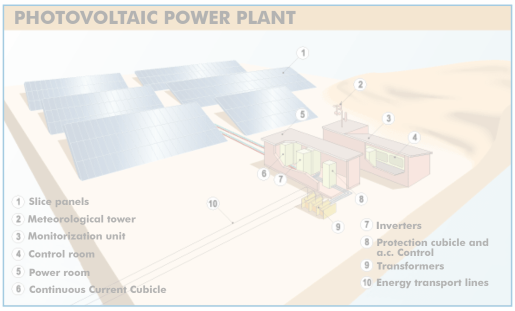
GAS POWER PLANT



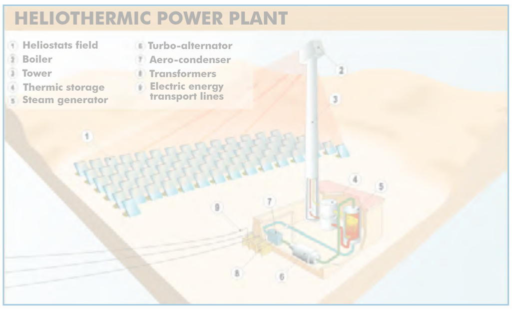
WIND-POWERED POWER PLANT



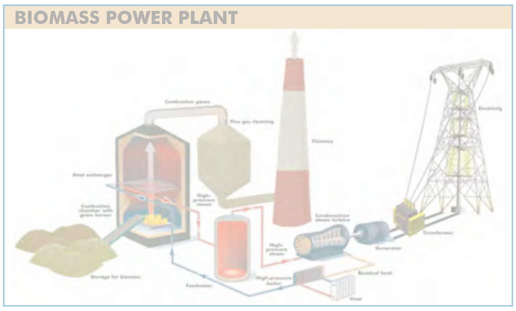
PHOTOVOLTAIC POWER PLANT



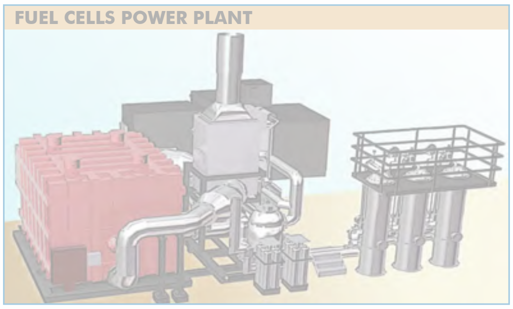
HELIOTHERMIC POWER PLANT



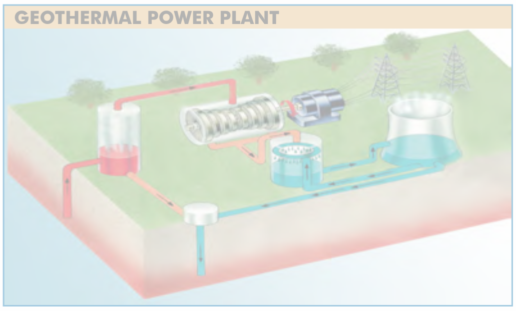
BIOMASS POWER PLANT



FUEL CELLS POWER PLANT



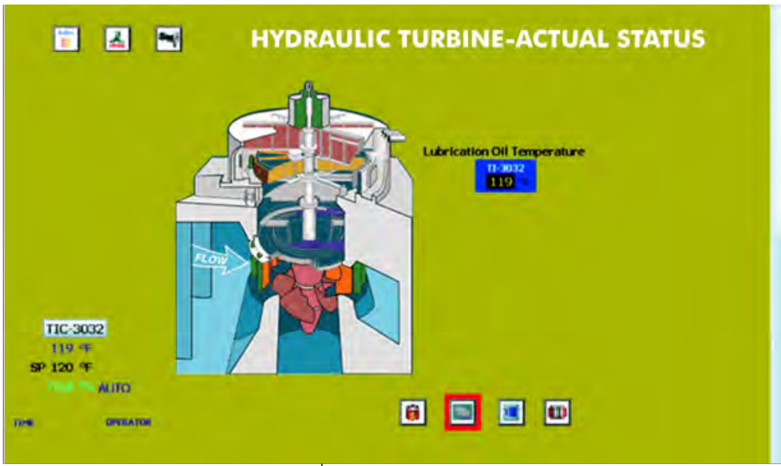
GEOTHERMAL POWER PLANT



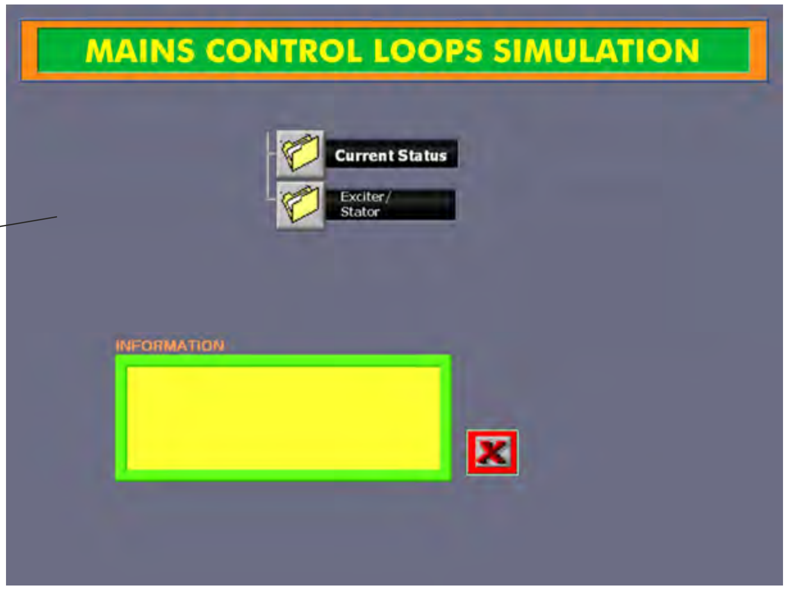
NOTE: Any of the 12 options available required HUB II. Mechanical Power Plants and Energy System with SCADA II.

HUB II. **Mechanical Power Plants and Energy System with SCADA II** (Hydroelectric Power Plant)

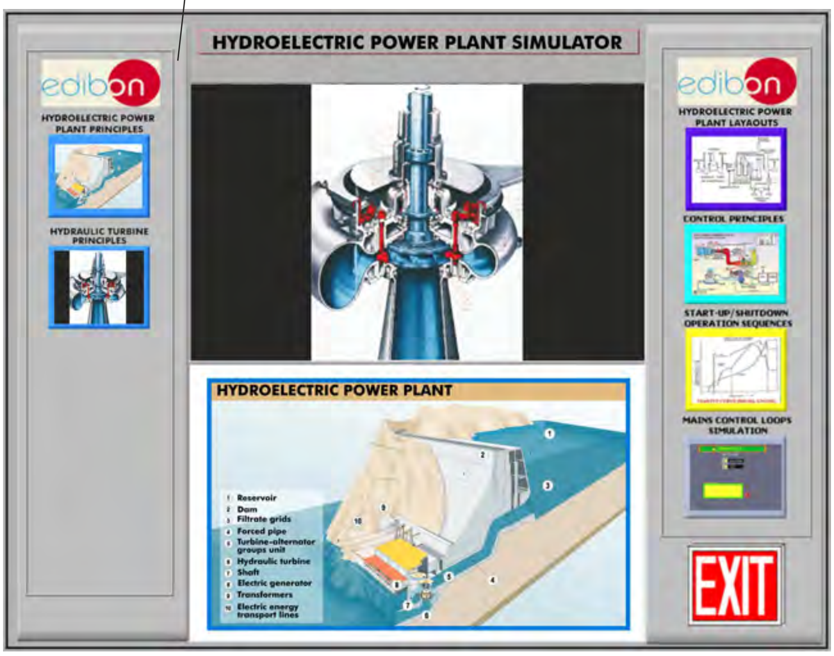
Main Screens



HUB II screen 3
(General state Power Plant diagram)



HUB II screen 2
(Mains Power Plant Control Loops Simulation)



HUB II screen 1
(Main menu screen)

EXERCICES AND PRACTICAL POSSIBILITIES

Some practical possibilities among many others:

With **HUB II. Mechanical Power Plants and Energy System with SCADA II + PPE/HY. Hydroelectric Power Plant**:

1.- Hydroelectric Power Plant General Principles of Operation.

2.- Hydraulic Turbine General Principles of Operation.

3.- Hydroelectric Power Plant General Control Layouts.

4.- Hydroelectric Power Plant Control and Instrumentation Principles.

5.- Introduction to Mechanical and Electrical System Simulation.

6.- Introduction to Hydroelectric Power Plant Block Diagram and Transfer Functions.

7.- Introduction to Proportional, Integral and Derivate (PID) Controllers used in Power Plant Control.

8.- Analysis of Proportional Controller.

9.- Analysis of Integral Controller.

10.- Analysis of Derivative Controller.

11.- Analysis of PID Controller.

12.- Analysis and Simulation of Hydraulic Turbine Feed System.

13.- Analysis and Simulation of Hydraulic Turbine Temperature Control.

14.- Analysis and Simulation of Hydraulic Turbine Governor/Speed Control.

15.- Analysis and Simulation of Hydraulic Turbine Generator Excitation System.

16.- Analysis and Simulation of Hydraulic Turbine Outer/Loop MW Control.

17.- Analysis and Simulation of Hydraulic Turbine Electrical Generator.

18.- Analysis and Simulation of Hydraulic Turbine Lubrication Oil Cooling Temperature Control.

19.- Analysis and Simulation of Hydraulic Turbine Generator Exciter Cooler Temperature Control.

20.- Hydroelectic Power Plant Start-Up Procedure Analysis and Simulation.

21.- Hydroelectic Power Plant Start-Up execution with the real Hardware.

22.- Hydroelectic Power Plant Shut-Down Procedure Analysis and Simulation.

23.- Hydroelectic Power Plant Shut-Down execution with the real Hardware.

24.- Hydroelectic Power Plant Active Power Control in isolated mode of operation (two generators).

25.- Hydroelectic Power Plant Frequency Control in isolated mode of operation.

26.- Hydroelectic Power Plant Reactive Power Control in isolated mode of operation (two generators).

27.- Hydroelectic Power Plant Voltage Control in isolated mode of operation.

28.- Hydroelectic Power Plant Synchronization.

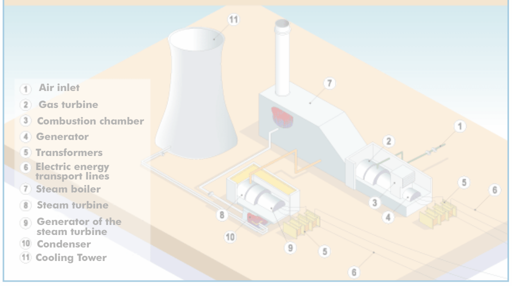
29.- Hydroelectic Power Plant Active Power Control when connected to the Grid.

30.- Hydroelectic Power Plant Reactive Power Control when connected to the Grid.

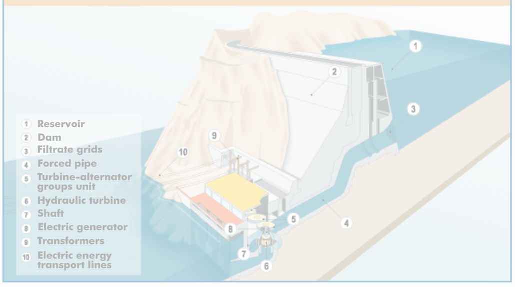
31.- Faults in Hydroelectic Power Plant Operation.

Available Power Plants:

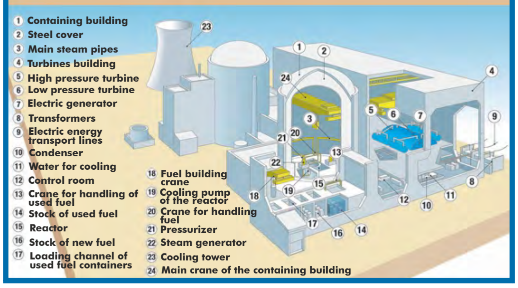
COMBINED CYCLE POWER PLANT



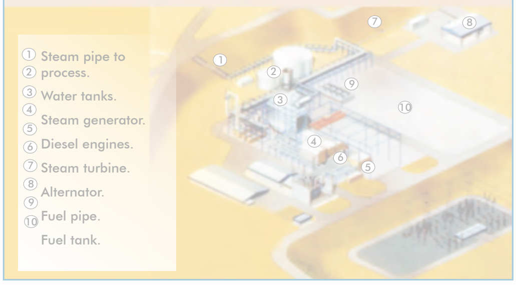
HYDROELECTRIC POWER PLANT



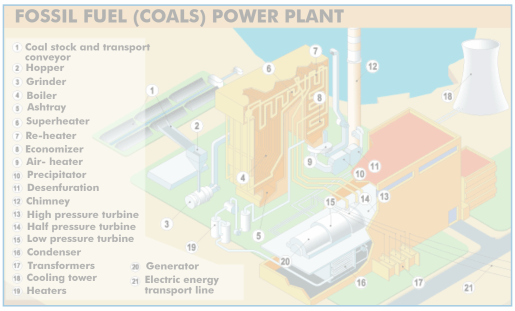
NUCLEAR POWER PLANT



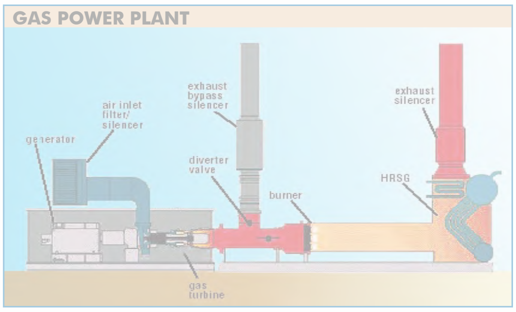
DIESEL FUEL POWER PLANT



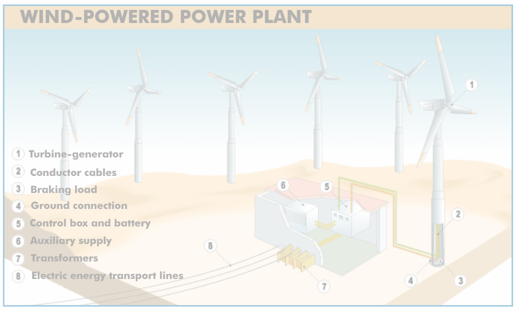
FOSSIL FUEL (COALS) POWER PLANT



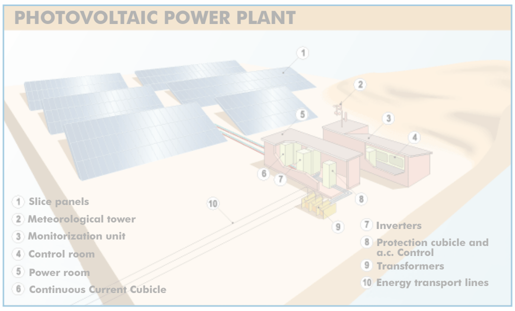
GAS POWER PLANT



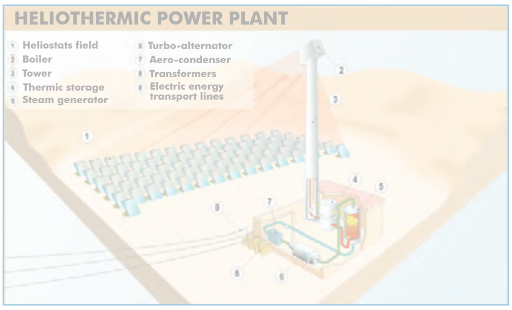
WIND-POWERED POWER PLANT



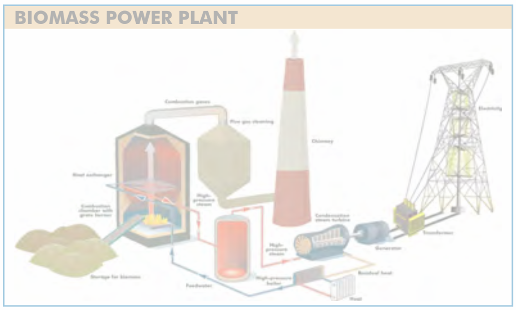
PHOTOVOLTAIC POWER PLANT



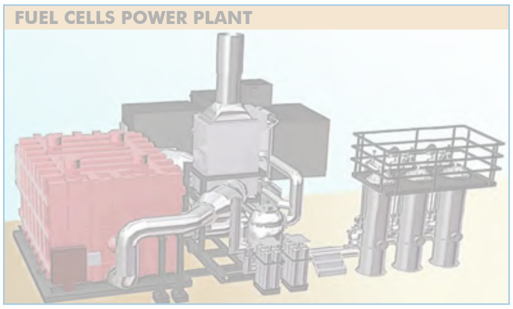
HELIOTHERMIC POWER PLANT



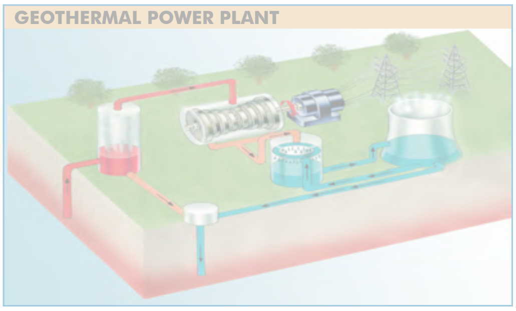
BIOMASS POWER PLANT



FUEL CELLS POWER PLANT



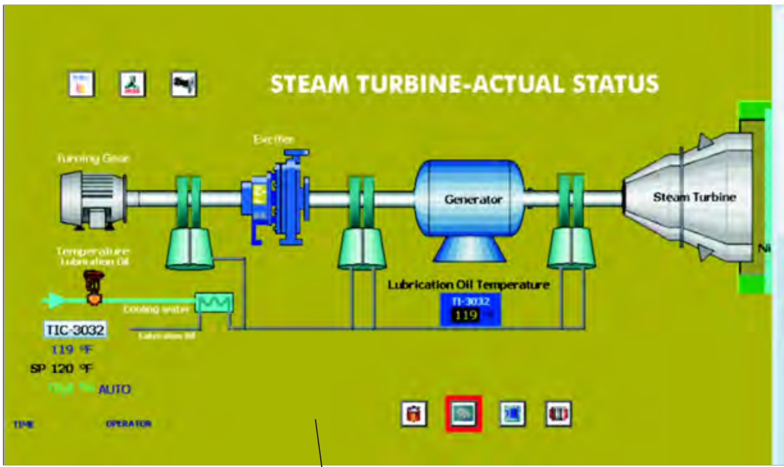
GEOTHERMAL POWER PLANT



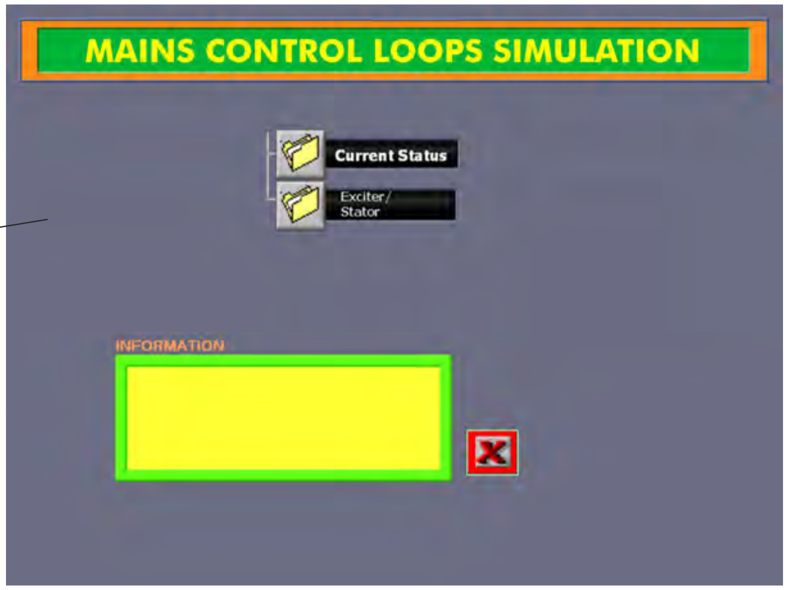
NOTE: Any of the 12 options available required HUB II. Mechanical Power Plants and Energy System with SCADA II.

HUB II. **Mechanical Power Plants and Energy System with SCADA II** (Nuclear Power Plant)

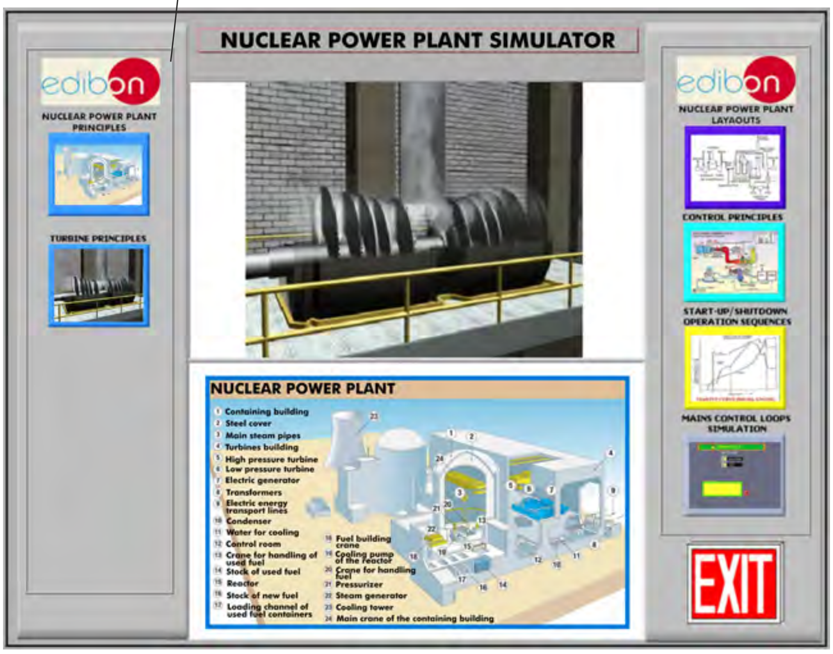
Main Screens



HUB II screen 3
(General state Power Plant diagram)



HUB II screen 2
(Mains Power Plant Control Loops Simulation)



HUB II screen 1
(Main menu screen)

EXERCICES AND PRACTICAL POSSIBILITIES

Some practical possibilities among many others:

With **HUB II. Mechanical Power Plants and Energy System with SCADA II + PPE/NU. Nuclear Power Plant**:

1.- Nuclear Power Plant General Principles of Operation.

2.- Steam Turbine General Principles of Operation.

3.- Nuclear Power Plant General Control Layouts.

4.- Nuclear Power Plant Control and Instrumentation Principles.

5.- Introduction to Mechanical and Electrical System Simulation.

6.- Introduction to Nuclear Power Plant Block Diagram and Transfer Functions.

7.- Introduction to Proportional, Integral and Derivate (PID) Controllers used in Power Plant Control.

8.- Analysis of Proportional Controller.

9.- Analysis of Integral Controller.

10.- Analysis of Derivative Controller.

11.- Analysis of PID Controller.

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13.- Analysis and Simulation of Steam Turbine Temperature Control.

14.- Analysis and Simulation of Steam Turbine Governor/Speed Control.

15.- Analysis and Simulation of Steam Turbine Generator Excitation System.

16.- Analysis and Simulation of Steam Turbine Outer/Loop MW Control.

