



① Unit: AEL-FCLL. Fuel Cell Energy Trainer

Key features:

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



For more information about Key Features, click here



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



European Union Certificate (total safety)



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



Certificate and Worlddidac Member

INTRODUCTION

A fuel cell is a device that converts the chemical energy from a fuel into electricity through a chemical reaction of positively charged hydrogen ions with oxygen or another oxidizing agent. Fuel cells are different from batteries in that they require a continuous source of fuel and oxygen or air to sustain the chemical reaction, whereas in a battery the chemicals present in the battery react with each other to generate an electromotive force (emf). Fuel cells can produce electricity continuously for as long as these inputs are supplied.

Fuel cells have been used in many other applications, such as for primary and backup power for commercial, industrial and residential buildings and in remote or inaccessible areas. They are also used to power fuel cell vehicles, including forklifts, automobiles, buses, boats, motorcycles and submarines.

GENERAL DESCRIPTION

The AEL-FCLL Fuel Cell Energy has been designed by Edibon in order to show how fuel cell works.

This trainer includes a stack of proton exchange membrane fuel cell (PEM) which is composed of several cells with channeled plate shape that allow the air flow through the membrane. The membrane facilitates the hydrogen flow, generating the electrons release. There are separate plates which conduct electricity, allowing that electrons flow, between each pair of cells. Moreover, solenoid valve, electronic load and protection systems are included. One important part of the AEL-FCLL is the optional Edibon Computer Control System (SCADA) for controlling the process and all parameters involved in the process.

Edibon offers the possibility of include an electrolyser to be independent of hydrogen cylinder.

The AEL-FCLL includes the following modules:

- N-FC/1K. Fuel cell of 1kW Module.
- N-EL/150. Electronic Load of 150W Module.
- N-MHSCSV. Metal Hydride Storage Cell Module and Solenoid Valve.

Optional SCADA software:

- AEL-FCLL/CCSOF. Computer Control + Data Acquisition + Data Management Software.

Optional learning software:

In addition, Edibon provides optional software (AEL-FCLL/ICAI) to reinforce knowledge about this field. This software is formed by:

- ECM-SOF. EDIBON Classroom Manager (Instructor Software).
- ESL-SOF. EDIBON Student Labsoft (Student Software).

The application AEL-FCLL is mounted on the following racks:

- N-RACK-M.(2 units).

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

With this unit there are several options and possibilities:

- Main items: 1, 3 and 4.
- Optional items: 2, 5, 6 and 7.

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

① **AEL-FCLL Unit.**

The trainer includes the following modules:

- **N-FC/1K. Fuel cell of 1kW Module.**
 Fuel Cell Stack.
 Power: 1000 W.
 Fan.
 DC converter.
- **N-EL/150. Electronic Load of 150W Module.**
 Maximum Power: 150 W.
 Voltage: 1...24 V.
 Maximum Current: 5 A.
 ON/OFF Switch.
- **N-MHSCSV. Metal Hydride Storage Cell Module and Solenoid Valve.**
 1-stage pressure regulator with manometer.
 Hydrogen connection line 3mm with quick action coupling system.
- **All necessary cables to realize the practical exercises are included.**

The complete unit includes as well:

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



N-FC/1K



N-EL/150



N-MHSCSV

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

The three softwares are part of the SCADA system.

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

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

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

Management, processing, comparison and storage of data.

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

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

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

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

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

④ **Manuals:**

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

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



AEL-FCLL/CCSOF

EXERCISES AND PRACTICAL POSSIBILITIES TO BE DONE WITH THE MAIN ITEMS

- 1.- Basic operations with the fuel cell
- 2.- Design and operation of a metal hydride storage cell
- 3.- Calculation of the efficiency of a PEM fuel cell.
- 4.- Study of the influence of air consumption and hydrogen consumption in the efficiency of a PEM fuel cell.
- 5.- Study of the power density of a PEM fuel cell .
- 6.- Representation of the polarization curve of a PEM fuel cell.
- 7.- Determination of the voltage and current density characteristics of a PEM fuel cell.
- 8.- Study influence of hydrogen consumption in the electric power generation.
- 9.- Study of the influence of the generated power in the efficiency of PEM a fuel cell.
- 10.- Study of the influence of the reagents' flows in the generation of electrical power.
- 11.- Study voltage conversion.
- 12.- Study sensors calibration (with optional SCADA.

