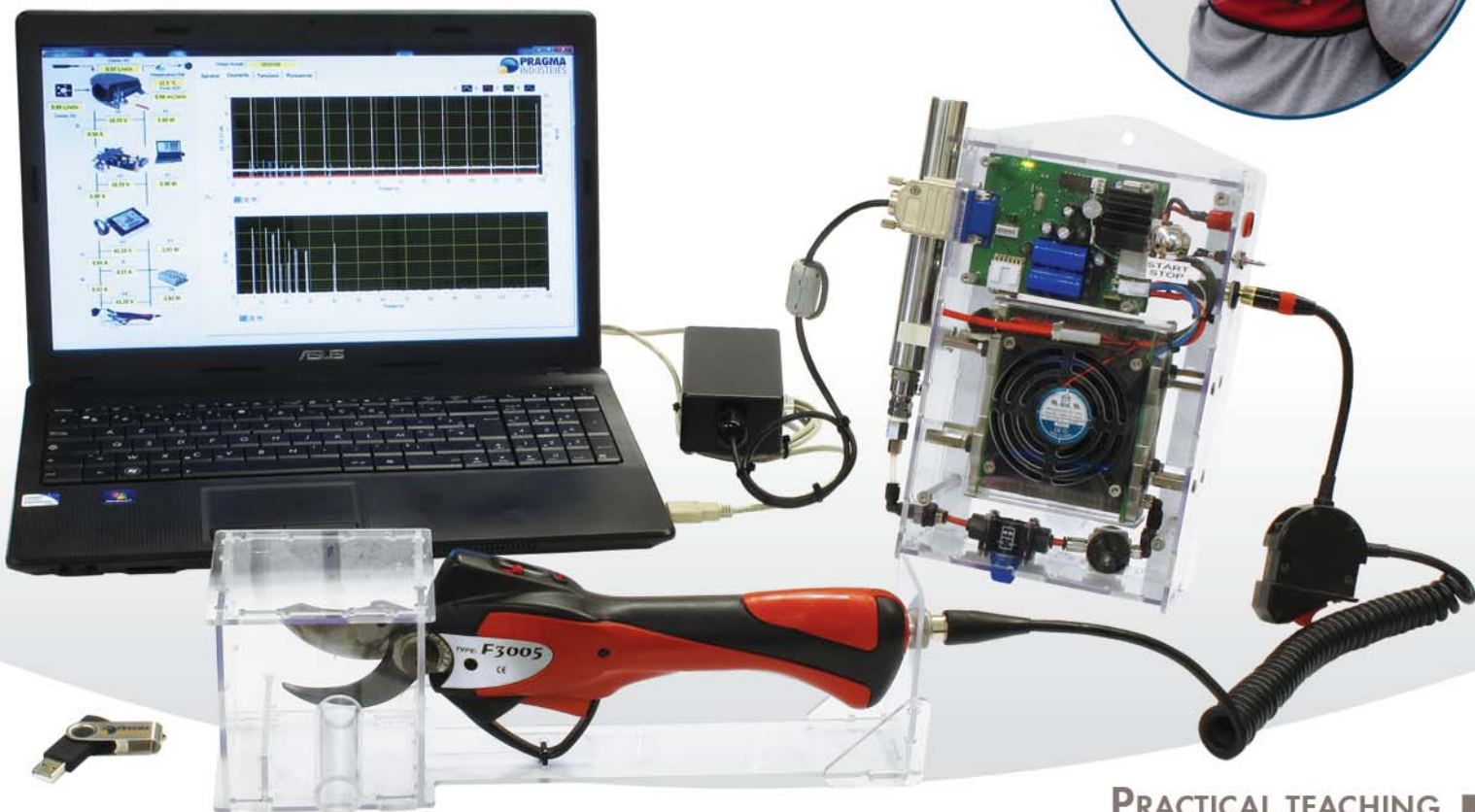


EXPERIMENTAL SYSTEM

FUEL CELL POWER TOOL for EDUCATION and PROJECTS



Fuel cell powered pruning shear

The "power tool" pack integrates all the components required to operate the electric pruning shear autonomously from the fuel cell without any other power source but hydrogen.

The power generator relies on a fuel cell/super capacitors hybrid architecture to supply all the power needed by the cutter while insuring endurance and high cutting frequency.