17.- Analysis and Simulation of Steam Turbine Electrical Generator.

18.- Analysis and Simulation of Steam Turbine Lubrication Oil Cooling Temperature Control.

19.- Analysis and Simulation of Steam Turbine Generator Exciter Cooler Temperature Control.

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21.- Nuclear Power Plant Start-Up execution with the real Hardware.

22.- Nuclear Power Plant Shut-Down Procedure Analysis and Simulation.

23.- Nuclear Power Plant Shut-Down execution with the real Hardware.

24.- Nuclear Power Plant Active Power Control in isolated mode of operation (two generators).

25.- Nuclear Power Plant Frequency Control in isolated mode of operation.

26.- Nuclear Power Plant Reactive Power Control in isolated mode of operation (two generators).

27.- Nuclear Power Plant Voltage Control in isolated mode of operation.

28.- Nuclear Power Plant Synchronization.

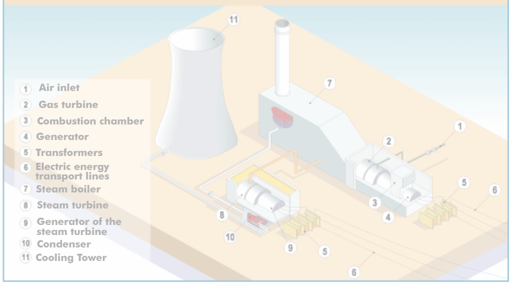
29.- Nuclear Power Plant Active Power Control when connected to the Grid.

30.- Nuclear Power Plant Reactive Power Control when connected to the Grid.

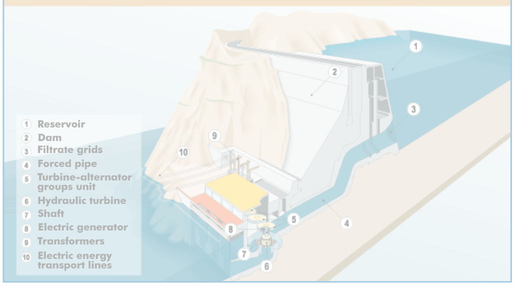
31.- Faults in Nuclear Power Plant Operation.

Available Power Plants:

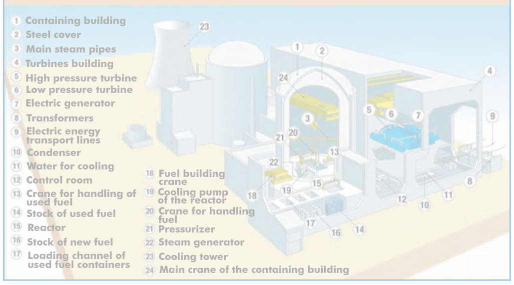
COMBINED CYCLE POWER PLANT



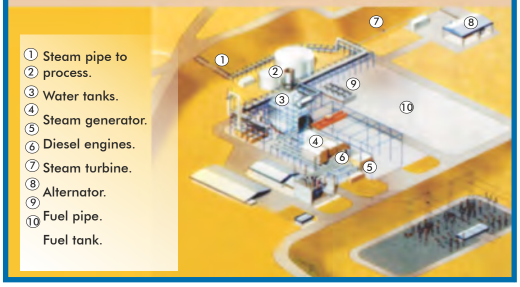
HYDROELECTRIC POWER PLANT



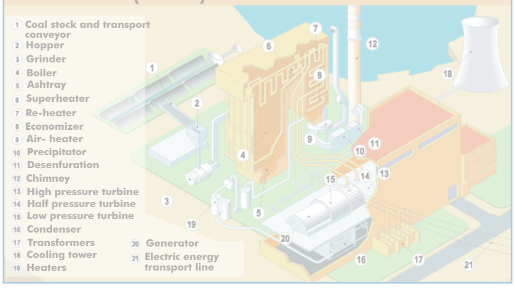
NUCLEAR POWER PLANT



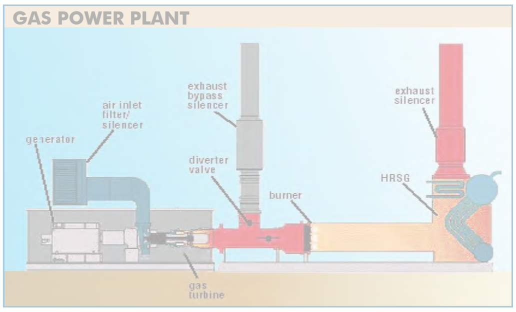
DIESEL FUEL POWER PLANT



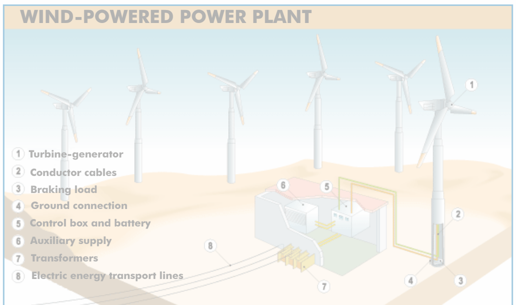
FOSSIL FUEL (COALS) POWER PLANT



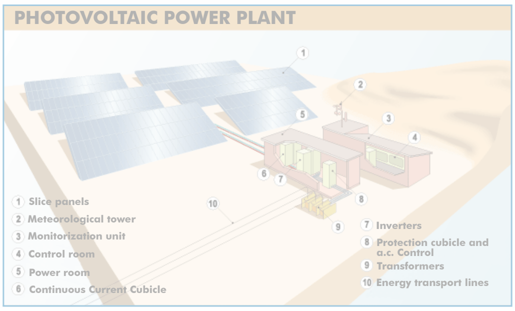
GAS POWER PLANT



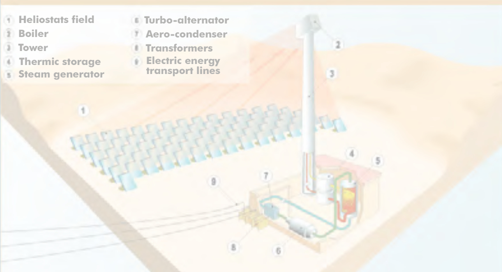
WIND-POWERED POWER PLANT



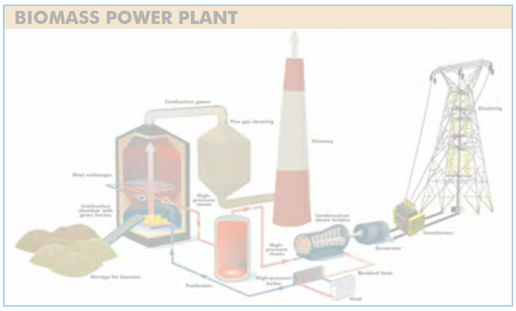
PHOTOVOLTAIC POWER PLANT



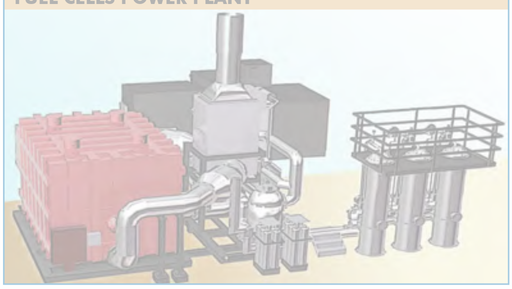
HELIOTHERMIC POWER PLANT



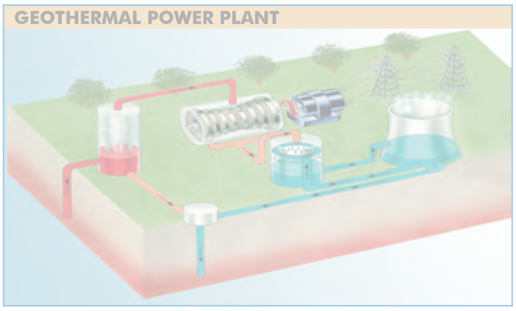
BIOMASS POWER PLANT



FUEL CELLS POWER PLANT



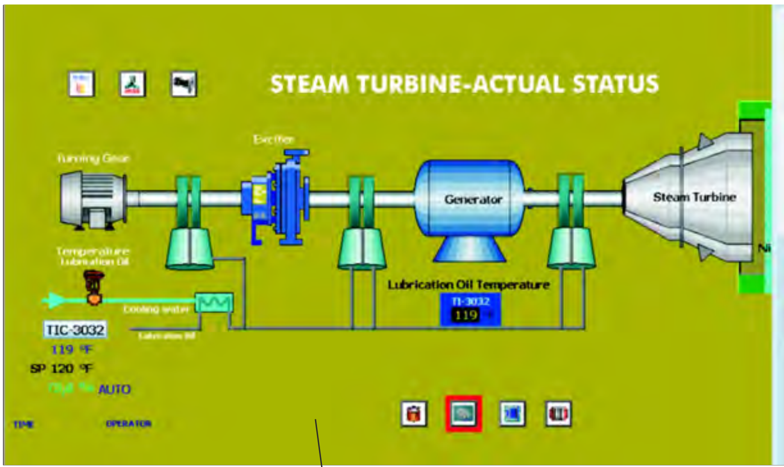
GEOTHERMAL POWER PLANT



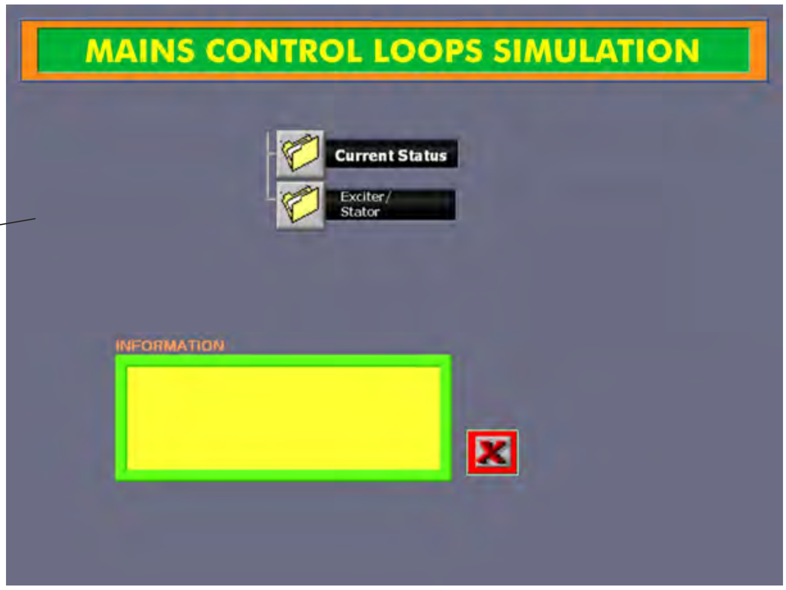
NOTE: Any of the 12 options available required HUB II. Mechanical Power Plants and Energy System with SCADA II.

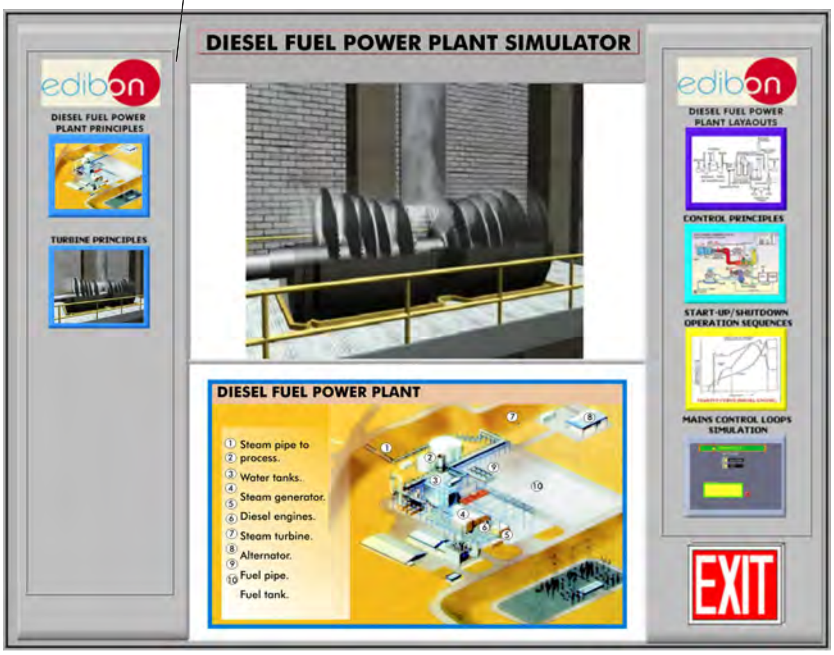
HUB II. **Mechanical Power Plants and Energy System with SCADA II** (Diesel Fuel Power Plant)

Main Screens



HUB II screen 3
(General state Power Plant diagram)





HUB II screen 2
(Mains Power Plant Control Loops Simulation)

HUB II screen 1
(Main menu screen)

EXERCICES AND PRACTICAL POSSIBILITIES

Some practical possibilities among many others:

With **HUB II. Mechanical Power Plants and Energy System with SCADA II + PPE/FD. Diesel Fuel Power Plant**:

1.- Diesel Fuel Power Plant General Principles of Operation.

2.- Steam Turbine General Principles of Operation.

3.- Diesel Fuel Power Plant General Control Layouts.

4.- Diesel Fuel Power Plant Control and Instrumentation Principles.

5.- Introduction to Mechanical and Electrical System Simulation.

6.- Introduction to Diesel Fuel Power Plant Block Diagram and Transfer Functions.

7.- Introduction to Proportional, Integral and Derivate (PID) Controllers used in Power Plant Control.

8.- Analysis of Proportional Controller.

9.- Analysis of Integral Controller.

10.- Analysis of Derivative Controller.

11.- Analysis of PID Controller.

12.- Analysis and Simulation of Steam Turbine Feed System.

13.- Analysis and Simulation of Steam Turbine Temperature Control.

14.- Analysis and Simulation of Steam Turbine Governor/Speed Control.

15.- Analysis and Simulation of Steam Turbine Generator Excitation System.

16.- Analysis and Simulation of Steam Turbine Outer/Loop MW Control.

17.- Analysis and Simulation of Steam Turbine Electrical Generator.

18.- Analysis and Simulation of Steam Turbine Lubrication Oil Cooling Temperature Control.

19.- Analysis and Simulation of Steam Turbine Generator Exciter Cooler Temperature Control.

20.- Diesel Fuel Power Plant Start-Up Procedure Analysis and Simulation.

21.- Diesel Fuel Power Plant Start-Up execution with the real Hardware.

22.- Diesel Fuel Power Plant Shut-Down Procedure Analysis and Simulation.

23.- Diesel Fuel Power Plant Shut-Down execution with the real Hardware.

24.- Diesel Fuel Power Plant Active Power Control in isolated mode of operation (two generators).

25.- Diesel Fuel Power Plant Frequency Control in isolated mode of operation.

26.- Diesel Fuel Power Plant Reactive Power Control in isolated mode of operation (two generators).

27.- Diesel Fuel Power Plant Voltage Control in isolated mode of operation.

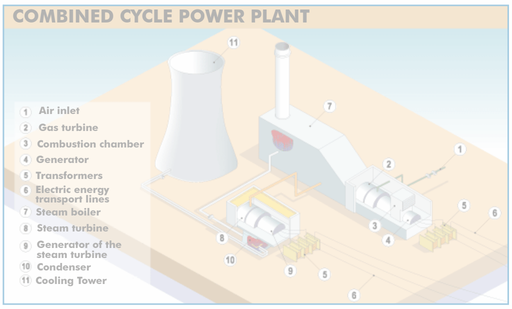
28.- Diesel Fuel Power Plant Synchronization.

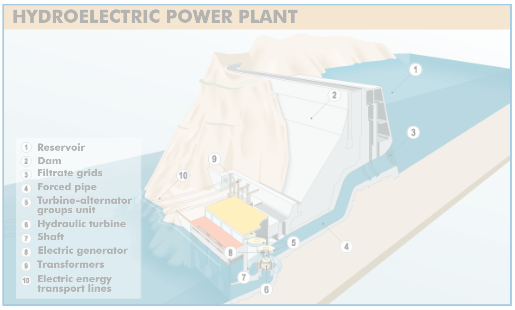
29.- Diesel Fuel Power Plant Active Power Control when connected to the Grid.

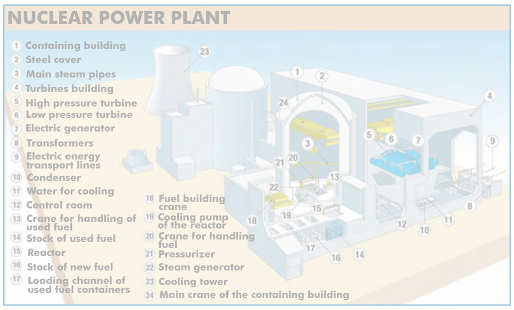
30.- Diesel Fuel Power Plant Reactive Power Control when connected to the Grid.

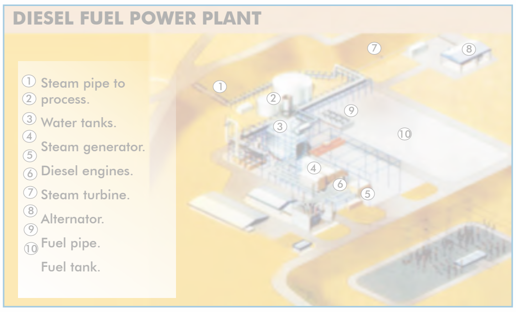
31.- Faults in Diesel Fuel Power Plant Operation.

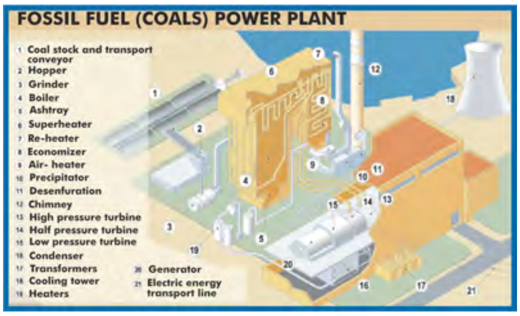
Available Power Plants:

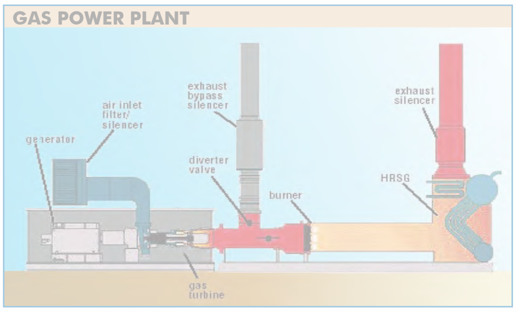


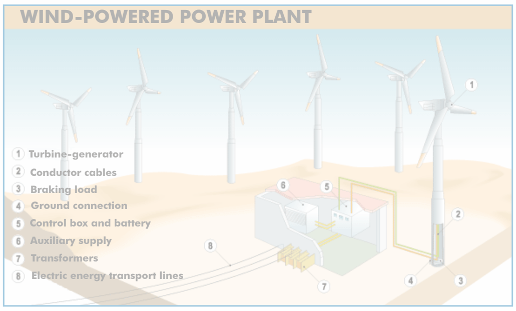


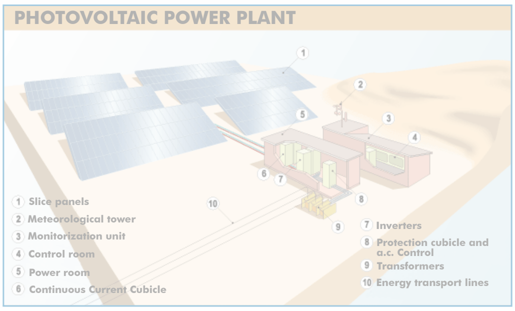


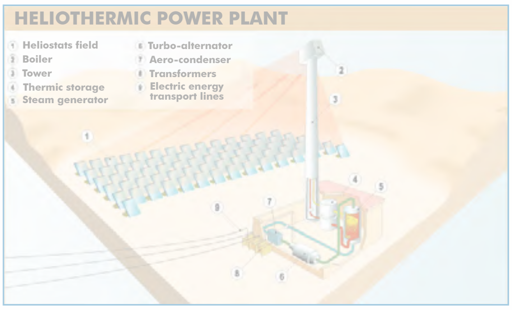


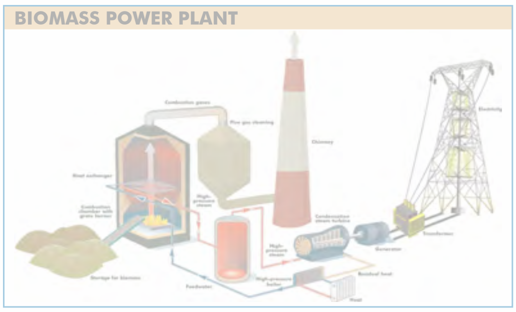


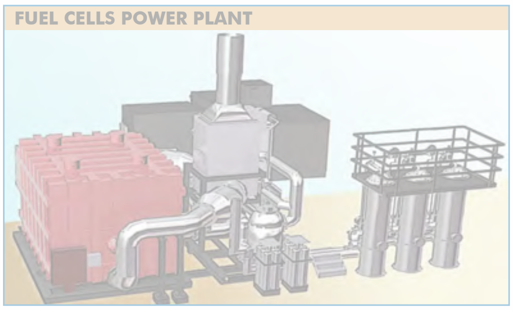


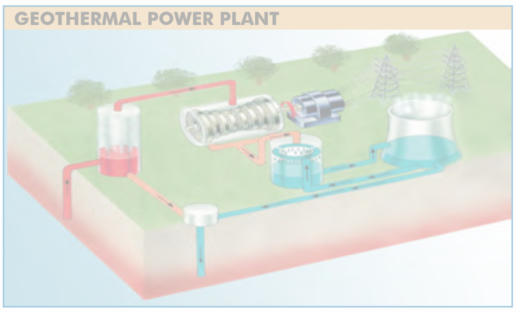








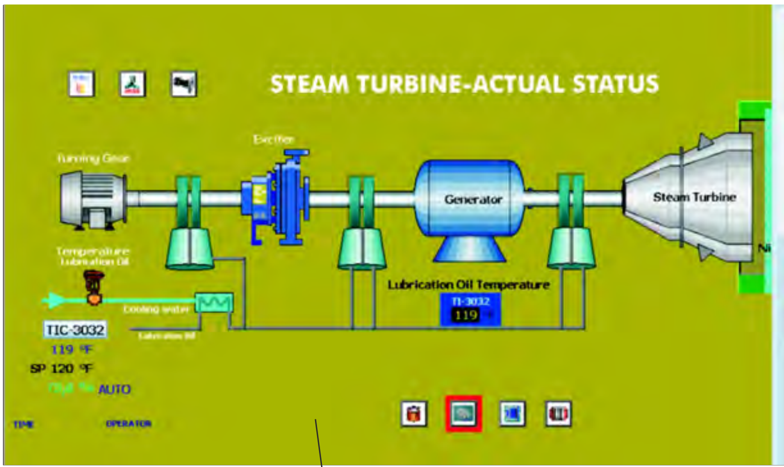




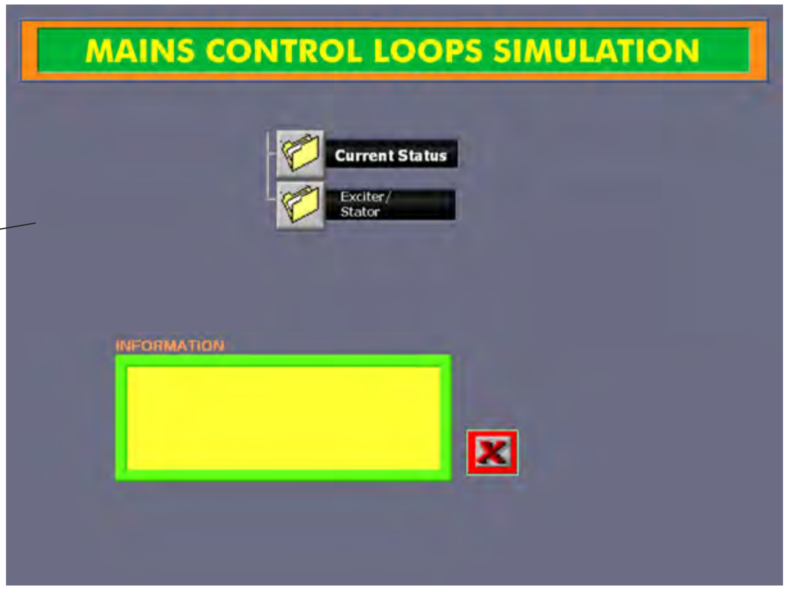
NOTE: Any of the 12 options available required HUB II. Mechanical Power Plants and Energy System with SCADA II.