Additional practical exercises with the electrolyser:

13.- Study of electrolyser.

14.- Study the standalone power supply.

Other possibilities to be done with this Unit:

15.- Many students view results simultaneously.

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

16.- The Computer Control System with SCADA allow a real industrial simulation.

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

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

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

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

REQUIRED SERVICES

- Electrical supply: three-phase, 380V./50 Hz. or 208V./60 Hz., 20 Kw.
- Computer (PC).

DIMENSIONS AND WEIGHTS

AEL-FCLL:

-Dimensions: 1600 x 550 x 2000 mm. approx.
(62.99 x 21.65 x 78.74 inches approx.)

-Weight: 100 Kg. approx.
(220 pounds approx.)

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

All these items try to give more possibilities for:

- a) Technical and Vocational Education configuration. (ICAI)
- b) Multipost Expansions options. (Mini ESN and ESN)

a) Technical and Vocational Education configuration

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

This complete software package consists of an Instructor Software (EDIBON Classroom Manager -ECM-SOF) totally integrated with the Student Software (EDIBON Student Labsoft -ESL-SOF). Both are interconnected so that the teacher knows at any moment what is the theoretical and practical knowledge of the students.

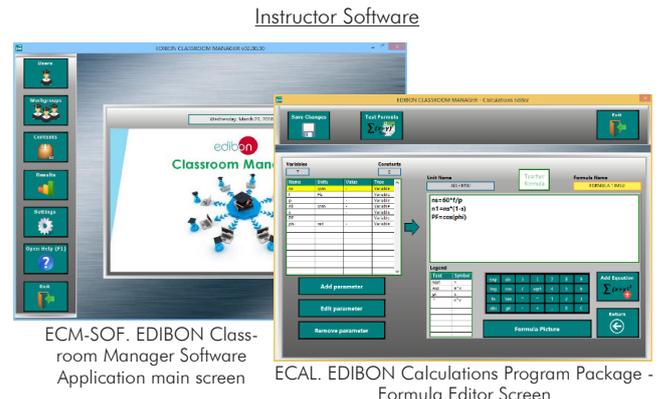
This software is optional and can be used additionally to items (1 to 4).

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

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

Innovative features:

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

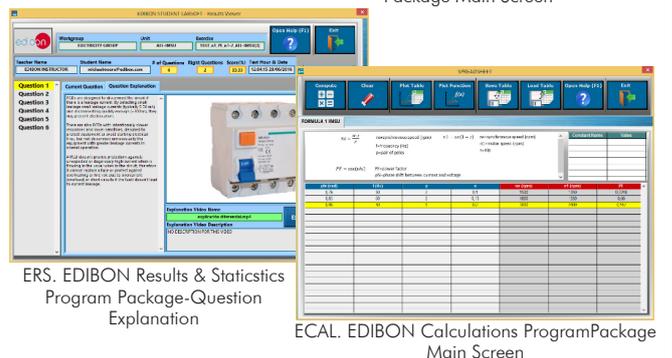
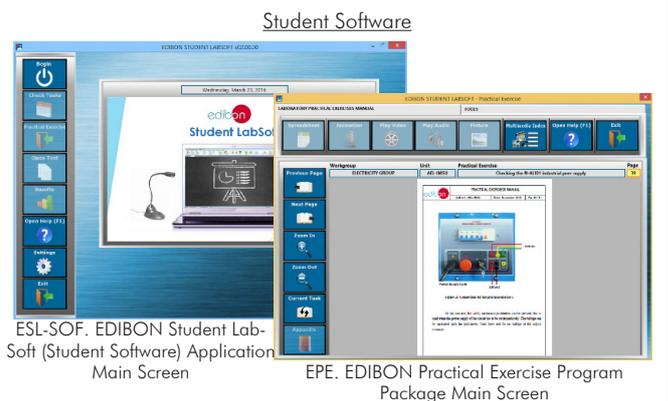


-ESL-SOF. EDIBON Student Labsoft (Student Software).