HUB II. **Mechanical Power Plants and Energy System with SCADA II** (Fossil Fuel (coals) Power Plant)

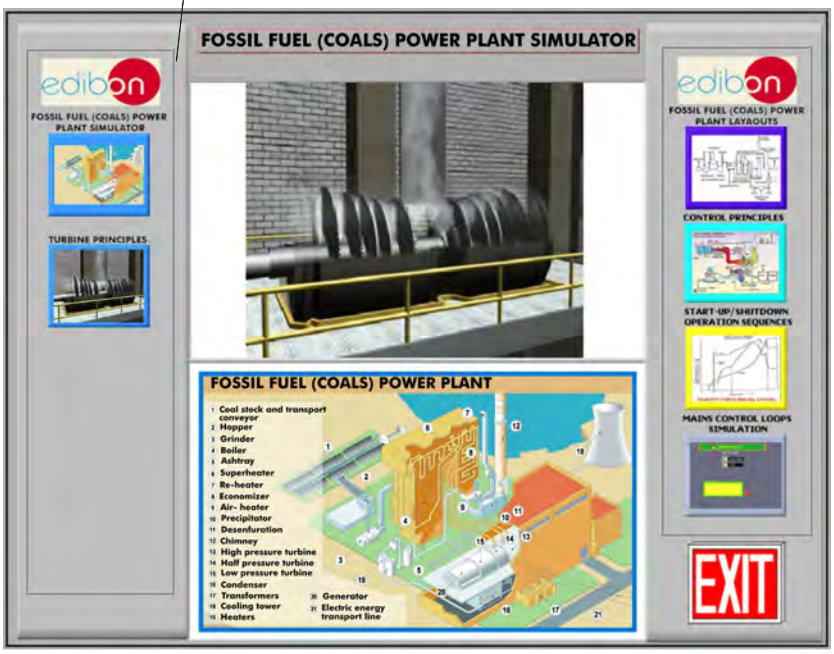
Main Screens



HUB II screen 3
(General state Power Plant diagram)



HUB II screen 2
(Mains Power Plant Control Loops Simulation)



HUB II screen 1
(Main menu screen)

EXERCICES AND PRACTICAL POSSIBILITIES

Some practical possibilities among many others:

With **HUB II. Mechanical Power Plants and Energy System with SCADA II + PPE/FF. Fossil Fuel (coals) Power Plant**:

1.- Fossil Fuel (coals) Power Plant General Principles of Operation.

2.- Steam Turbine General Principles of Operation.

3.- Fossil Fuel (coals) Power Plant General Control Layouts.

4.- Fossil Fuel (coals) Power Plant Control and Instrumentation Principles.

5.- Introduction to Mechanical and Electrical System Simulation.

6.- Introduction to Fossil Fuel (coals) Power Plant Block Diagram and Transfer Functions.

7.- Introduction to Proportional, Integral and Derivate (PID) Controllers used in Power Plant Control.

8.- Analysis of Proportional Controller.

9.- Analysis of Integral Controller.

10.- Analysis of Derivative Controller.

11.- Analysis of PID Controller.

12.- Analysis and Simulation of Steam Turbine Feed System.

13.- Analysis and Simulation of Steam Turbine Temperature Control.

14.- Analysis and Simulation of Steam Turbine Governor/Speed Control.

15.- Analysis and Simulation of Steam Turbine Generator Excitation System.

16.- Analysis and Simulation of Steam Turbine Outer/Loop MW Control.

17.- Analysis and Simulation of Steam Turbine Electrical Generator.

18.- Analysis and Simulation of Steam Turbine Lubrication Oil Cooling Temperature Control.

19.- Analysis and Simulation of Steam Turbine Generator Exciter Cooler Temperature Control.

20.- Fossil Fuel (coals) Power Plant Start-Up Procedure Analysis and Simulation.

21.- Fossil Fuel (coals) Power Plant Start-Up execution with the real Hardware.

22.- Fossil Fuel (coals) Power Plant Shut-Down Procedure Analysis and Simulation.

23.- Fossil Fuel (coals) Power Plant Shut-Down execution with the real Hardware.

24.- Fossil Fuel (coals) Power Plant Active Power Control in isolated mode of operation (two generators).

25.- Fossil Fuel (coals) Power Plant Frequency Control in isolated mode of operation.

26.- Fossil Fuel (coals) Power Plant Reactive Power Control in isolated mode of operation (two generators).

27.- Fossil Fuel (coals) Power Plant Voltage Control in isolated mode of operation.

28.- Fossil Fuel (coals) Power Plant Synchronization.

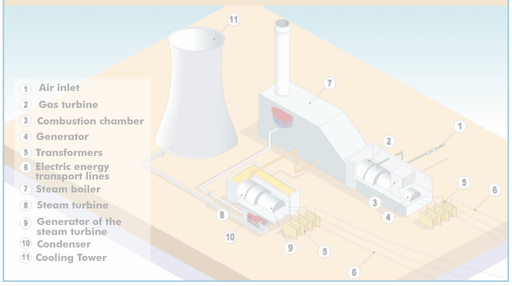
29.- Fossil Fuel (coals) Power Plant Active Power Control when connected to the Grid.

30.- Fossil Fuel (coals) Power Plant Reactive Power Control when connected to the Grid.

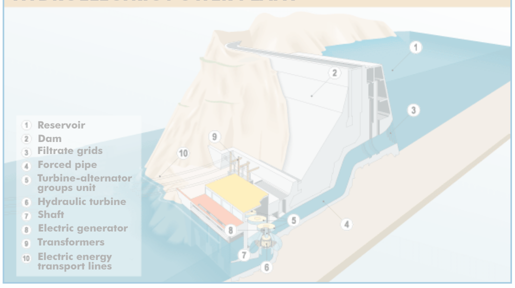
31.- Faults in Fossil Fuel (coals) Power Plant Operation.

Available Power Plants:

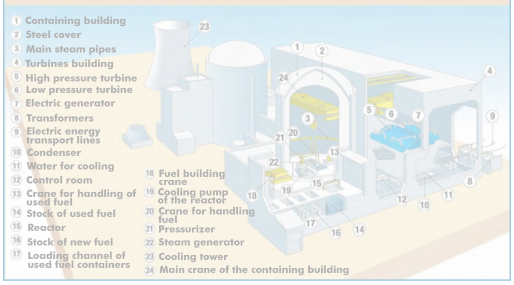
COMBINED CYCLE POWER PLANT



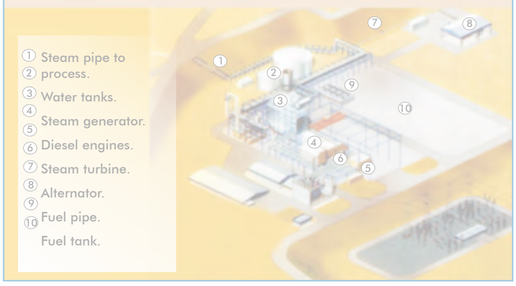
HYDROELECTRIC POWER PLANT



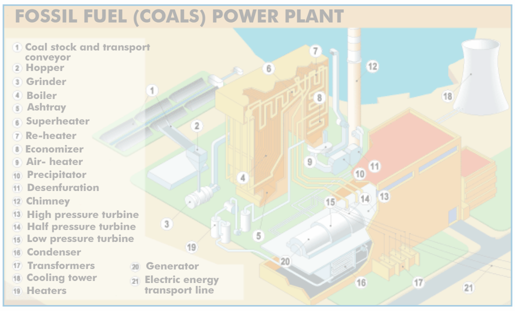
NUCLEAR POWER PLANT



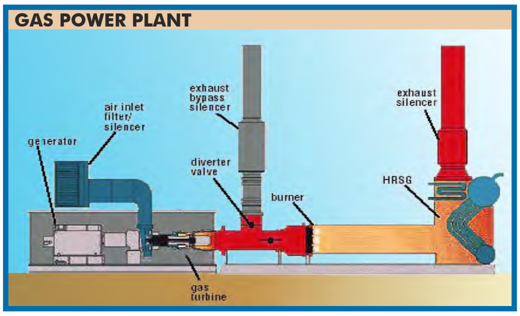
DIESEL FUEL POWER PLANT



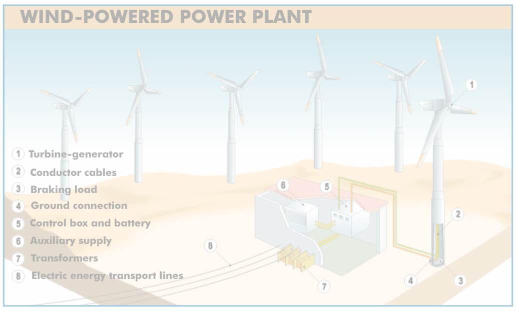
FOSSIL FUEL (COALS) POWER PLANT



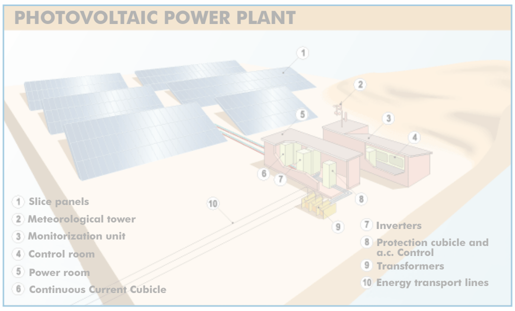
GAS POWER PLANT



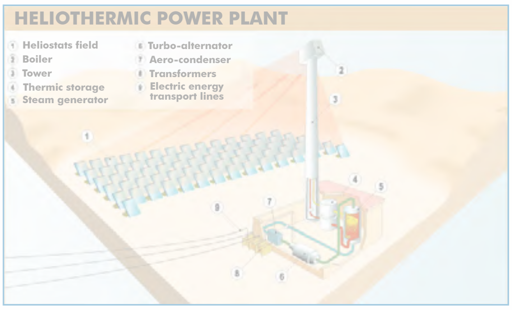
WIND-POWERED POWER PLANT



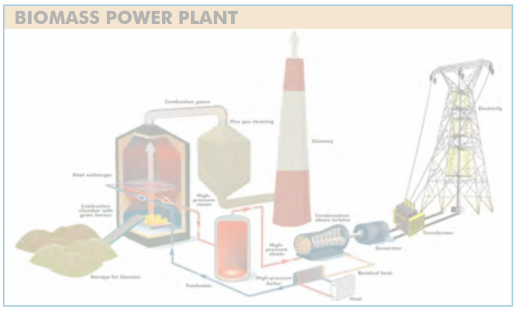
PHOTOVOLTAIC POWER PLANT



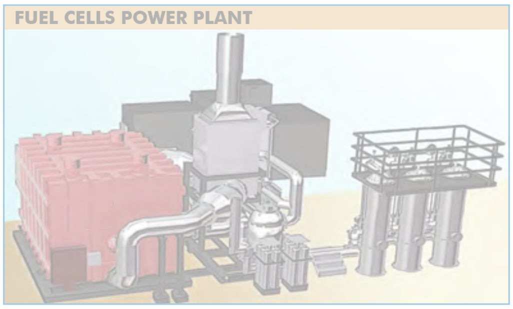
HELIOTHERMIC POWER PLANT



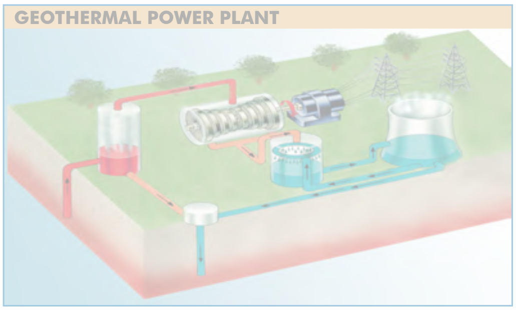
BIOMASS POWER PLANT



FUEL CELLS POWER PLANT

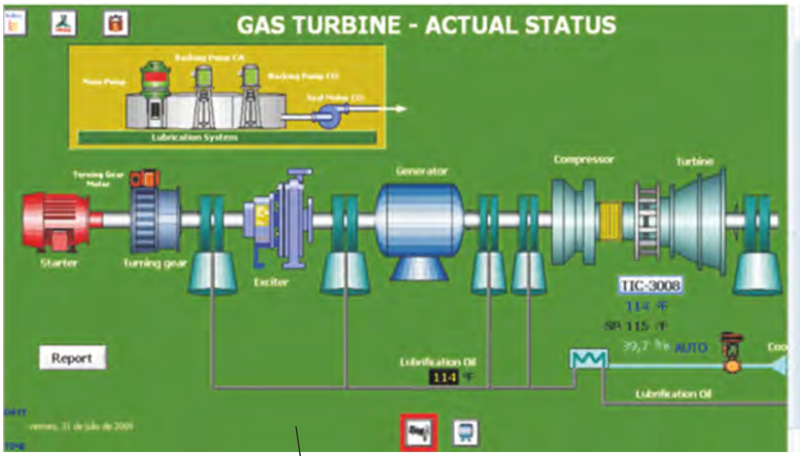


GEOTHERMAL POWER PLANT

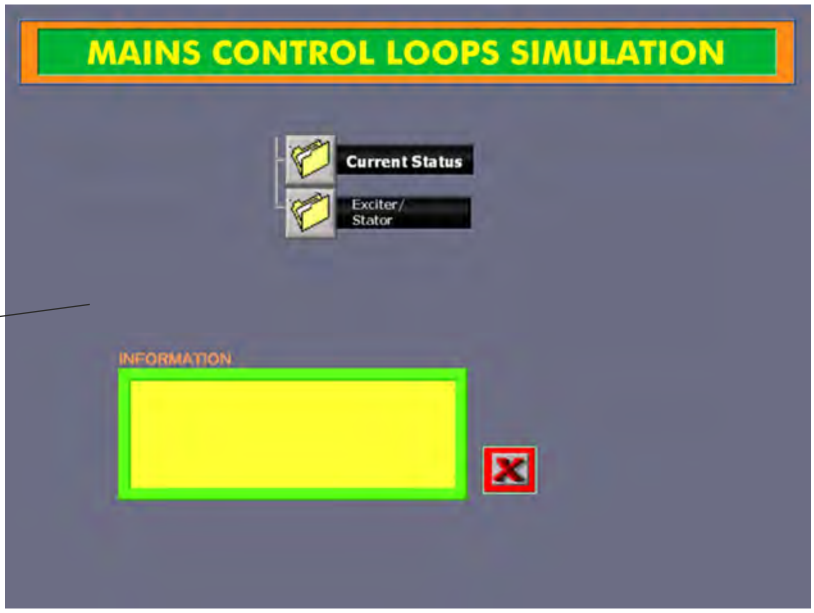


NOTE: Any of the 12 options available required HUB II. Mechanical Power Plants and Energy System with SCADA II.

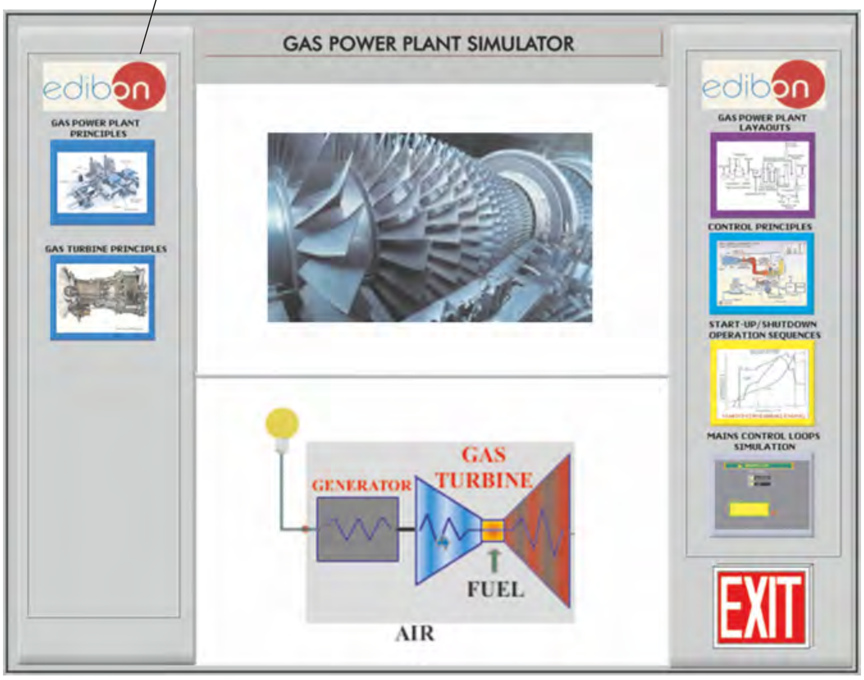
Main Screens



HUB II screen 3
(General state Power Plant diagram)



HUB II screen 2
(Mains Power Plant Control Loops Simulation)



HUB II screen 1
(Main menu screen)

EXERCICES AND PRACTICAL POSSIBILITIES

Some practical possibilities among many others:

With **HUB II. Mechanical Power Plants and Energy System with SCADA II + PPE/GA. Gas Power Plant**:

1.- Gas Power Plant General Principles of Operation.

2.- Gas Turbine General Principles of Operation.

3.- Gas Power Plant General Control Layouts.

4.- Gas Power Plant Control and Instrumentation Principles.

5.- Introduction to Mechanical and Electrical System Simulation.

6.- Introduction to Gas Turbine Power Plant Block Diagram and Transfer Functions.

7.- Introduction to Proportional, Integral and Derivate (PID) Controllers used in Power Plant Control.

8.- Analysis of Proportional Controller.

9.- Analysis of Integral Controller.

10.- Analysis of Derivative Controller.

11.- Analysis of PID Controller.

12.- Analysis and Simulation of Gas Turbine Fuel System.

13.- Analysis and Simulation of Compressor-Turbine System.

14.- Analysis and Simulation of Gas Turbine Temperature Control.

15.- Analysis and Simulation of Gas Turbine Governor/Speed Control.

16.- Analysis and Simulation of Gas Turbine Generator Excitation System.

17.- Analysis and Simulation of Gas Turbine Outer/Loop MW Control.

18.- Analysis and Simulation of Gas Turbine Electrical Generator.

19.- Analysis and Simulation of Gas Turbine Lubrication Oil Cooling Temperature Control.

20.- Analysis and Simulation of Gas Turbine Generator Exciter Cooler Temperature Control.

21.- Gas Turbine Power Plant Start-Up Procedure Analysis and Simulation.

22.- Gas Turbine Power Plant Start-Up execution with the real Hardware.

23.- Gas Turbine Power Plant Shut-Down Procedure Analysis and Simulation.

24.- Gas Turbine Power Plant Shut-Down execution with the real Hardware.

25.- Gas Turbine Power Plant Active Power Control in isolated mode of operation (two generators).

26.- Gas Turbine Power Plant Frequency Control in isolated mode of operation.

27.- Gas Turbine Power Plant Reactive Power Control in isolated mode of operation (two generators).

28.- Gas Turbine Power Plant Voltage Control in isolated mode of operation.

29.- Gas Turbine Power Plant Synchronization.

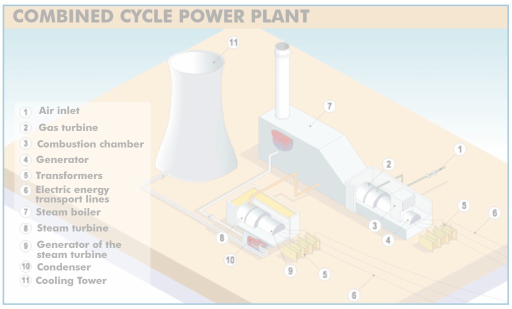
30.- Gas Turbine Power Plant Active Power Control when connected to the Grid.

31.- Gas Turbine Power Plant Reactive Power Control when connected to the Grid.

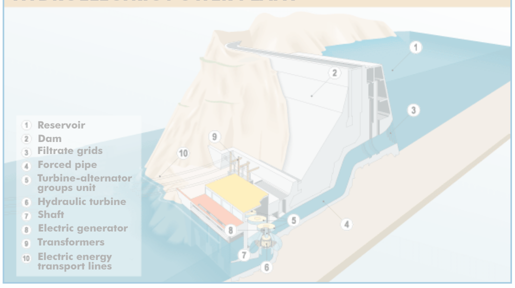
32.- Faults in Gas Power Plant Operation.

Available Power Plants:

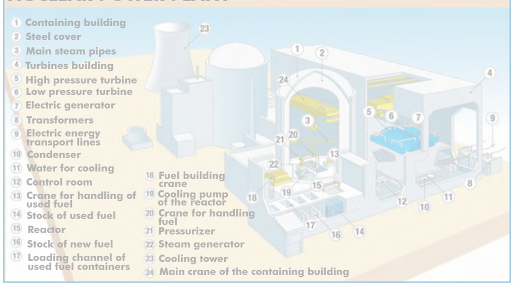
COMBINED CYCLE POWER PLANT



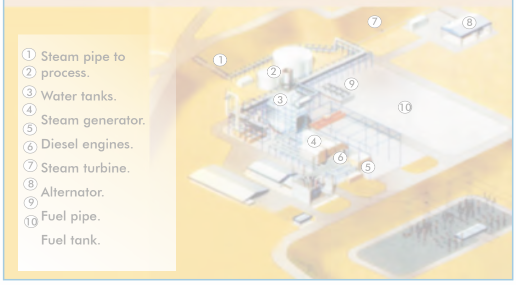
HYDROELECTRIC POWER PLANT



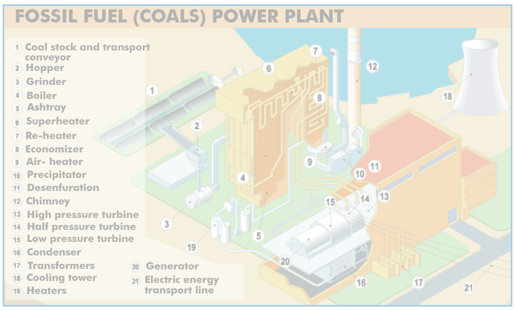
NUCLEAR POWER PLANT



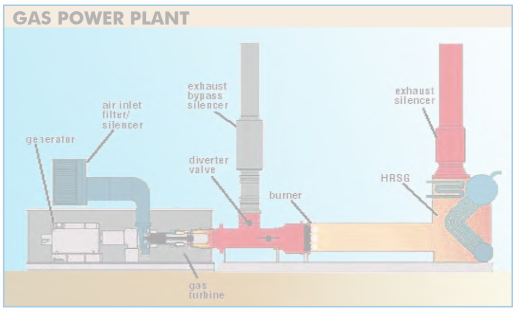
DIESEL FUEL POWER PLANT



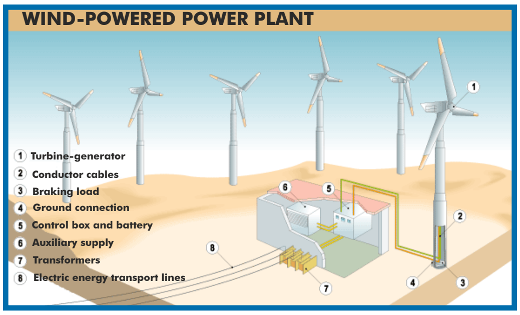
FOSSIL FUEL (COALS) POWER PLANT



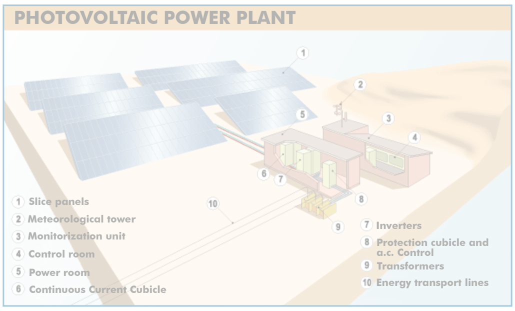
GAS POWER PLANT



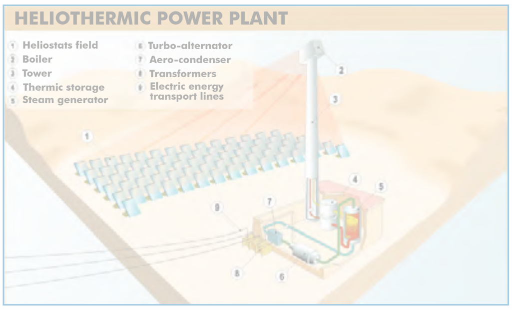
WIND-POWERED POWER PLANT



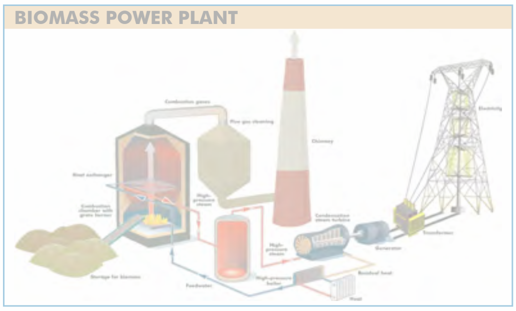
PHOTOVOLTAIC POWER PLANT



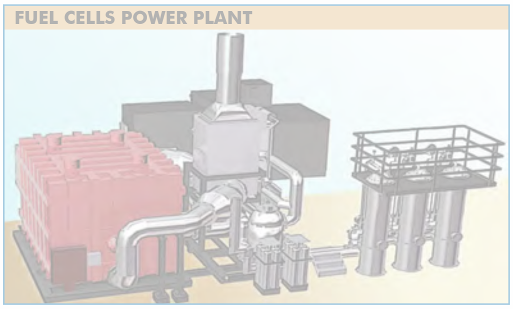
HELIOTHERMIC POWER PLANT



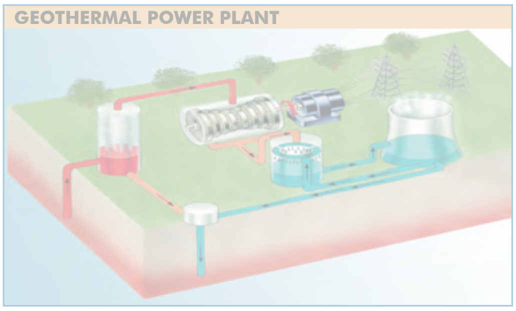
BIOMASS POWER PLANT



FUEL CELLS POWER PLANT



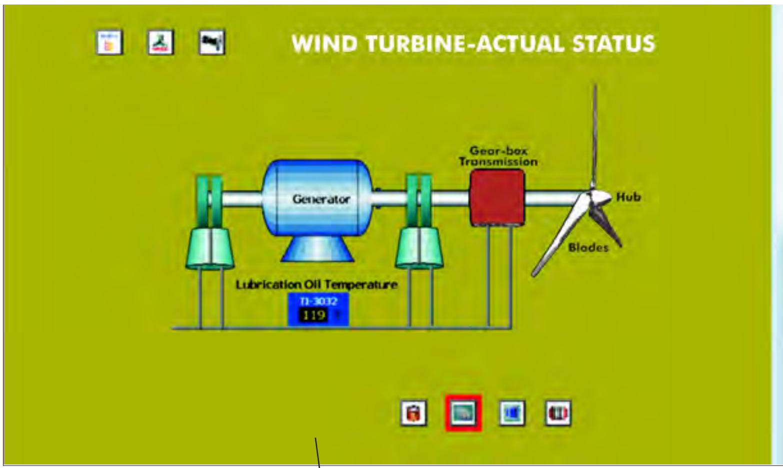
GEOTHERMAL POWER PLANT



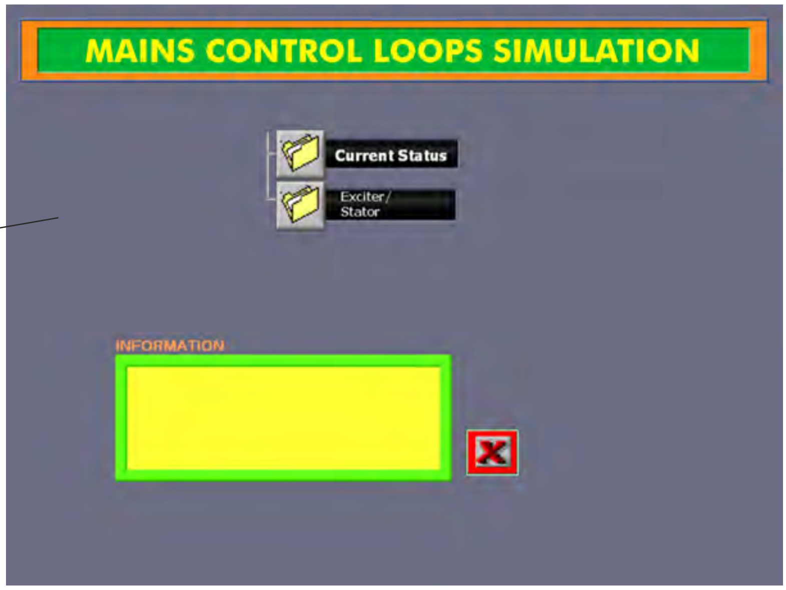
NOTE: Any of the 12 options available required HUB II. Mechanical Power Plants and Energy System with SCADA II.

HUB II. **Mechanical Power Plants and Energy System with SCADA II** (Wind Powered Power Plant)

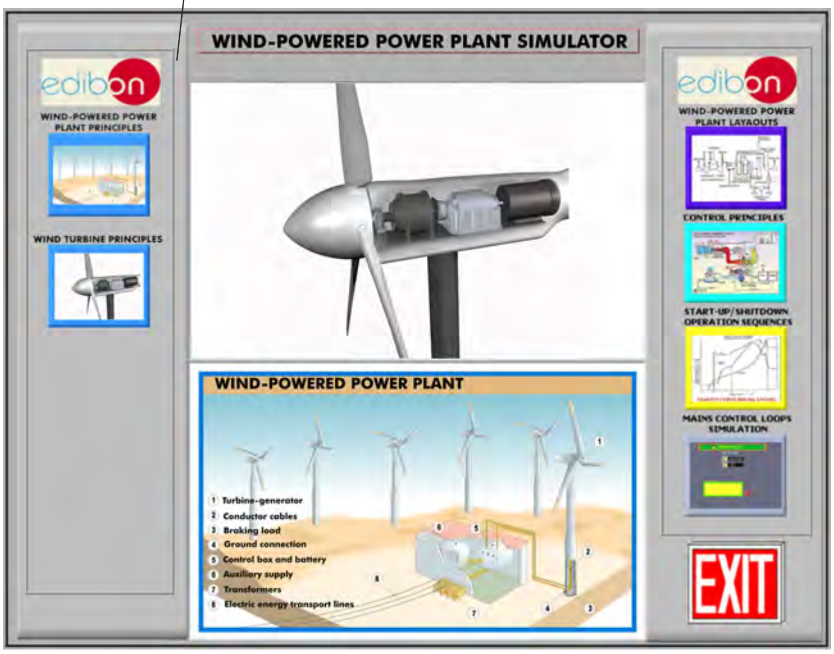
Main Screens



HUB II screen 3
(General state Power Plant diagram)



HUB II screen 2
(Mains Power Plant Control Loops Simulation)



HUB II screen 1
(Main menu screen)

EXERCICES AND PRACTICAL POSSIBILITIES

Some practical possibilities among many others:

With **HUB II. Mechanical Power Plants and Energy System with SCADA II + PPE/WP. Wind Powered Power Plant**:

1.- Wind Powered Power Plant General Principles of Operation.

2.- Wind Turbine General Principles of Operation.

3.- Wind Powered Power Plant General Control Layouts.

4.- Wind Powered Power Plant Control and Instrumentation Principles.

5.- Introduction to Mechanical and Electrical System Simulation.

6.- Introduction to Wind Powered Power Plant Block Diagram and Transfer Functions.

7.- Introduction to Proportional, Integral and Derivate (PID) Controllers used in Power Plant Control.

8.- Analysis of Proportional Controller.

9.- Analysis of Integral Controller.

10.- Analysis of Derivative Controller.

11.- Analysis of PID Controller.

12.- Analysis and Simulation of Wind Turbine Governor/Speed Control.

13.- Analysis and Simulation of Wind Turbine Generator Excitation System.

14.- Analysis and Simulation of Wind Turbine Outer/Loop MW Control.

15.- Analysis and Simulation of Wind Turbine Electrical Generator.

16.- Analysis and Simulation of Wind Turbine Lubrication Oil Cooling Temperature Control.

17.- Analysis and Simulation of Wind Turbine Generator Exciter Cooler Temperature Control.

18.- Wind Powered Power Plant Start-Up Procedure Analysis and Simulation.

19.- Wind Powered Power Plant Start-Up execution with the real Hardware.

20.- Wind Powered Power Plant Shut-Down Procedure Analysis and Simulation.

21.- Wind Powered Power Plant Shut-Down execution with the real Hardware.

22.- Wind Powered Power Plant Active Power Control in isolated mode of operation (two generators).

23.- Wind Powered Power Plant Frequency Control in isolated mode of operation.

24.- Wind Powered Power Plant Reactive Power Control in isolated mode of operation (two generators).

25.- Wind Powered Power Plant Voltage Control in isolated mode of operation.

26.- Wind Powered Power Plant Synchronization.

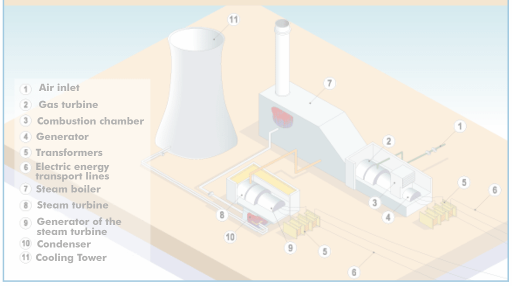
27.- Wind Powered Power Plant Active Power Control when connected to the Grid.

28.- Wind Powered Power Plant Reactive Power Control when connected to the Grid.

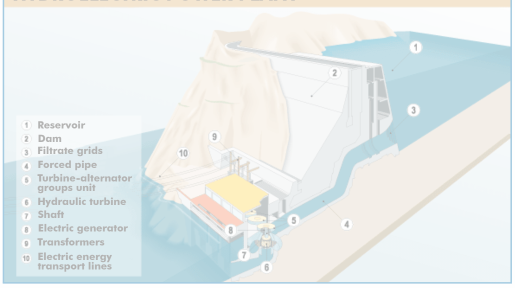
29.- Faults in Wind Powered Power Plant Operation.

Available Power Plants:

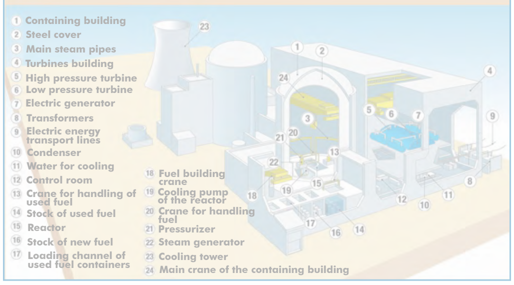
COMBINED CYCLE POWER PLANT



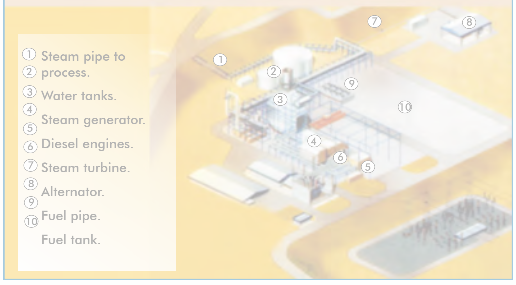
HYDROELECTRIC POWER PLANT



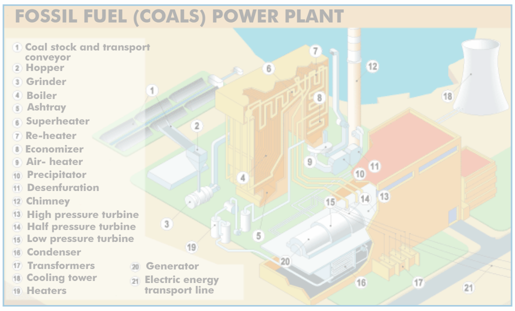
NUCLEAR POWER PLANT



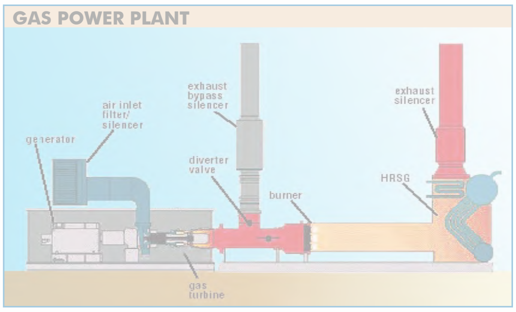
DIESEL FUEL POWER PLANT



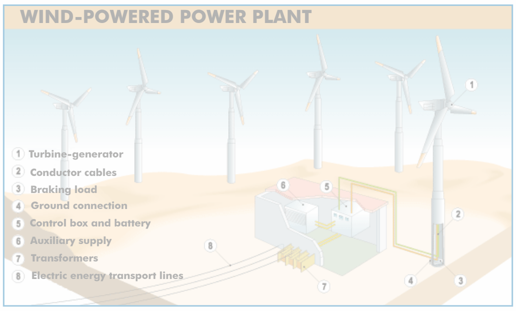
FOSSIL FUEL (COALS) POWER PLANT



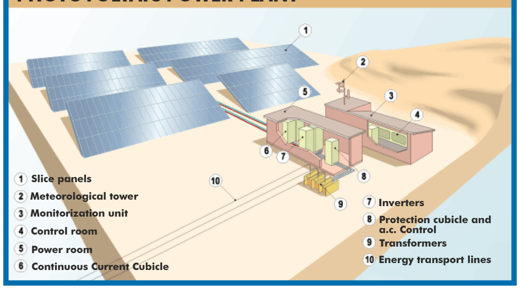
GAS POWER PLANT



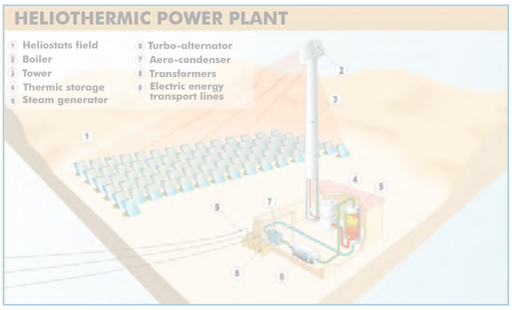
WIND-POWERED POWER PLANT



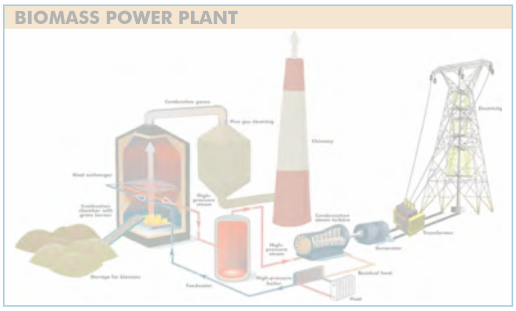
PHOTOVOLTAIC POWER PLANT



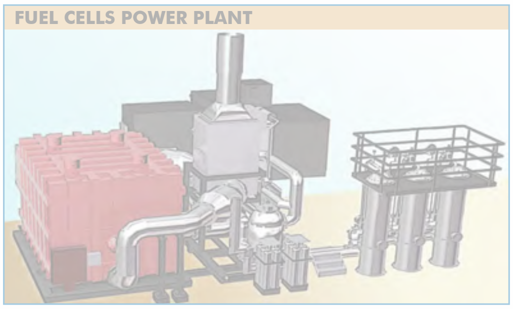
HELIOTHERMIC POWER PLANT



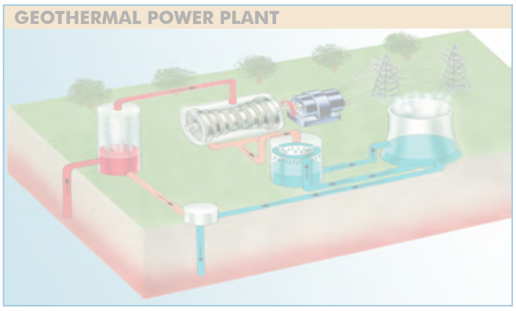
BIOMASS POWER PLANT



FUEL CELLS POWER PLANT



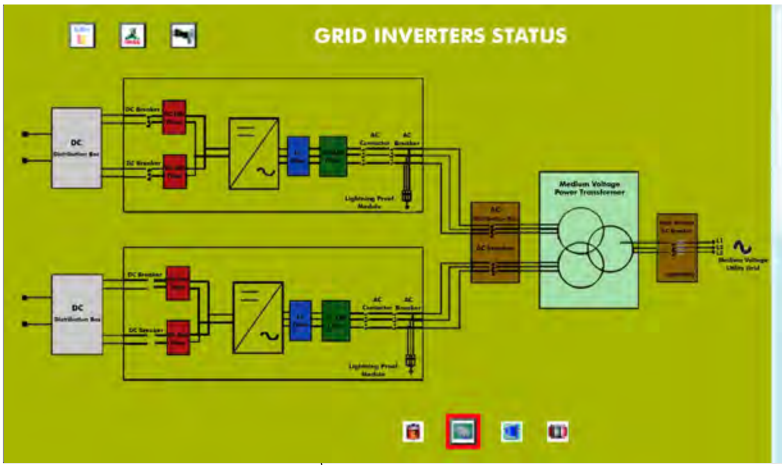
GEOTHERMAL POWER PLANT



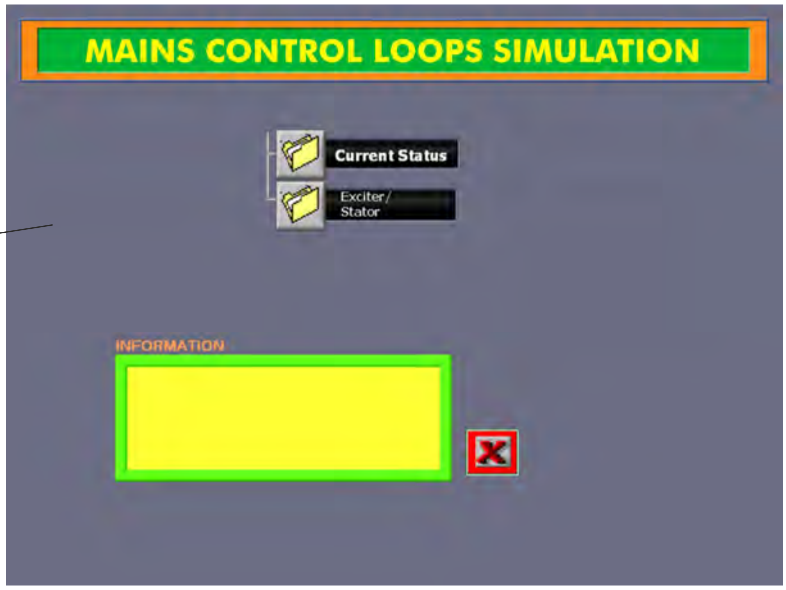
NOTE: Any of the 12 options available required HUB II. Mechanical Power Plants and Energy System with SCADA II.

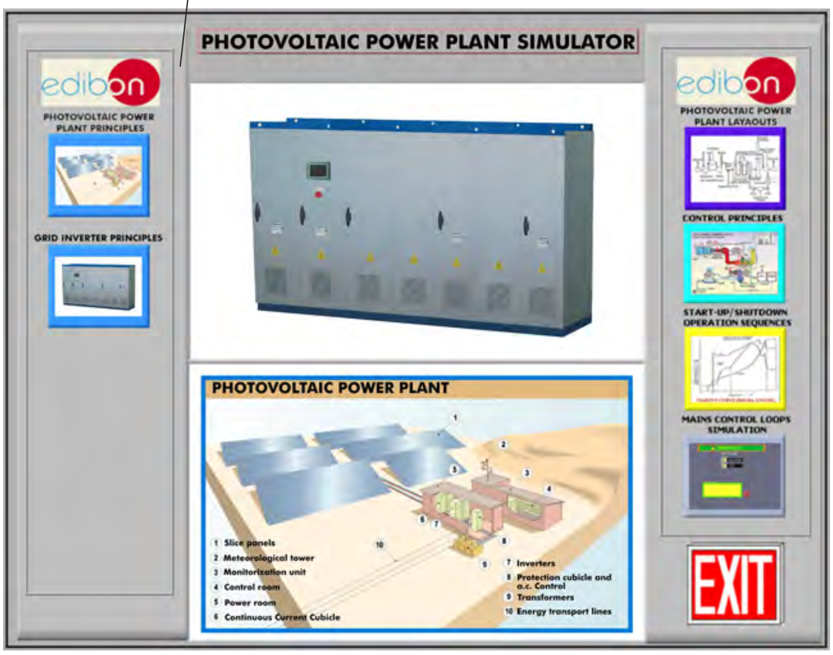
HUB II. **Mechanical Power Plants and Energy System with SCADA II** (Photovoltaic Power Plant)

Main Screens



HUB II screen 3
(General state Power Plant diagram)





HUB II screen 2
(Mains Power Plant Control Loops Simulation)

HUB II screen 1
(Main menu screen)

EXERCICES AND PRACTICAL POSSIBILITIES

Some practical possibilities among many others:

With **HUB II. Mechanical Power Plants and Energy System with SCADA II + PPE/FV. Photovoltaic Power Plant**:

1.- Photovoltaic Power Plant General Principles of Operation.

2.- Photovoltaic Grid Inverter General Principles of Operation.

3.- Photovoltaic Power Plant General Control Layouts.