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

Innovative features:

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



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

www.edibon.com/products/catalogues/en/units/electricity/ICAI-Electricity/ICAI-Electricity.pdf

⑥ **Mini ESN. EDIBON Mini Scada-Net System.**

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

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

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

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

Main characteristics:

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

Main advantages:

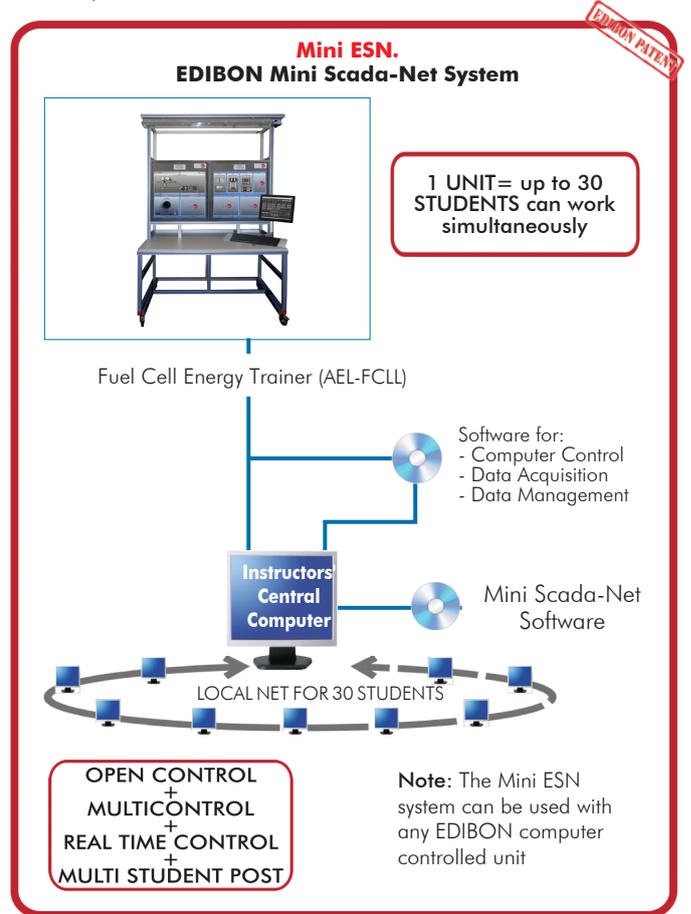
- It allows an easier and quicker understanding.
- This system allows you can save time and cost.
- Future expansions with more EDIBON Units.

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

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

⑦ **ESN. EDIBON Scada-Net System.**

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



ORDER INFORMATION

Main items (always included in the supply)

Minimum supply always includes:

- ① **Unit. AEL-FCLL. Fuel Cell Energy Trainer.**
- ③ **Cables and Accessories**, for normal operation.
- ④ **Manuals.**

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

Optional items (supplied under specific order)

- ② AEL-FCLL/CCSOF. Computer Control + Data Acquisition + Data Management Software.
 - a) Technical and Vocational configuration
- ⑤ AEL-FCLL/ICAI. Interactive Computer Aided Instruction Software System.
 - b) Multipost Expansions options
- ⑥ Mini ESN. EDIBON Mini Scada-Net System.
- ⑦ ESN. EDIBON Scada-Net System.

① AEL-FCLL. Unit.

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Compatible with the industry standards.

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- Evaluation Methods to prove your knowledge and progression.
- Test self-correction.
- Calculations computing and plotting.
- Equation System Solver Engine.
- User Monitoring Learning & Printable Reports.
- Multimedia-Supported auxiliary resources.

b) Multipost Expansions options

⑥ Mini ESN. EDIBON Mini Scada-Net System.

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

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

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

Main characteristics:

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

Main advantages:

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

The system basically will consist of:

This system is used with a Computer Controlled Unit.

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

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

REPRESENTATIVE



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