4.- Photovoltaic Power Plant Control and Instrumentation Principles.

5.- Introduction to Mechanical and Electrical System Simulation.

6.- Introduction to Photovoltaic Power Plant Block Diagram and Transfer Functions.

7.- Introduction to Proportional, Integral and Derivate (PID) Controllers used in Power Plant Control.

8.- Analysis of Proportional Controller.

9.- Analysis of Integral Controller.

10.- Analysis of Derivative Controller.

11.- Analysis of PID Controller.

12.- Analysis and Simulation of Grid Inverter System.

13.- Photovoltaic Power Plant Start-Up Procedure Analysis and Simulation.

14.- Photovoltaic Power Plant Start-Up execution with the real Hardware.

15.- Photovoltaic Power Plant Shut-Down Procedure Analysis and Simulation.

16.- Photovoltaic Power Plant Shut-Down execution with the real Hardware.

17.- Photovoltaic Power Plant Active Power Control in isolated mode of operation.

18.- Photovoltaic Power Plant Frequency Control in isolated mode of operation.

19.- Photovoltaic Power Plant Reactive Power Control in isolated mode of operation.

20.- Photovoltaic Power Plant Voltage Control in isolated mode of operation.

21.- Photovoltaic Power Plant Synchronization.

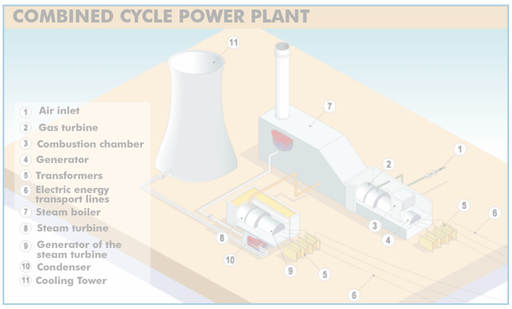
22.- Photovoltaic Power Plant Active Power Control when connected to the Grid.

23.- Photovoltaic Power Plant Reactive Power Control when connected to the Grid.

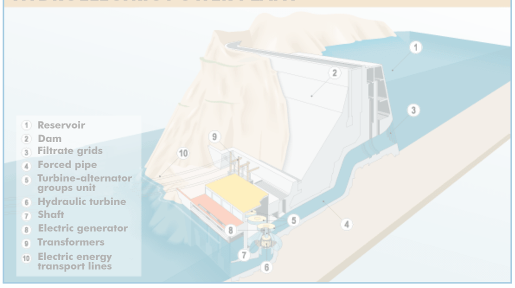
24.- Faults in Photovoltaic Power Plant Operation.

Available Power Plants:

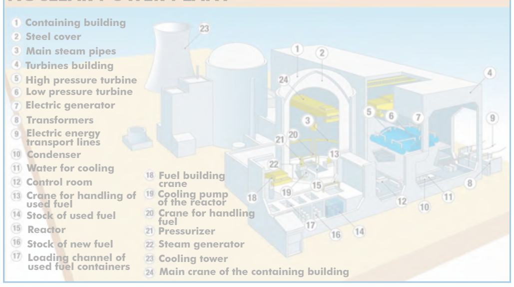
COMBINED CYCLE POWER PLANT



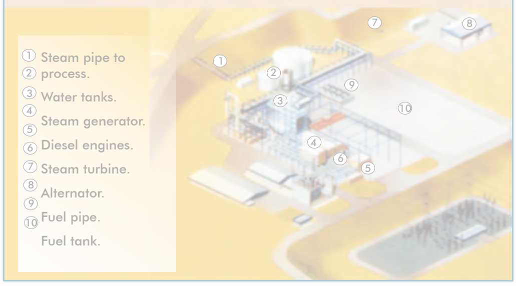
HYDROELECTRIC POWER PLANT



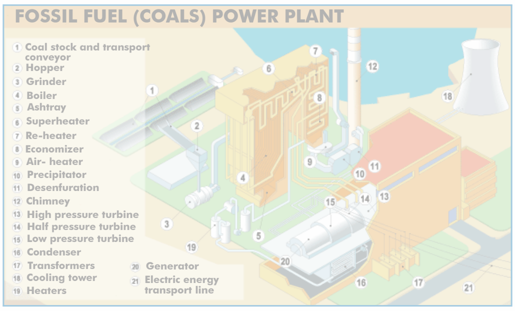
NUCLEAR POWER PLANT



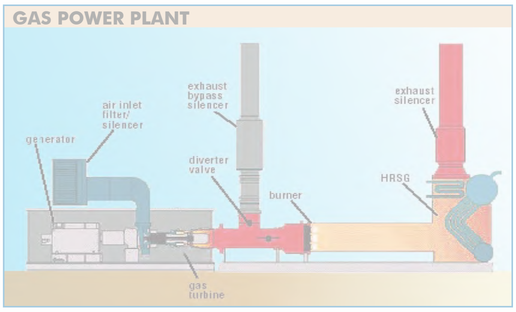
DIESEL FUEL POWER PLANT



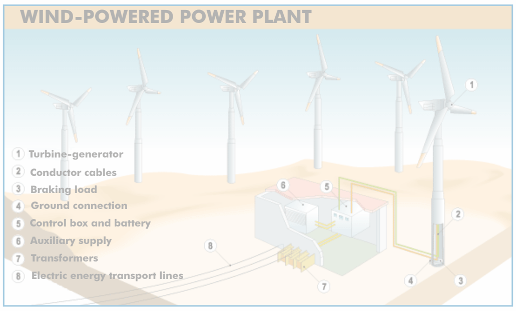
FOSSIL FUEL (COALS) POWER PLANT



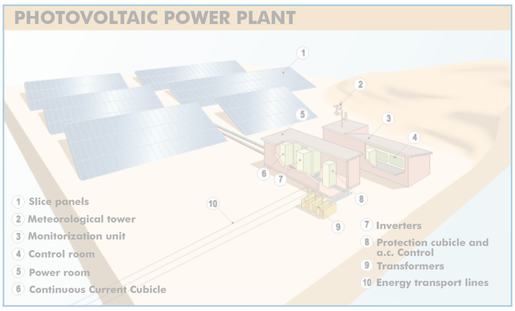
GAS POWER PLANT



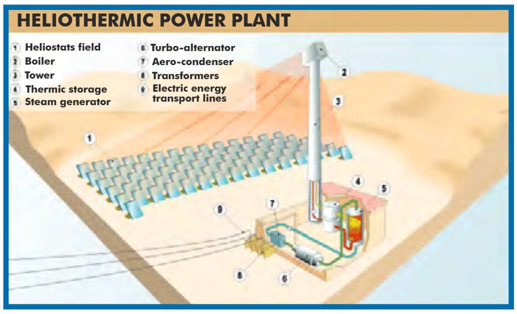
WIND-POWERED POWER PLANT



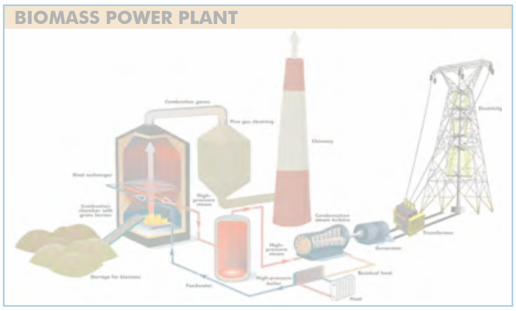
PHOTOVOLTAIC POWER PLANT



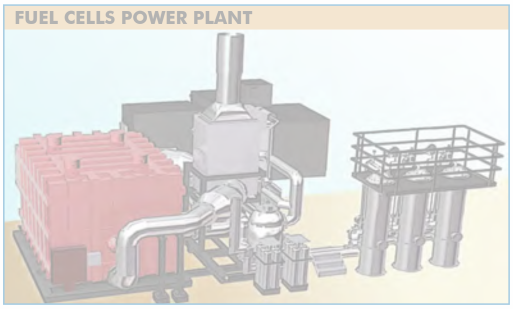
HELIOTHERMIC POWER PLANT



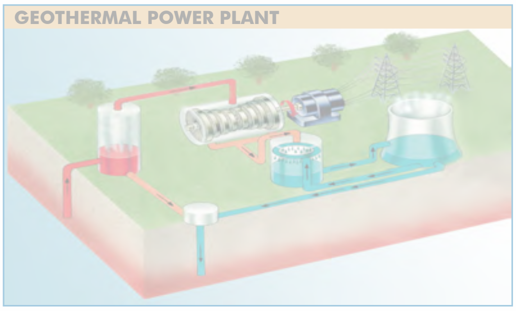
BIOMASS POWER PLANT



FUEL CELLS POWER PLANT



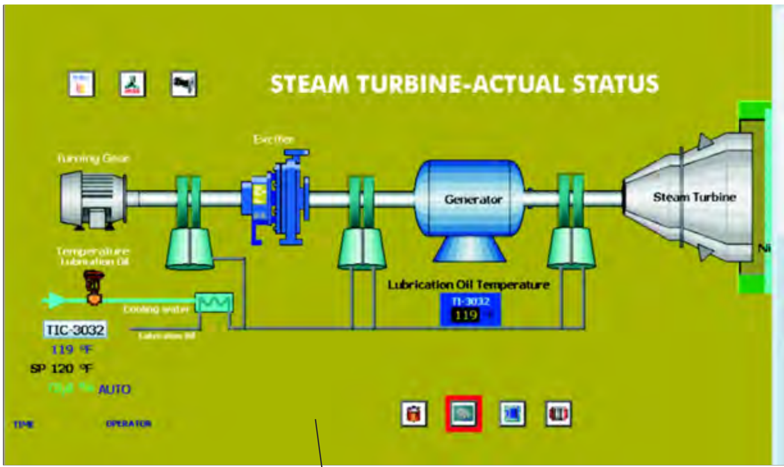
GEOTHERMAL POWER PLANT



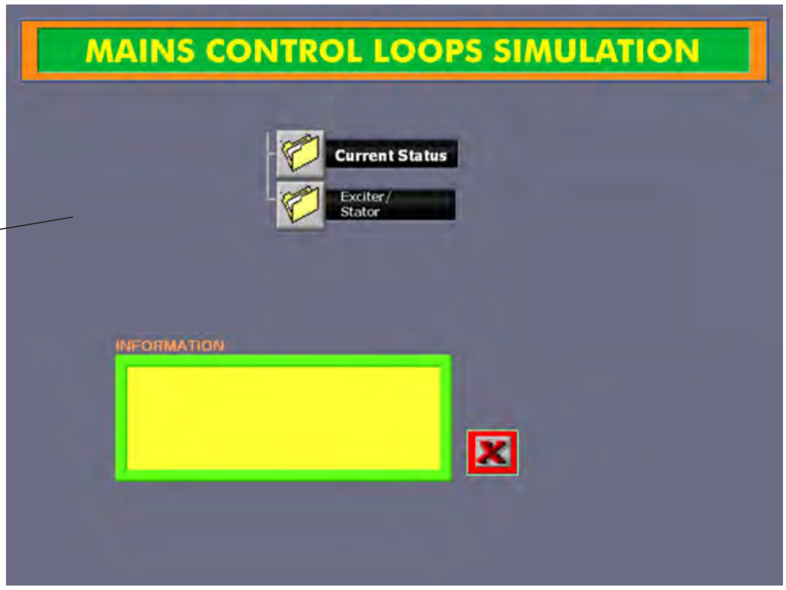
NOTE: Any of the 12 options available required HUB II. Mechanical Power Plants and Energy System with SCADA II.

HUB II. **Mechanical Power Plants and Energy System with SCADA II** (Heliothermic Power Plant)

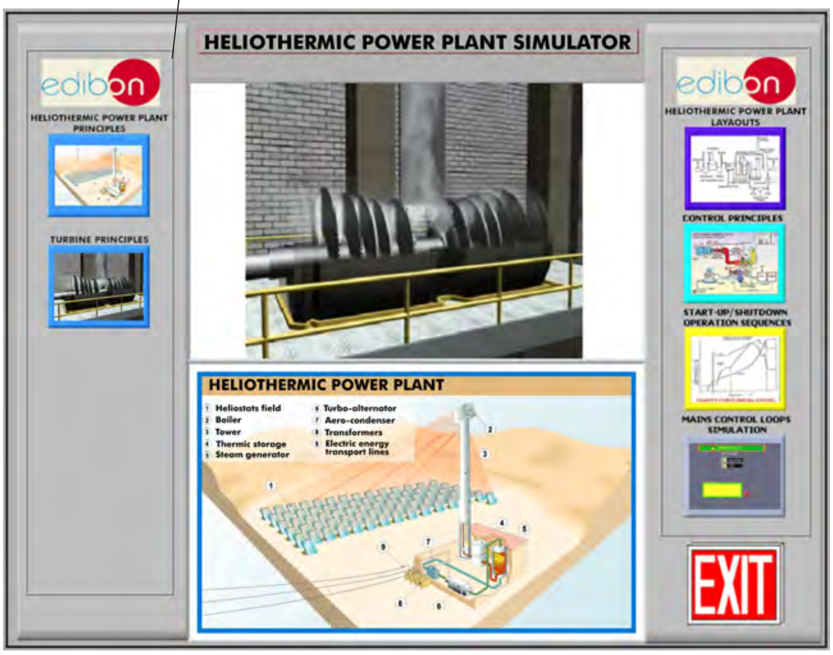
Main Screens



HUB II screen 3
(General state Power Plant diagram)



HUB II screen 2
(Mains Power Plant Control Loops Simulation)



HUB II screen 1
(Main menu screen)

EXERCICES AND PRACTICAL POSSIBILITIES

Some practical possibilities among many others:

With **HUB II. Mechanical Power Plants and Energy System with SCADA II + PPE/HE. Heliothermic Power Plant**:

1.- Heliothermic Power Plant General Principles of Operation.

2.- Steam Turbine General Principles of Operation.

3.- Heliothermic Power Plant General Control Layouts.

4.- Heliothermic Power Plant Control and Instrumentation Principles.

5.- Introduction to Mechanical and Electrical System Simulation.

6.- Introduction to Heliothermic Power Plant Block Diagram and Transfer Functions.

7.- Introduction to Proportional, Integral and Derivate (PID) Controllers used in Power Plant Control.

8.- Analysis of Proportional Controller.

9.- Analysis of Integral Controller.

10.- Analysis of Derivative Controller.

11.- Analysis of PID Controller.

12.- Analysis and Simulation of Steam Turbine Feed System.

13.- Analysis and Simulation of Steam Turbine Temperature Control.

14.- Analysis and Simulation of Steam Turbine Governor/Speed Control.

15.- Analysis and Simulation of Steam Turbine Generator Excitation System.

16.- Analysis and Simulation of Steam Turbine Outer/Loop MW Control.

17.- Analysis and Simulation of Steam Turbine Electrical Generator.

18.- Analysis and Simulation of Steam Turbine Lubrication Oil Cooling Temperature Control.

19.- Analysis and Simulation of Steam Turbine Generator Exciter Cooler Temperature Control.

20.- Heliothermic Power Plant Start-Up Procedure Analysis and Simulation.

21.- Heliothermic Power Plant Start-Up execution with the real Hardware.

22.- Heliothermic Power Plant Shut-Down Procedure Analysis and Simulation.

23.- Heliothermic Power Plant Shut-Down execution with the real Hardware.

24.- Heliothermic Power Plant Active Power Control in isolated mode of operation (two generators).

25.- Heliothermic Power Plant Frequency Control in isolated mode of operation.

26.- Heliothermic Power Plant Reactive Power Control in isolated mode of operation (two generators).

27.- Heliothermic Power Plant Voltage Control in isolated mode of operation.

28.- Heliothermic Power Plant Synchronization.

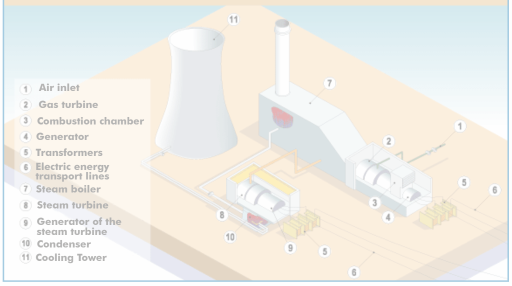
29.- Heliothermic Power Plant Active Power Control when connected to the Grid.

30.- Heliothermic Power Plant Reactive Power Control when connected to the Grid.

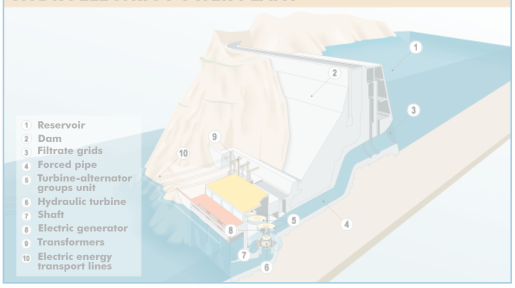
31.- Faults in Heliothermic Power Plant Operation.

Available Power Plants:

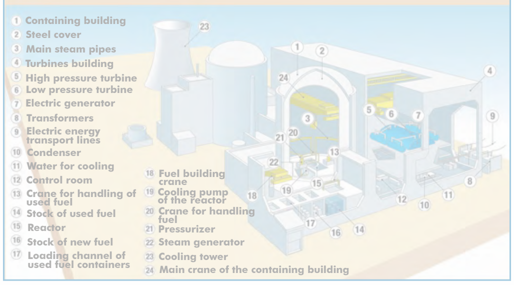
COMBINED CYCLE POWER PLANT



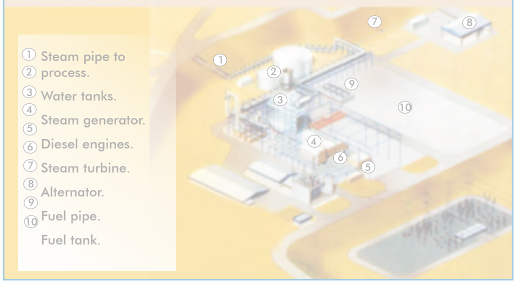
HYDROELECTRIC POWER PLANT



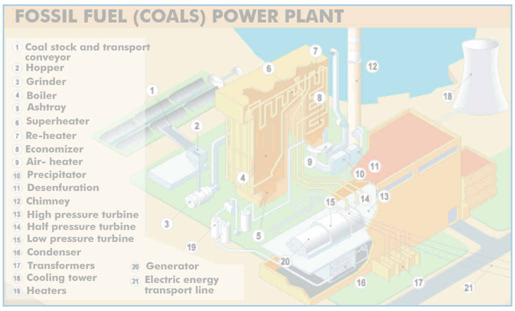
NUCLEAR POWER PLANT



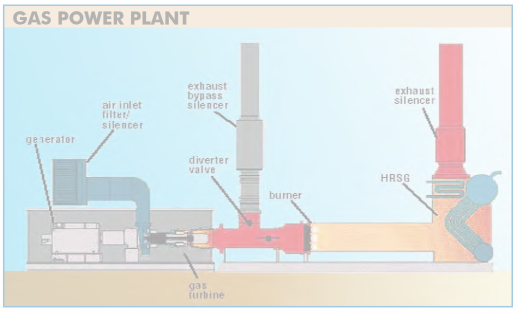
DIESEL FUEL POWER PLANT



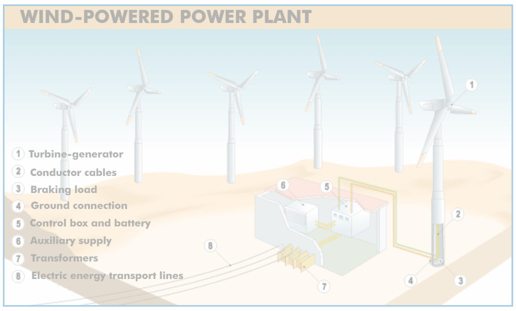
FOSSIL FUEL (COALS) POWER PLANT



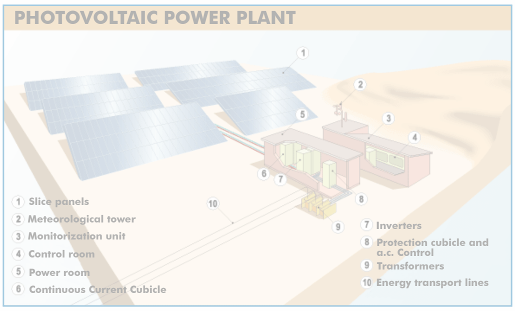
GAS POWER PLANT



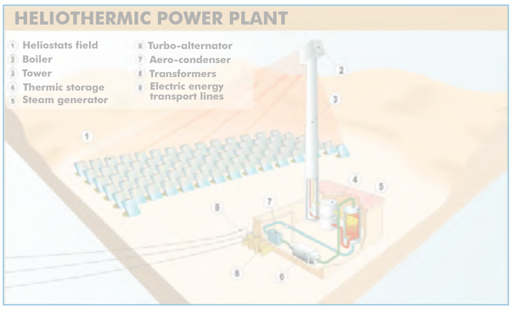
WIND-POWERED POWER PLANT



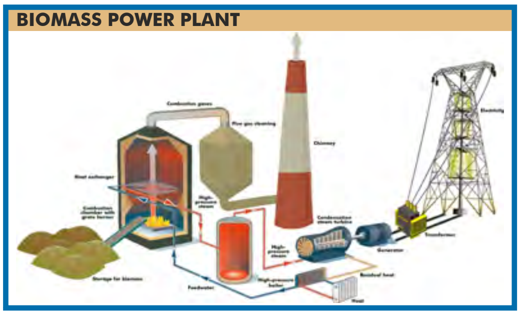
PHOTOVOLTAIC POWER PLANT



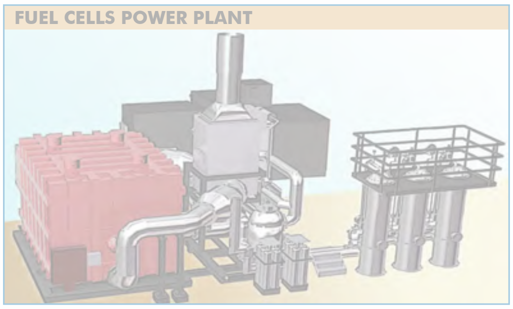
HELIOTHERMIC POWER PLANT



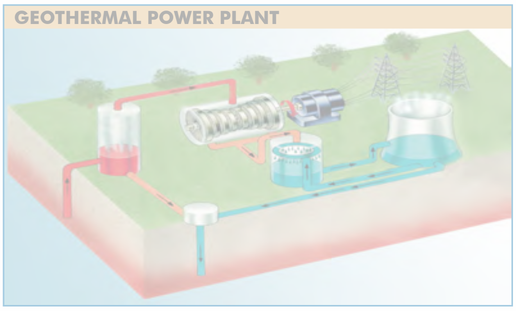
BIOMASS POWER PLANT



FUEL CELLS POWER PLANT



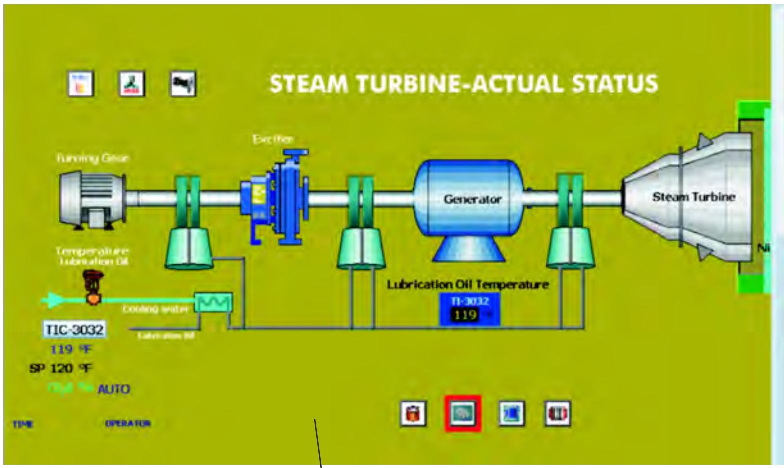
GEOTHERMAL POWER PLANT



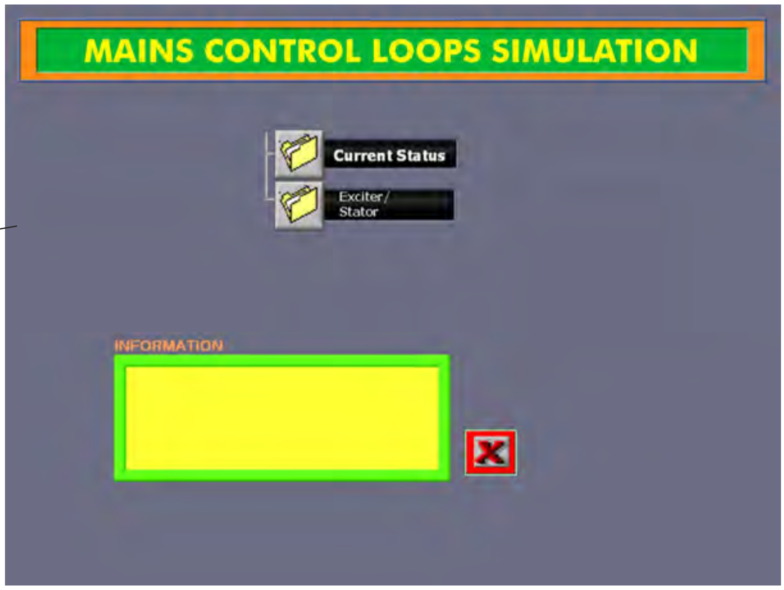
NOTE: Any of the 12 options available required HUB II. Mechanical Power Plants and Energy System with SCADA II.

HUB II. **Mechanical Power Plants and Energy System with SCADA II** (Biomass Power Plant)

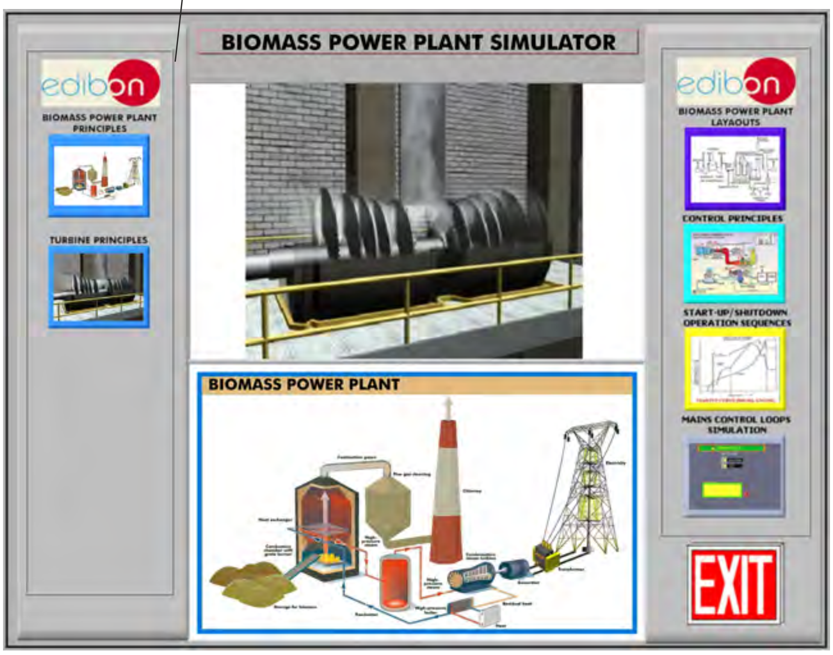
Main Screens



HUB II screen 3
(General state Power Plant diagram)



HUB II screen 2
(Mains Power Plant Control Loops Simulation)



HUB II screen 1
(Main menu screen)

EXERCICES AND PRACTICAL POSSIBILITIES

Some practical possibilities among many others:

With **HUB II. Mechanical Power Plants and Energy System with SCADA II + PPE/BM. Biomass Power Plant**:

1.- Biomass Power Plant General Principles of Operation.

2.- Steam Turbine General Principles of Operation.

3.- Biomass Power Plant General Control Layouts.

4.- Biomass Power Plant Control and Instrumentation Principles.

5.- Introduction to Mechanical and Electrical System Simulation.

6.- Introduction to Biomass Power Plant Block Diagram and Transfer Functions.

7.- Introduction to Proportional, Integral and Derivate (PID) Controllers used in Power Plant Control.

8.- Analysis of Proportional Controller.

9.- Analysis of Integral Controller.

10.- Analysis of Derivative Controller.

11.- Analysis of PID Controller.

12.- Analysis and Simulation of Steam Turbine Feed System.

13.- Analysis and Simulation of Steam Turbine Temperature Control.

14.- Analysis and Simulation of Steam Turbine Governor/Speed Control.

15.- Analysis and Simulation of Steam Turbine Generator Excitation System.

16.- Analysis and Simulation of Steam Turbine Outer/Loop MW Control.

17.- Analysis and Simulation of Steam Turbine Electrical Generator.

18.- Analysis and Simulation of Steam Turbine Lubrication Oil Cooling Temperature Control.

19.- Analysis and Simulation of Steam Turbine Generator Exciter Cooler Temperature Control.

20.- Biomass Power Plant Start-Up Procedure Analysis and Simulation.

21.- Biomass Power Plant Start-Up execution with the real Hardware.

22.- Biomass Power Plant Shut-Down Procedure Analysis and Simulation.

23.- Biomass Power Plant Shut-Down execution with the real Hardware.

24.- Biomass Power Plant Active Power Control in isolated mode of operation (two generators).

25.- Biomass Power Plant Frequency Control in isolated mode of operation.

26.- Biomass Power Plant Reactive Power Control in isolated mode of operation (two generators).

27.- Biomass Power Plant Voltage Control in isolated mode of operation.

28.- Biomass Power Plant Synchronization.

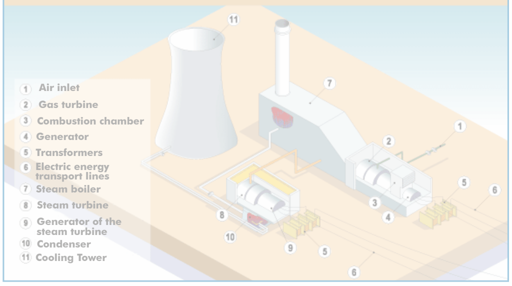
29.- Biomass Power Plant Active Power Control when connected to the Grid.

30.- Biomass Power Plant Reactive Power Control when connected to the Grid.

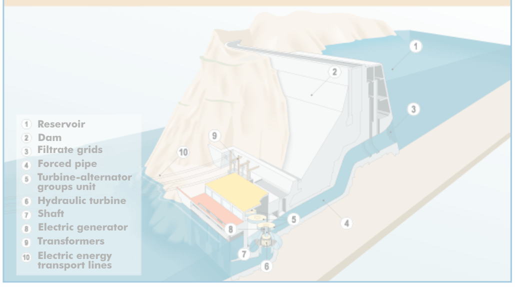
31.- Faults in Biomass Power Plant Operation.

Available Power Plants:

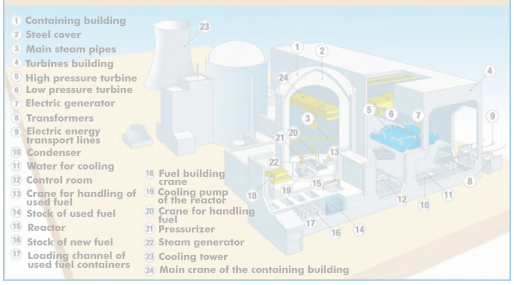
COMBINED CYCLE POWER PLANT



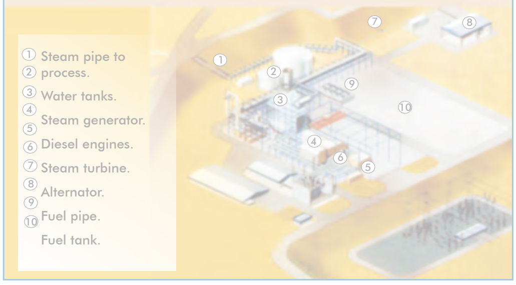
HYDROELECTRIC POWER PLANT



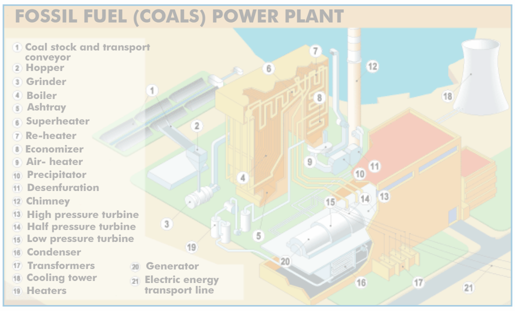
NUCLEAR POWER PLANT



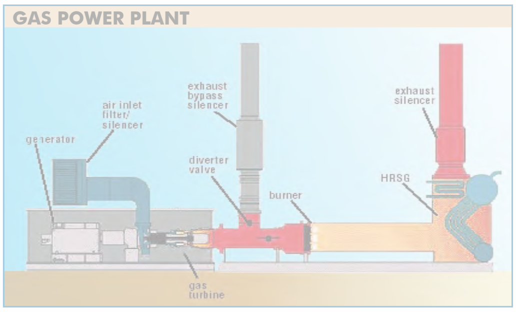
DIESEL FUEL POWER PLANT



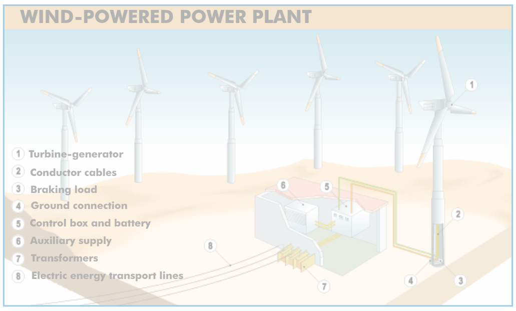
FOSSIL FUEL (COALS) POWER PLANT



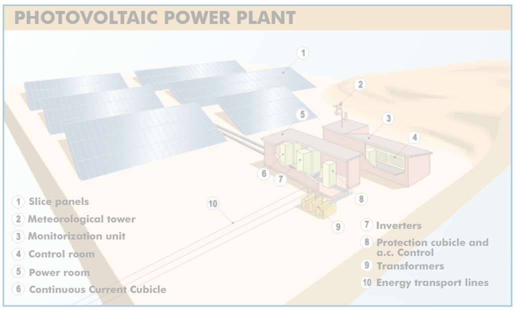
GAS POWER PLANT



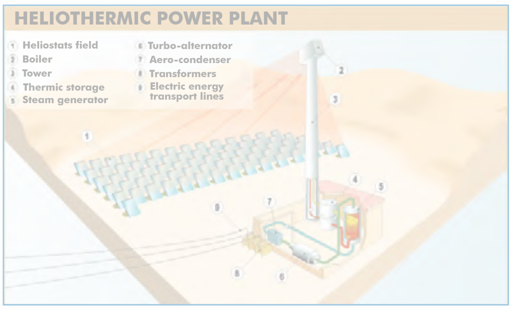
WIND-POWERED POWER PLANT



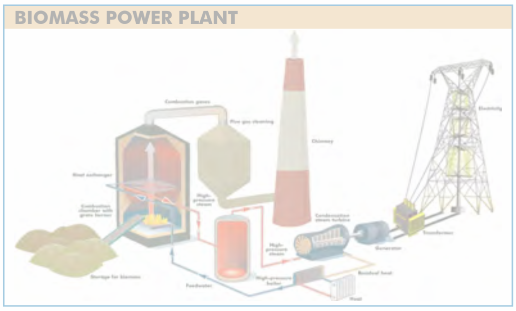
PHOTOVOLTAIC POWER PLANT



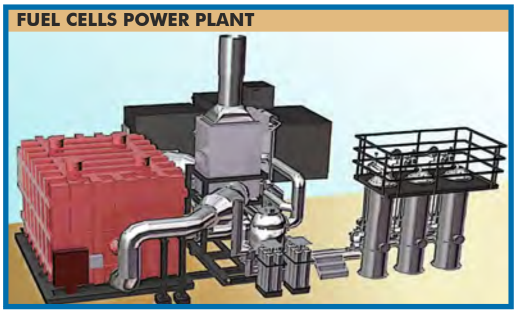
HELIOTHERMIC POWER PLANT



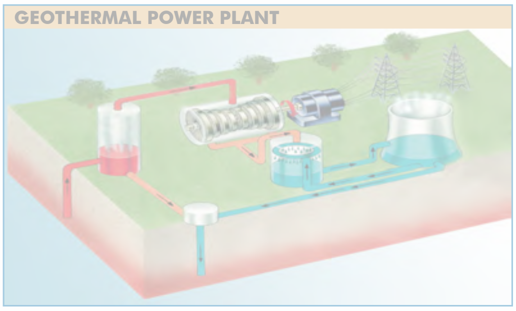
BIOMASS POWER PLANT



FUEL CELLS POWER PLANT



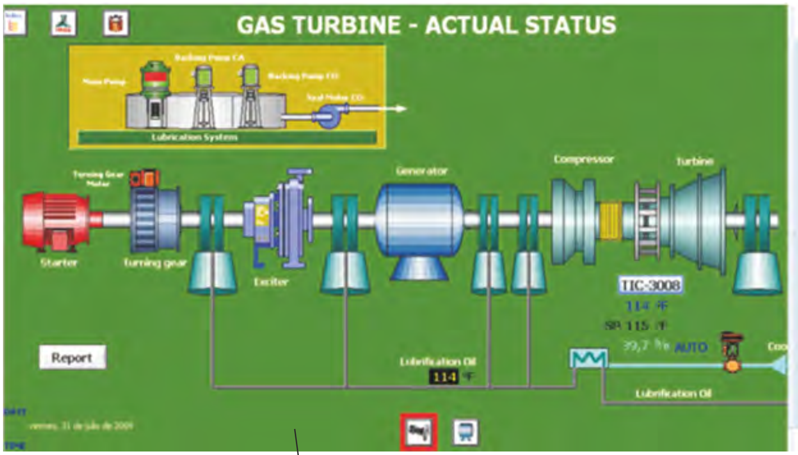
GEOTHERMAL POWER PLANT



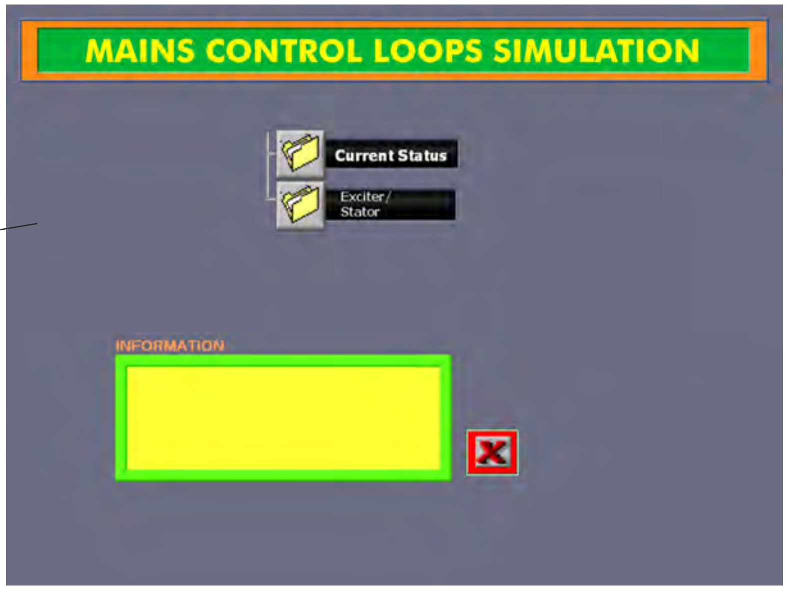
NOTE: Any of the 12 options available required HUB II. Mechanical Power Plants and Energy System with SCADA II.

HUB II. **Mechanical Power Plants and Energy System with SCADA II** (Fuel Cells Power Plant)

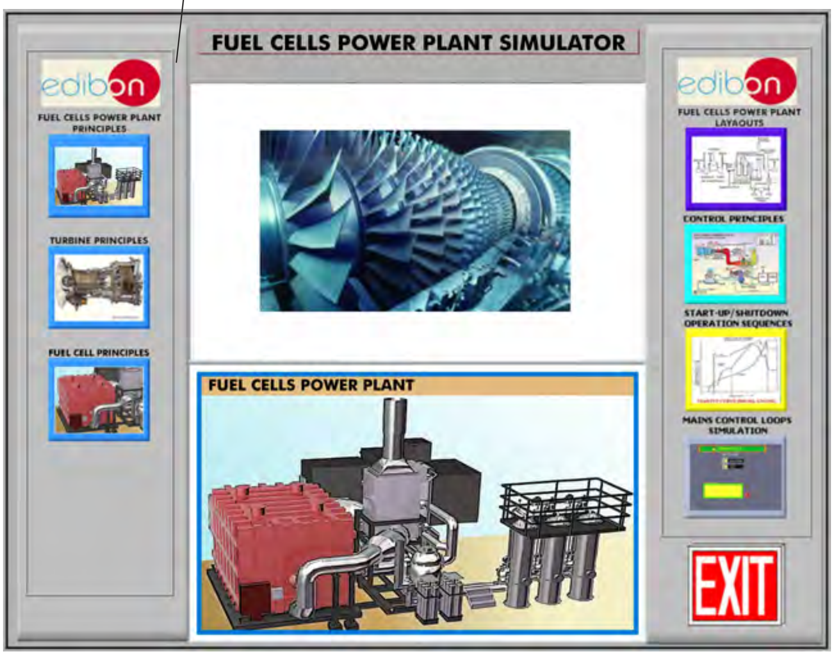
Main Screens



HUB II screen 3
(General state Power Plant diagram)



HUB II screen 2
(Mains Power Plant Control Loops Simulation)



HUB II screen 1
(Main menu screen)

EXERCICES AND PRACTICAL POSSIBILITIES

Some practical possibilities among many others:

With **HUB II. Mechanical Power Plants and Energy System with SCADA II + PPE/FC. Fuel Cells Power Plant**:

1.- Fuel Cells Power Plant General Principles of Operation.

2.- Gas Turbine General Principles of Operation.

3.- Fuel Cell Principles Operation.

4.- Fuel Cells Power Plant General Control Layouts.

5.- Fuel Cells Power Plant Control and Instrumentation Principles.

6.- Introduction to Mechanical and Electrical System Simulation.

7.- Introduction to Gas Turbine Power Plant Block Diagram and Transfer Functions.

8.- Introduction to Proportional, Integral and Derivate (PID) Controllers used in Power Plant Control.

9.- Analysis of Proportional Controller.

10.- Analysis of Integral Controller.

11.- Analysis of Derivative Controller.

12.- Analysis of PID Controller.

13.- Analysis and Simulation of Fuel Cell System of the Fuel Cells Power Plant.

14.- Analysis and Simulation of Gas Turbine Fuel System of the Fuel Cells Power Plant.

15.- Analysis and Simulation of Compressor-Turbine System.

16.- Analysis and Simulation of Gas Turbine Temperature Control.

17.- Analysis and Simulation of Gas Turbine Governor/Speed Control.

18.- Analysis and Simulation of Gas Turbine Generator Excitation System.

19.- Analysis and Simulation of Gas Turbine Outer/Loop MW Control.

20.- Analysis and Simulation of Gas Turbine Electrical Generator.

21.- Analysis and Simulation of Gas Turbine Lubrication Oil Cooling Temperature Control.

22.- Analysis and Simulation of Gas Turbine Generator Exciter Cooler Temperature Control.

23.- Fuel Cells Power Plant Start-Up Procedure Analysis and Simulation.

24.- Fuel Cells Power Plant Start-Up execution with the real Hardware.

25.- Fuel Cells Power Plant Shut-Down Procedure Analysis and Simulation.

26.- Fuel Cells Power Plant Shut-Down execution with the real Hardware.

27.- Fuel Cells Power Plant Active Power Control in isolated mode of operation (two generators).

28.- Fuel Cells Power Plant Frequency Control in isolated mode of operation.

29.- Fuel Cells Power Plant Reactive Power Control in isolated mode of operation (two generators).

30.- Fuel Cells Power Plant Voltage Control in isolated mode of operation.

31.- Fuel Cells Power Plant Synchronization.

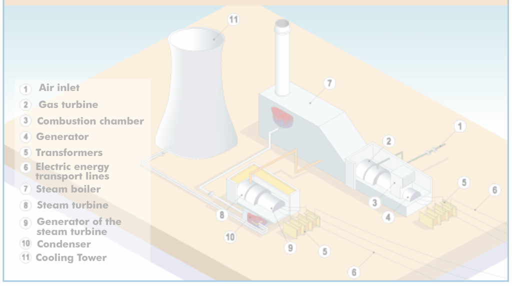
32.- Fuel Cells Power Plant Active Power Control when connected to the Grid.

33.- Fuel Cells Power Plant Reactive Power Control when connected to the Grid.

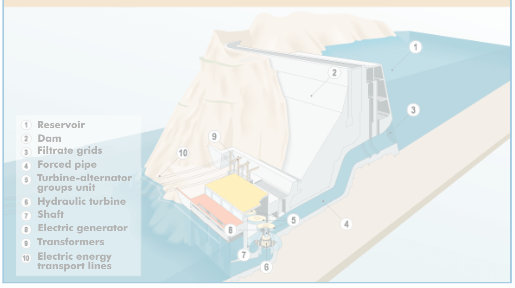
34.- Faults in Fuel Cells Power Plant Operation.

Available Power Plants:

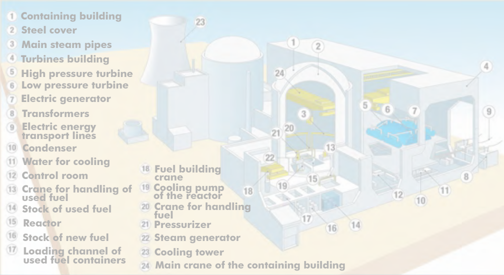
COMBINED CYCLE POWER PLANT



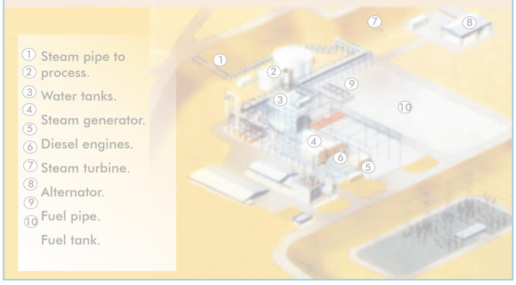
HYDROELECTRIC POWER PLANT



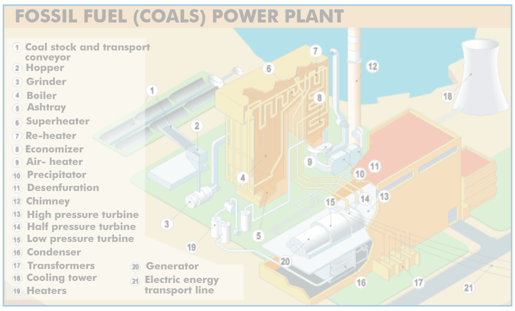
NUCLEAR POWER PLANT



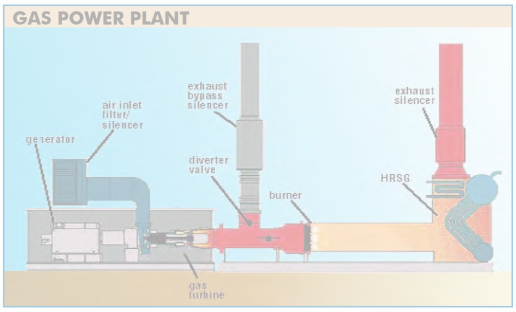
DIESEL FUEL POWER PLANT



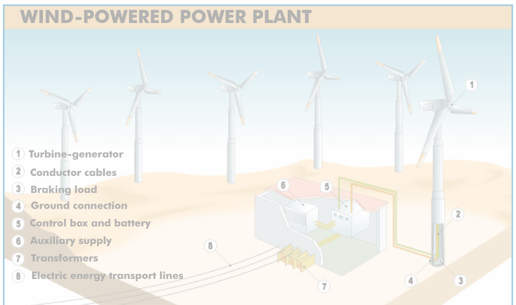
FOSSIL FUEL (COALS) POWER PLANT



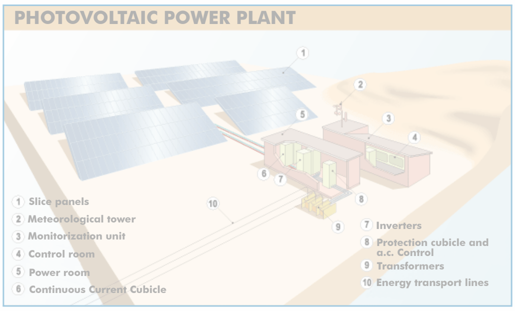
GAS POWER PLANT



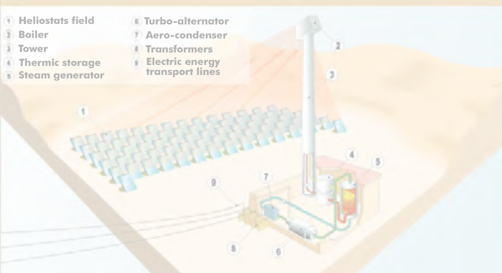
WIND-POWERED POWER PLANT



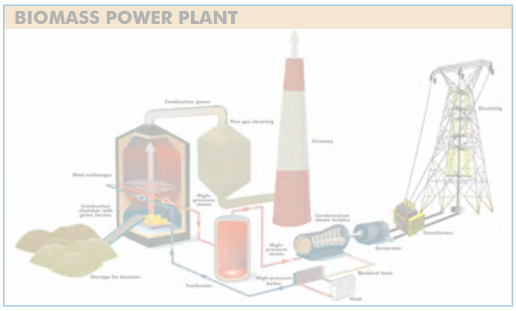
PHOTOVOLTAIC POWER PLANT



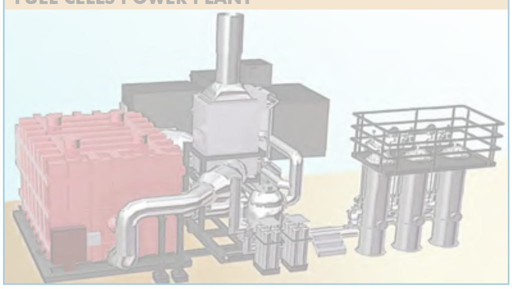
HELIOTHERMIC POWER PLANT



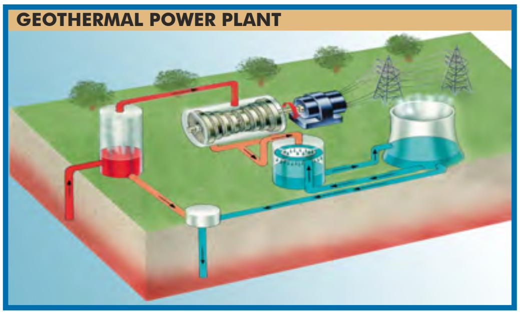
BIOMASS POWER PLANT



FUEL CELLS POWER PLANT



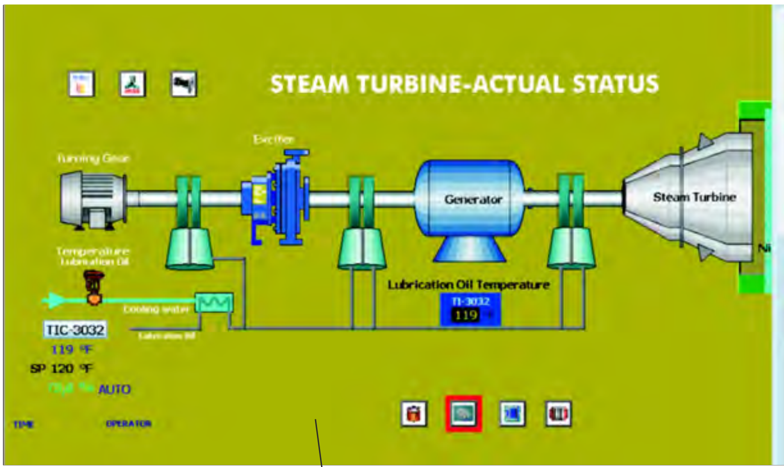
GEOTHERMAL POWER PLANT



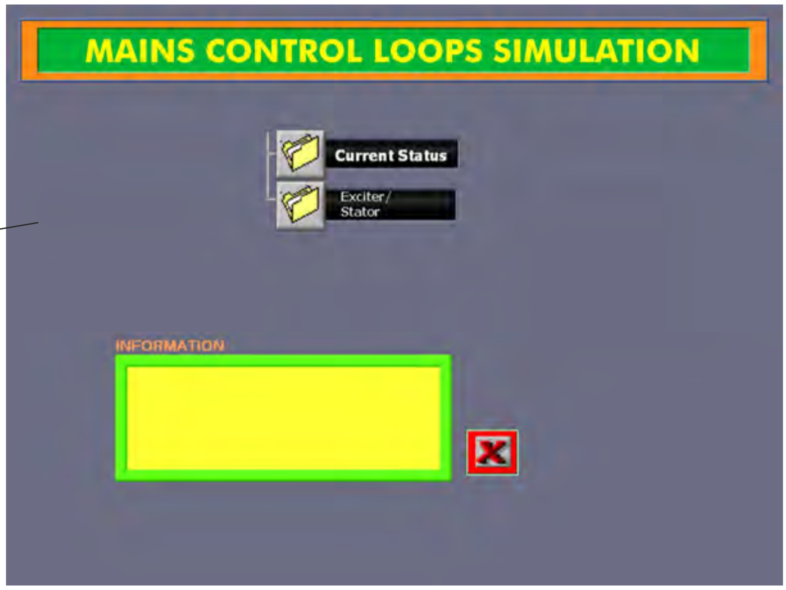
NOTE: Any of the 12 options available required HUB II. Mechanical Power Plants and Energy System with SCADA II.

HUB II. **Mechanical Power Plants and Energy System with SCADA II** (Geothermal Power Plant)

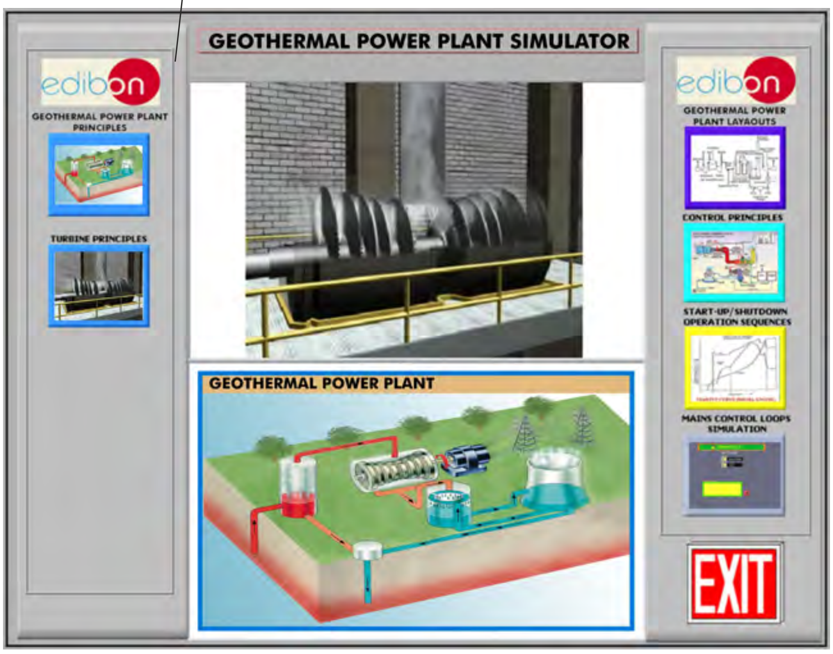
Main Screens



HUB II screen 3
(General state Power Plant diagram)



HUB II screen 2
(Mains Power Plant Control Loops Simulation)



HUB II screen 1
(Main menu screen)

EXERCICES AND PRACTICAL POSSIBILITIES

Some practical possibilities among many others:

With **HUB II. Mechanical Power Plants and Energy System with SCADA II + PPE/GT. Geothermal Power Plant**:

1.- Geothermal Power Plant General Principles of Operation.

2.- Steam Turbine General Principles of Operation.

3.- Geothermal Power Plant General Control Layouts.

4.- Geothermal Power Plant Control and Instrumentation Principles.

5.- Introduction to Mechanical and Electrical System Simulation.

6.- Introduction to Geothermal Power Plant Block Diagram and Transfer Functions.

7.- Introduction to Proportional, Integral and Derivate (PID) Controllers used in Power Plant Control.

8.- Analysis of Proportional Controller.

9.- Analysis of Integral Controller.

10.- Analysis of Derivative Controller.

11.- Analysis of PID Controller.

12.- Analysis and Simulation of Steam Turbine Feed System.

13.- Analysis and Simulation of Steam Turbine Temperature Control.

14.- Analysis and Simulation of Steam Turbine Governor/Speed Control.

15.- Analysis and Simulation of Steam Turbine Generator Excitation System.

16.- Analysis and Simulation of Steam Turbine Outer/Loop MW Control.

17.- Analysis and Simulation of Steam Turbine Electrical Generator.

18.- Analysis and Simulation of Steam Turbine Lubrication Oil Cooling Temperature Control.

19.- Analysis and Simulation of Steam Turbine Generator Exciter Cooler Temperature Control.

20.- Geothermal Power Plant Start-Up Procedure Analysis and Simulation.

21.- Geothermal Power Plant Start-Up execution with the real Hardware.

22.- Geothermal Power Plant Shut-Down Procedure Analysis and Simulation.

23.- Geothermal Power Plant Shut-Down execution with the real Hardware.

24.- Geothermal Power Plant Active Power Control in isolated mode of operation (two generators).

25.- Geothermal Power Plant Frequency Control in isolated mode of operation.

26.- Geothermal Power Plant Reactive Power Control in isolated mode of operation (two generators).

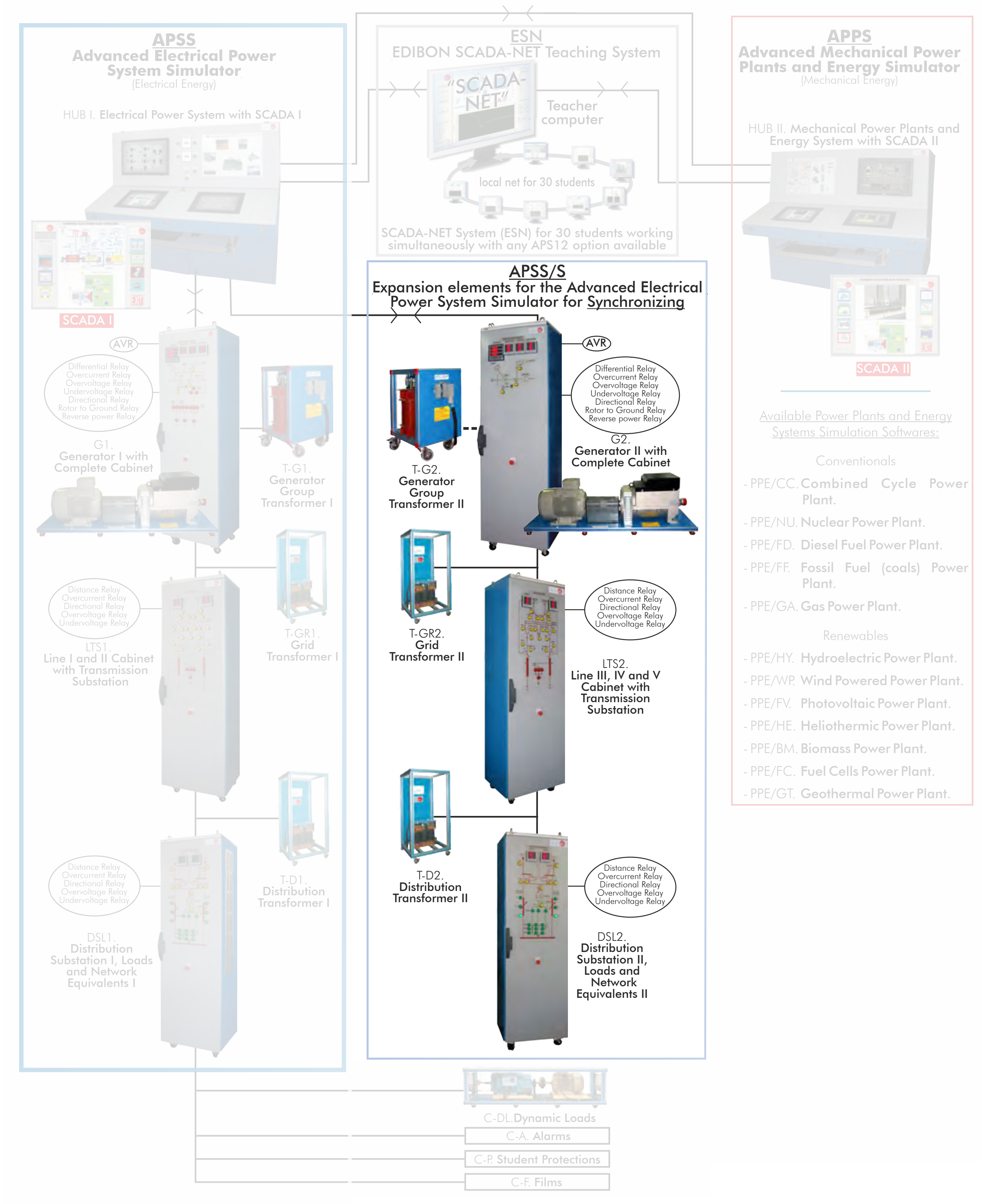
27.- Geothermal Power Plant Voltage Control in isolated mode of operation.

28.- Geothermal Power Plant Synchronization.

29.- Geothermal Power Plant Active Power Control when connected to the Grid.

30.- Geothermal Power Plant Reactive Power Control when connected to the Grid.

31.- Faults in Geothermal Power Plant Operation.



APSS/S. Expansion elements of the Advanced Electrical Power System Simulator for Synchronizing and Area Interconnection, includes:

- **-G2.** Generator II with Complete Cabinet.
- **-T-G2.** Generator Group Transformer II.
- **-T-GR2.** Grid Transformer II.
- **-LTS2.** Line III, IV and V Cabinet with Transmission Substation.
- **-C-DL.** Dynamic Loads.
- **-DSL2.** Distribution Substation II, Loads and Network Equivalents II.
- **-T-D2.** Distribution Transformer II.

APSS/S. **Expansion elements for the Advanced Electrical Power System Simulator for Synchronizing**

G2. **Generator II with Complete Cabinet**, including AVR, with Synchronization System, Protection Relays and Power Analyzers

TECHNICAL SPECIFICATIONS

Generator:
- Base plate in painted steel and anodized aluminium structure.
- Generator:
  Three-phase synchronous generator: 7KVA, 230/400Vac, 1500 r.p.m., Cos φ: 0.8 , with brush excitation system.
- Motor prime mover:
  Three-phase squirrel cage motor, 7KW, 1500 r.p.m., 400 Vac, 50Hz, Cos φ: 0.86, driven by a vector controlled multifunction inverter with RS-485 interface.
- Shaft encoder.
- Semiflex coupling.

Etc.

Cabinet:
- Metallic cubicle, with wheels.
- Front panel diagram.
- Inductances for simulating the transient and sub-transient state of the generator.
- Power supply.
- Current transformers. Voltage transformers.
- Vector inverter with automatic frequency load controller (AFLC).
- Automatic/manual voltage regulator (AVR) and automatic/manual synchronization device.
- Magneto-thermal switches.
- Connectors.
- Power energy analyzers with RS-485 communication interface:
  Voltage: Range 20-500 Vrms. Prec.: ±0.5%. Phase to phase-Phase to neutral. Current: Range 0.02-5 Arms. Prec.: ±0.5%.
  Frequency: Range 48 to 62 Hz. ±0.1Hz. Power: Active, Reactive and Apparent. Range 0.01 to 9900 kW. Prec.: ±1%.
  Power Factor: Power Factor for each phase and average. Range -0.1 to + 0.1. Prec.: ±1%.
- Digital protection relays with RS-485 communication interface.
- Differential Relay.
- Overcurrent Relay.
- Overvoltage Relay.
- Undervoltage Relay.
- Directional Relay.
- Generator Rotor to Ground Relay.
- Generator Reverse Power Flow Relay.
- Programable logic controller (PLC) with 42 I/O signals and RS-485 interfaces for generation system topology configuration.
- Contactors.
- Power switches and fault state indicators in the front panel.
- Emergency switch included.
- Back-up generation protection devices.

Etc.

DIMENSIONS & WEIGHT

Generator:
- Dimensions: 150 x 50 x 50 cm. approx.
- Weight: 150 Kg. approx.

Cabinet:
- Dimensions: 70 x 70 x 220 cm. approx.
- Weight: 100 Kg. approx.

Transformers

SPECIFICATIONS

T-G2. **Generator Group Transformer II:**

- Three-phase power transformer, 5KVA, Dy11 connection, with multi- tapped primary and secondary windings.
- Anodized aluminium structure and panels in painted steel.
- It includes wheels for mobility.

T-GR2. **Grid Transformer II:**

- Three-phase power transformer with connection group Dy11, 5kVA , with multi- tapped secondary.

T-D2. **Distribution Transformer II:**

- Three-phase transformer, 2kVA, phaser group Yd1, with multi-tapped primary.

DIMENSIONS & WEIGHT

Each transformer:

- Dimensions: 55 x 53 x 80 cm. approx.
- Weight: 30 Kg. approx.

LTS2. **Line III, IV and V Cabinet with Transmission Substation**

Front side

Inner

SPECIFICATIONS

- Metallic cubicle, with wheels.
- Front panel diagram.
- Inductances and capacitors for lines parameters simulation.
- Voltage transformers.
- Current transformers.
- Magneto-thermal switches.
- Connectors.
- Contactors.
- It includes tapping points for changing the length of lines and the configuration of PI or T line loss profiling, and fault injection with the help of PLC control device.
- Digital protection relay with RS-485 communication interface.
- Distance Relay.
- Overcurrent Relay.
- Directional Relay.
- Undervoltage Relay.
- Overvoltage Relay.
- Power meter analyzers with RS-485 communication interface:
  Voltage: Range 20-500 Vrms. Prec.: ±0.5%. Phase to phase-Phase to neutral. Current: Range 0.02-5 Arms. Prec.: ±0.5%.
  Frequency: Range 48 to 62 Hz. ±0.1Hz. Power: Active, Reactive and Apparent. Range 0.01 to 9900 kW. Prec.: ±1%.
  Power Factor: Power Factor for each phase and average. Range -0.1 to + 0.1. Prec.: ±1%.
- Programmable logic controller (PLC) with 42 I/O signals for controlling and state estimation of all line elements and fault injection switches.
- State indicator lamps in the front panel.
- Emergency switch included.
- Etc.

DIMENSIONS & WEIGHT

- Dimensions: 70 x 70 x 220 cm. approx.
- Weight: 100 Kg. approx.

DSL2. **Distribution Substation II, Loads and Network Equivalents II**

Front side

Inner

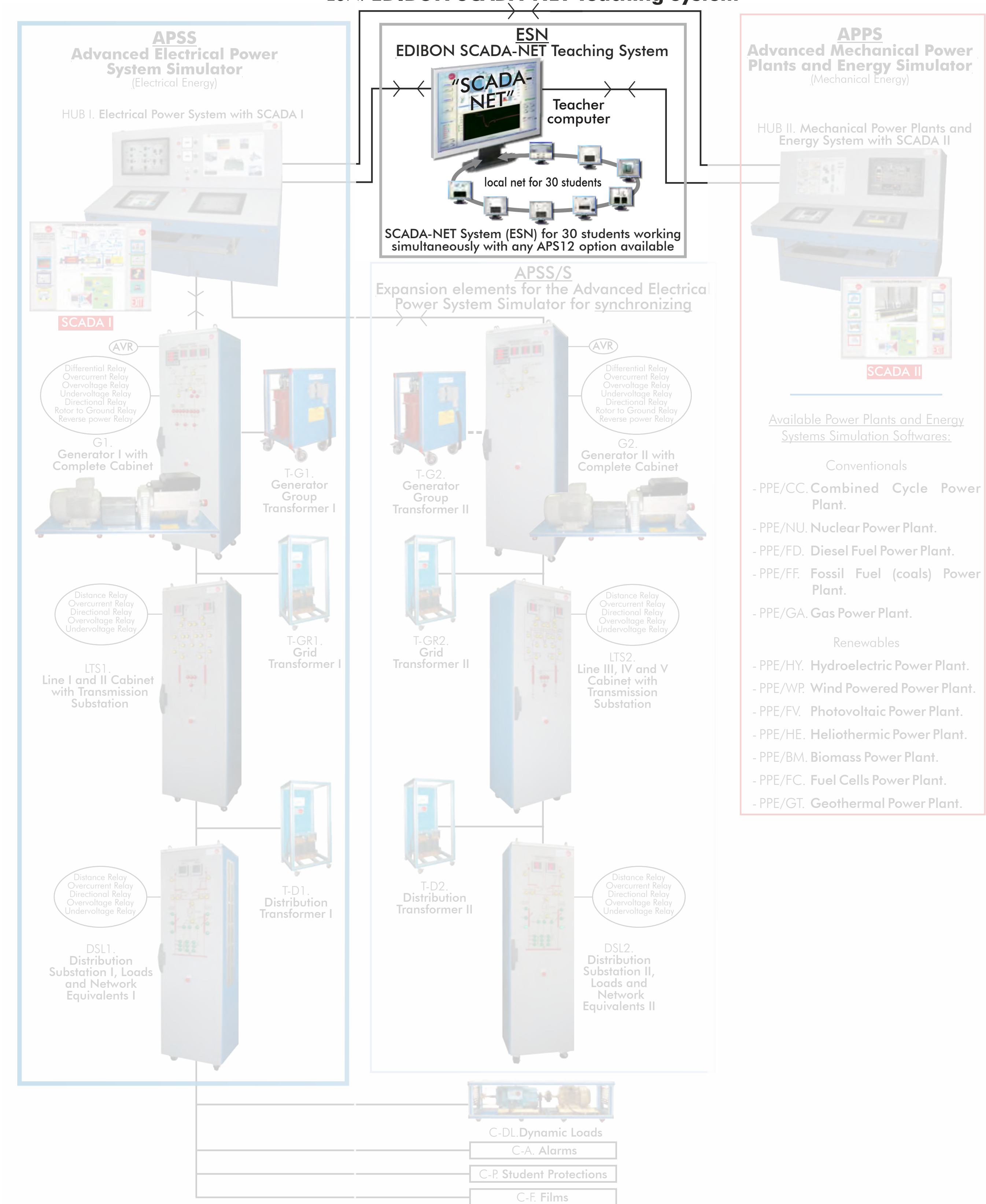
SPECIFICATIONS

- Metallic cubicle, with wheels.
- Front panel diagram.
- Inductances, capacitors, resistors and active load modules for load simulation.
- Contactors.
- Power meter analyzers with RS-485 communication interface:
  Voltage: Range 20-500 Vrms. Prec.: ±0.5%. Phase to phase-Phase to neutral. Current: Range 0.02-5 Arms. Prec.: ±0.5%.
  Frequency: Range 48 to 62 Hz. ±0.1Hz. Power: Active, Reactive and Apparent. Range 0.01 to 9900 kW. Prec.: ±1%.
  Power Factor: Power Factor for each phase and average. Range -0.1 to + 0.1. Prec.: ±1%.
- Voltage transformers.
- Digital protection relays with RS-485 communication interface.
- Directional Relay.
- Differential Relay.
- Overcurrent Relay.
- Undervoltage Relay.
- Overvoltage Relay.
- Dissipator fan.
- Connectors.
- Magneto-thermal circuit breaker.
- It includes tapping points for charging load topology configuration and fault injection with the help of PLC control device.
- Programmable logic controller (PLC) with 42 I/O signals for controlling, state estimation of all distribution substation elements and load configuration and fault injection.
- Back-up protection for external network connection.
- Etc.

DIMENSIONS & WEIGHT

- Dimensions: 70 x 70 x 220 cm. approx.
- Weight: 100 Kg. approx.

ESN. **EDIBON SCADA-NET Teaching System**



What is SCADA-NET ?

Let us explain first what is a SCADA and what is a net.

- SCADA: This is a common expression used for Supervision, Control and Acquisition system.

  The SCADA is a control system including as main part the PID control (P= Proportional, I= Integral, D= Derivative). This PID control is the most common control used in many unitary processes in most industrial applications when you produce different kind of products.
- NET: Everybody knows what is a local net, where you have a main computer and several computers linked together with the main computer.
- **SCADA-NET:**

  This is the connection between any SCADA's (many unitary processes) with a local net with many computers.

  So, Computer Controlled Units or units with SCADA are the key of the system. EDIBON has designed several SCADA's using of Open Control, Multicontrol and Real Time Control make the system very powerful in terms of teaching.
- **INTEGRATED LABORATORIES:**

  These are what EDIBON has designed, allowing to integrate the classroom and the laboratory in ONLY ONE PLACE.

  This new way to teach will increase drastically the teachers and students efficiency.

  Having classroom and labs in the same place when you are doing industrial simulation (PC and PLC control) will allow to do everything more easily and the students will get "CLEAR CONCEPTS", with Real Industrial Systems, as industrial systems used in Mechanics (units), Electronics (interfaces), Data Acquisition Boards (National Instruments is very well know), Software (Lab View is very well know), Computer (any computer) and PLC (any PLC available in the market).

DESCRIPTION

General Description:

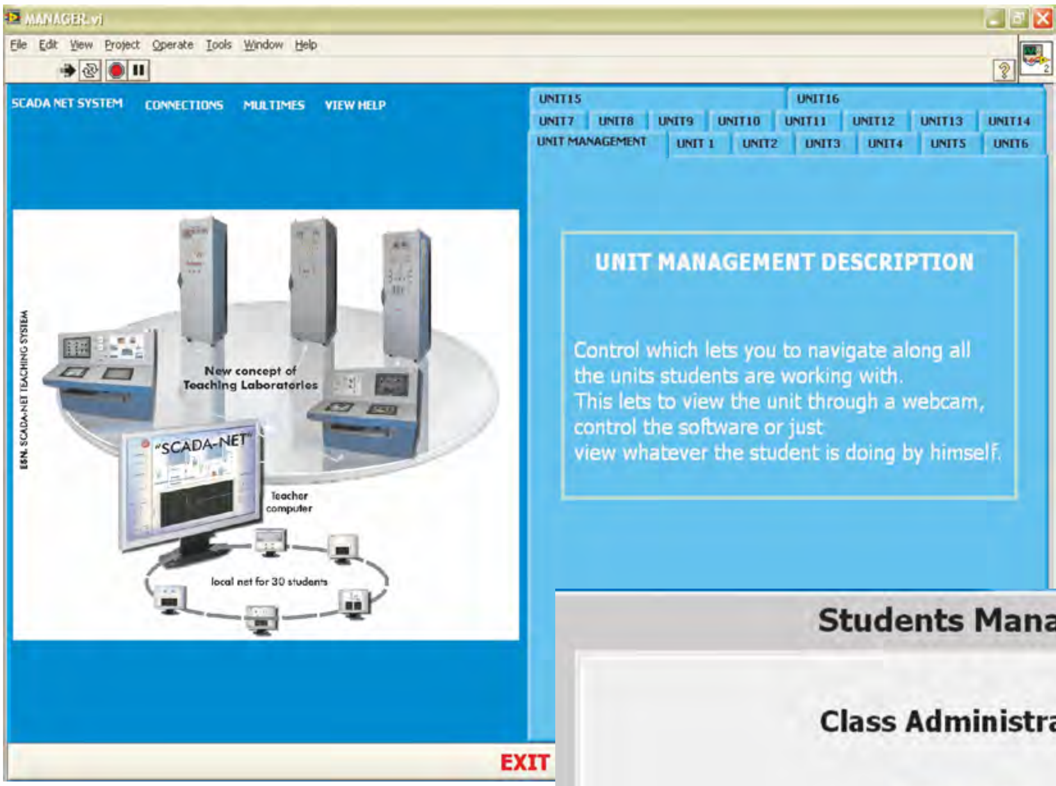
The ESN (EDIBON SCADA-NET) system consists on the adaptation of EDIBON modules controlling from computers integrated in a local network.

The ESN can be considered like a Computer Aided Instruction System for "Computer Controlled Modules".

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

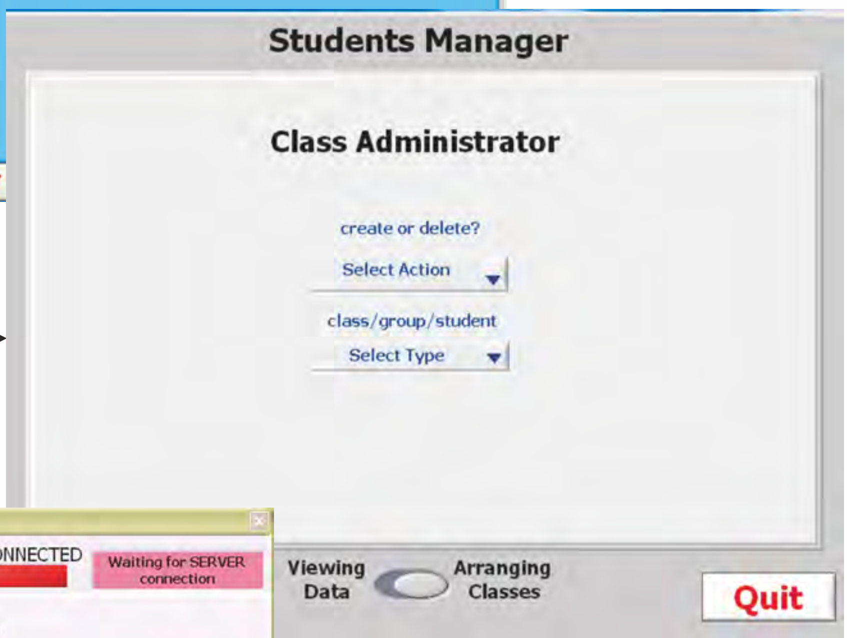
Thanks to a computer, the Manager/Instructor Computer located "between" the modules and the local net, the manager can manage the access to the different modules, and the permissions to control/view all the modules. The user/student can visualise the modules in his own PC during the experiment.

The communication between the users and the modules are managed by the manager/instructor. There is no possibility of communication between them if the manager does not allow it.



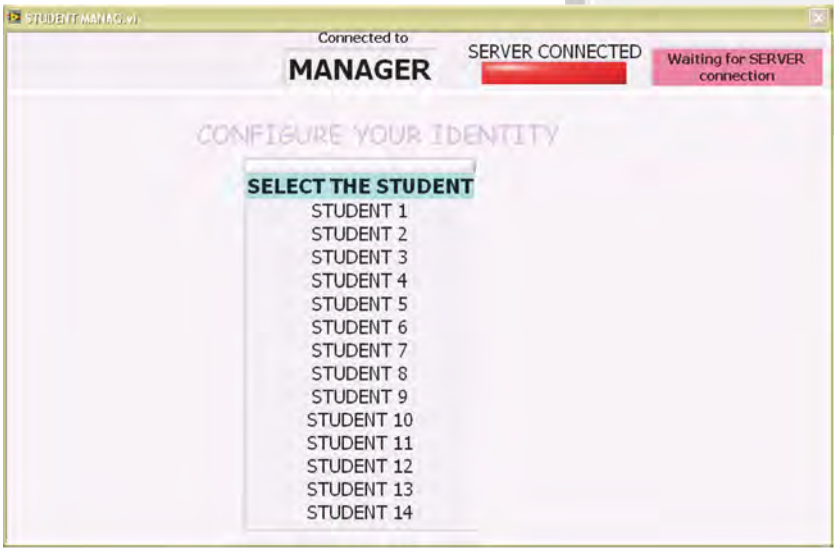
◀ Manager Software Main Screen:

- Right Side: Modules management.
- Left Side: Connections management.



Students Manager: ▶

Software which is used by manager to organize the students into groups/classes.



◀ Student Software Main Screen

continue...

ESN-System, main actions:

The manager can set **two working levels** for users:

a) Visualisation:

The manager/instructor controls the module meanwhile the users/students view the manager actions, in their screens. This would be a good first stage to learn how to work with the system. This could help to the users know how, to control the system from their own computer.

b) Control:

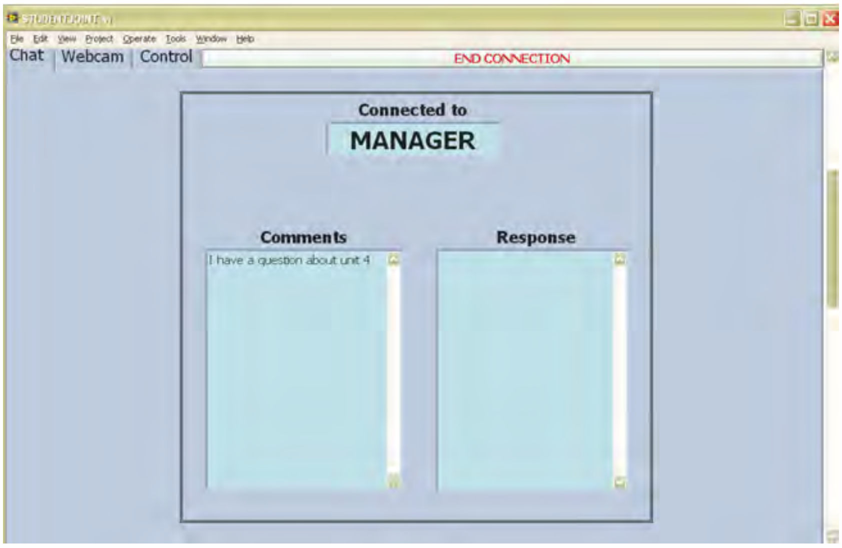
The manager/instructor lets the control of the module to one of his users/students, who will be able to obtain his own results. These results will be sent to the manager computer, to be checked by him. The rest of the users will visualise the actions of their mate, or maybe control another different module.

The manager has the possibility of dividing his class on work groups. Each group can work with a different module, and, within a group, one of the users can assume the control of the module and the rest just visualise his actions.

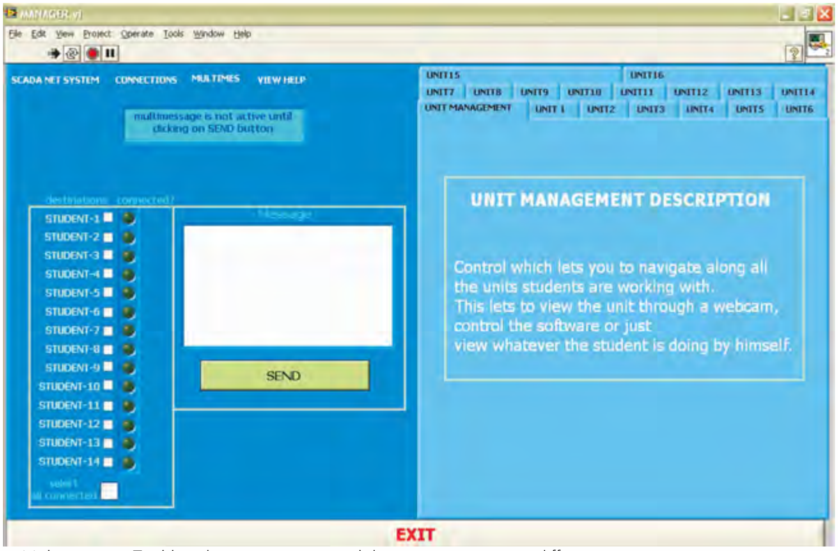
If any of the users has a question or a doubt about the practice, he just has to start a computerised conversation with the manager through a window in the software.

The manager can keep as conversations as he wants at the same time. Also, this window can be used by instructor to send some suggestions or questions to the students in a group.

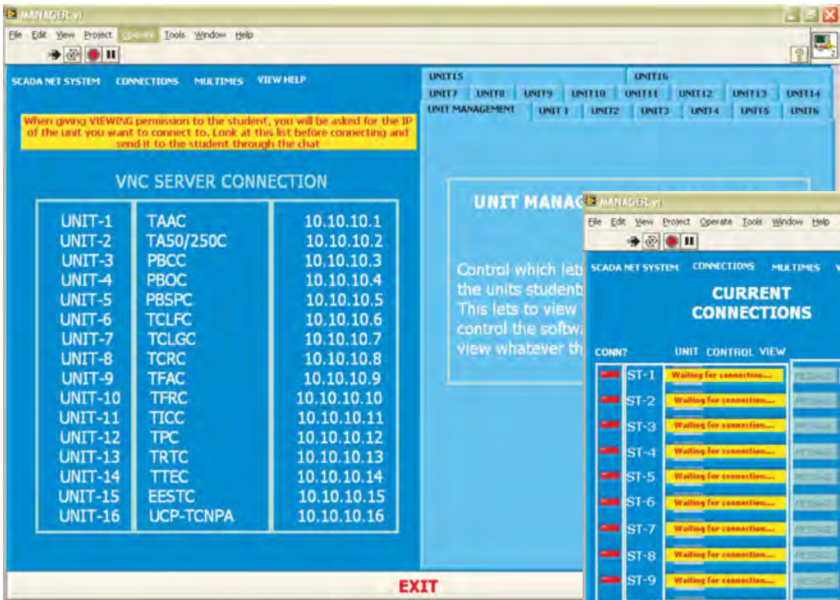
The manager has also the possibility of sending the same message to all the users, or maybe just to some of them, by using the "multimessage" option.



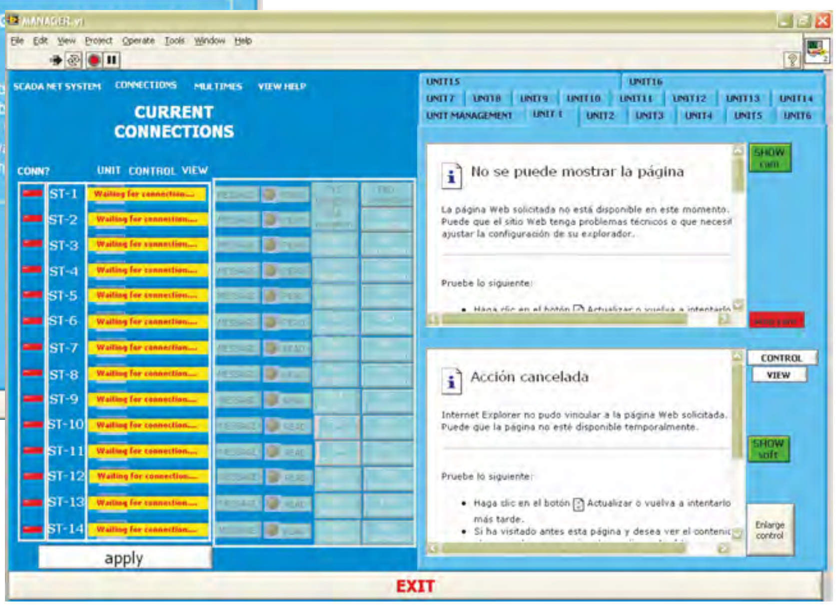
Student Communicator lets the student send/receive some questions/comments to from manager.



Multimessage Tool lets the manager to send the same message to different users.



Help window for manager



Connections Control Panel lets the manager to set which connections are active, to give any kind of permissions to students.

continue...

Technical Description:

The ESN system is constituted by several EDIBON unitary processes or modules (UPM), each one with their own computer and webcam. Another computer for the manager and other several computers for the users. Each computer has its own software:

- in the module computer the **MODULE software** should be installed;
- in the users computers the **STUDENT (USER) software** must be installed and
- in the manager computer the **INSTRUCTOR (MANAGER) software** must installed too.

In order to communicate all the computers a switch is also provided. This switch lets the communications between all he computers in the network.

Regarding to big laboratories in which it is difficult to see the unit while working from all the worksets, each user will be able to see the unit which they are working with through a camera previously installed in the module. This will be used just to have an idea of what the module looks like and how it changes when some action is sent to any module from any user computer.

To make easy the visualisation by the manager computer to the users, when this takes the control, a projector with its screen is provided. In this way, the manager computer can be published for all the users on a common screen.

The number of modules or users/students can be modified depending on the customer requirements. A typical ESN system is constituted by 20 modules and 30 students, for example.

The ESN Software is an acquisition and control software developed entirely by EDIBON engineers. In this development, we have been taken into account the experience accumulated in more than 20 years developing teaching equipment at very high level and technology.

The system is **prepared to communicate to an undefined number of computers**. It will depend on the net features.

All the communications are made through a TCP/IP connection, which provides a high security and speed data transfer. The access to a PC will be made through the name of the machine into the network.

The network lets to transfer video data, binary data, files...

In this system, there are **different configuration levels** that allow the Manager/Instructor to design in the fair measure the execution of the different practical exercises.

The basic level is prepared for the capture and storage of data that the student will process and will work with later.

The medium level allows the student the use of the graphic tools that allows, in real time, the visualisation of the data experiment.

Finally, it has an advance level specially designed for the capture configuration and the sensors device calibration. This system is subject to a key provided by EDIBON.

Interconnection elements and modules software adaptation:

- Each module requires a PC for working individually.
- Each unitary process requires the proper hardware adaptation.
- Each module will have all software for allowing interconnections.
- Each module requires its own unitary process softwares. (Acquisition, Control and Management Software).
- Each user/student should have a software.
- The manager will have his own software.

MAIN POSSIBILITIES OF THE SYSTEM

- Any amount of modules working at the same time.
- Any number of users/students working simultaneously. Normally one controlling each module. (Technically depending of the actions more than one can work with only one (UPM)).
- One computer (manager) management of all the system.
- Possibility of dividing the classroom into groups, working each group with a different module.
- Any user/student can work doing "real time" control/visualisation.
- The manager/teacher can see in his computer what any user/student is doing in any module.
- Continuous communication between the manager and all the users/students connected.
- The ESN System is MODULAR, OPEN and EXPANDIBLE.
- The system is supplied with "all necessary accessories", computers...etc.
- The system has its own manual.

SUMMARY GROUP OF ELEMENTS INCLUDED IN THE SYSTEM

The system includes the following group of elements:

1) **Modules with SCADA:**
   - Unitary Process Modules (UPM).
   - Electronic Interface (EI) for getting the sensors (parameters) signals.
   - Data Acquisition Board (DAB), getting data at 250 KS/second (kilo samples per second).
   - Software:
     - One software for understanding the module with the computer through the electronic interface.
     - One software for understanding the module with the computer through the DAS (data acquisition board).
     - One software to manage and manipulate the data you to get from UPM.

     All the three we name "software".

   IMPORTANT!: Detailed specifications in any reference EDIBON module.

2) **Computers (PC):**

   Any computer in the market can be used.

   Any UPM in the ESN system requires a computer.

3) **Modules Adaptation (MA):**

   All the computer controlled modules (one per unitary process) require some modifications in the EI (electronic interface) in order to allow manipulating and managing all the signals given by the sensors. Each module uses more or less different number of sensors, depending of the parameters involved in the process and we are interested to measure.

4) **Software Adaptation (SA):**

   All the computer controlled modules requires its complex software adaptation in order to be connected to the other parts of the ESN.

   This software will allow, among others, the module to be controlled separately.

5) **Webcam (WC):**

   Any unit will have a web cam in order to see, in the user/student computer, how is working.

   The webcam delivers clear, colorful images and compatibility with major video calling applications. It uses a VGA sensor (640 x 480 pixels) to provide solid image quality, including 1.3-megapixel (software enhanced) photos. The webcam allows you to easily capture, e-mail and upload video or photos with a single click; universal monitor clip/base which installs securely on LCD monitors and ultrathin notebooks, or can be used on flat surfaces. Plus, it's compatible with all leading instant messaging applications.

6) **Manager/Instructor Software (MIS):**
   - This MIS or teacher software will allow to handle all the signals coming from all sensors of all (UPU), in order to suit to the users/students computers working with any particular module (UPM).
   - It will allow the users/students organisation and managing by the manager/teacher.
   - It will allow to managing the users/students passwords and how to work and to use the ESN.
   - It will allow to get "access" to the (UPM) and its UPM Software.
   - It will allow the interconnection, at any time, between the Manager and User for:
     - Receiving the manager questions from the user.
     - Guiding the user for using the UPM, PC, MA, SA and WC.
     - Asking questions, technical o theoretical, related with any module, as: module itself, module operation, module results, etc.
     - Evaluating the user, in real time o during the complete process, in order to know the level of understanding.
     - "Chat" between manager and user at any time.
     - Sending and receiving results and files at any time between the manager and user, and vice-versa.

7) **User/Student Software (US):**
   - This software package will allow the user to handle all the signals coming from UPM, PC, MA, SA, but with the limitations decided by the manager and its MIS, in order to give the user (student) the proper and adequate information for a better knowledge and proper understanding.
   - It will include the "password access".
   - To ask the manager the module (UPM) he will work with.
   - To see any unit working but with previous manager acceptance.
   - To work and control any UPM, with previous manager acceptance.
   - To chat with the manager.
   - To send the files and questions to the manager, in real time.

8) **Classroom accessories and complements:**
   - Projector.
   - Red Extra Plane Laser Pointer.
   - Tripod Projection Screen.
   - Shelf.

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

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