The pruning shear, requiring 670W of power on a strong cut, takes advantage of the hybrid architecture to operate from a fuel cell of only 50W. The pruning shear, usually powered by conventional belt-carried batteries, is a common tool in vineyards and professional gardening.

The whole pack is designed to fit education projects on fuel cells. The pruning shear and power electronics module are protected with suitable clear casing to prevent any hazardous operation.

All the components are equipped with sensors (current, voltage, temperature) and are connected to a signal converter module for PC data logging.

The Labview™ and Matlab™ based software allows a complete modeling of the system to understand the energy transfer, efficiencies, power and energy parameters. It is also possible to simulate other applications than the pruning shear.

PRACTICAL TEACHING

COMPLETE DIDACTIC SYSTEM

REAL LIFE APPLICATION



PRAGMA INDUSTRIES

PRAGMA-INDUSTRIES.COM

FUEL CELL POWERED PRUNING SHEAR

Item. PPT101

- Complete fuel cell system with H₂ storage
- Designed for practical, hands-on teaching
- Application-based course

Fields: electrochemistry and energy courses, fuel cells and FC systems engineering, electromechanics, renewable energy
Applications: classroom instruction, hands-on learning, advanced classes, vocational/professional training, R&D projects

The Power Tool package is particularly suitable for teachers and instructors wishing to rely on a didactic system that is very close to a commercial/practical fuel cell application. Beyond the hydrogen energy education, the Power Tool pack leads to a pragmatic comparison between two energy storage techniques: conventional rechargeable batteries and fuel cells (weight, operation range, durability, form factor, embedding factor, usage mode....).

The included software delivers real-time operating parameters and leads the user through an analytical work to compare the theoretical model to the practical case. The numerical model and physical fuel cell can be used with other applications than the pruner, for example in a student project (RC vehicle integration, electric bike range extender, PV coupling, battery charger...).

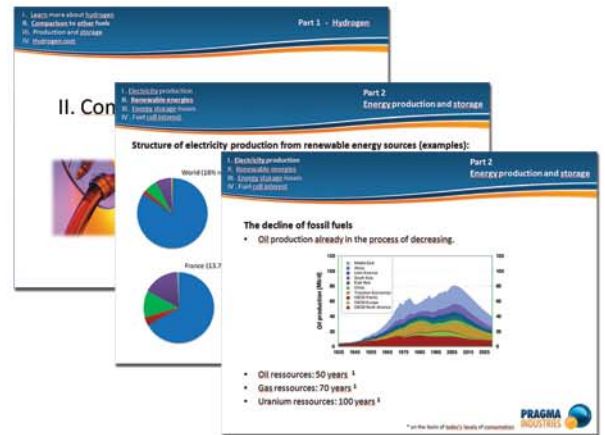


List of experiments

- Understanding how a fuel cell works
- Analyzing an hybrid electric architecture fuel cell/super capacitors
- Measuring energy transfer from hydrogen tank to power tool, calculating efficiencies
- Dimensioning an hybrid system (power and energy) for a specific application
- Modeling with Matlab™
- Comparing rechargeable batteries with fuel cell system for energy storage
- Integrating the fuel cell system into other applications
- Data transfer, analog/digital conversion, sensors and signal collection
- Product design, eco-design, innovation methodology and many more possibilities...

Choose amongst a range of accessories to complete your set:

- H₂ tank fast charging kit
- Additional rechargeable hydrogen tanks

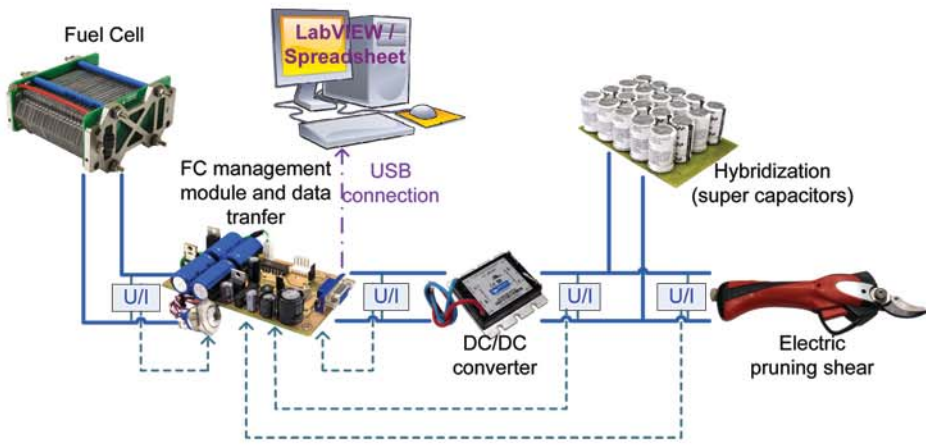


Key features

- Instrumented system based on a real professional application
- Didactic software complete data acquisition module
- Matlab and spreadsheet examples included
- Possibility to use the fuel cell with other applications (12V or 48V output)
- Safety of the low pressure hydrogen vessel (metal hydride type)
- H₂ tank fast charging (10 minutes)
- Real world application for hands-on learning
- Clear and thorough documentation on fuel cells and hydrogen for classroom course preparation
- Strong cross-coupling of studied topics

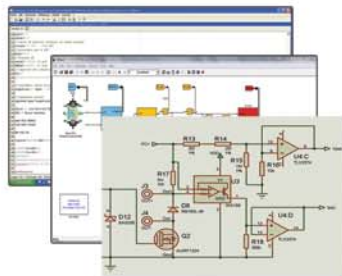
PPT101 Specifications

Fuel Cell	50W / 4,2A /12-20V
Air supply	Integrated fan
H ₂ supply	Automatic purge
Hydrogen storage	ABS metal hydrides Low pressure
H ₂ storage capacity	20 standard liters
Storage lifetime	> 2000 cycles charge/discharge
H ₂ pressure control	0.3 barg manufacture preset
Endurance with a single reservoir	3 to 4 hours for conventional education course work
Pruner power	670W / 14A / 48V
Hybridization	Super capacitors
Data logging	FC temperature Currents and voltages for every system block
Security	Pruning shear clear casing (with aperture for wooden sticks) Power electronics clear casing Low voltage and max temperature shut down



Package content

- 50W PEM fuel cell
- Fuel cell management electronics
- Super capacitors hybridization with DC/DC converter
- Rechargeable hydrogen storage canister
- Hydrogen pressure regulator
- System/PC data transfer module
- Electric pruning shear with casing
- System clear casing with harness gear for back mounting
- Fuel cell spare parts for training
- Real time data logging and display software (PC)
- Examples with Matlab and spreadsheet
- Fuel Cells and Hydrogen course (130 slides PowerPoint)
- Mechanical and electronics CAD files
- Microcontroller source code
- Experiments guidebook
- Suitcase



Training course material

The training course material supplied with the Power Tool Pack brings a multi-technologies approach in the fields of energy management, use and transformation of matter, data transfer and information processing. Functional analysis and modeling are put at the forefront of product design with numerous supports (Matlab, spreadsheet). Included software tools and libraries allow efficient power tool performance analysis depending on the operating mode like diameter of wood cut, cut frequency, full or half cycle cut. Investigation can be achieved by simulating the system with varying parameters and configurations and then confirmation by experimentation. Numerous data are fed back by the system to the user: power, currents, voltages, energy produced and consumed at several system stages, gas consumption, cell temperature...

CAD files and electronics diagrams supplied, as well as a voluntarily open architecture (open source code) offer a fantastic working environment for educational projects, valorizing design and innovation methodologies. Students will be able to produce virtual and real fuel cell powered prototypes.



Fuel cell

Fuel cell controller board

Super capacitors bank

DC/DC converter

Hydrogen tank

Shut off valve and pressure reducer



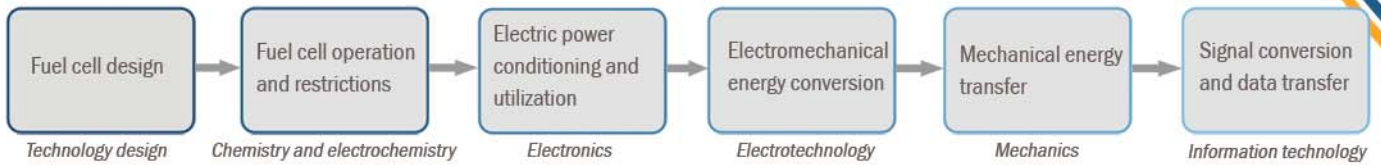
More information about our products range on our website:
www.pragma-industries.com

DIDATIC SCHEME

System analysis

From the fuel cell design to the pruning shear operation and data logging...

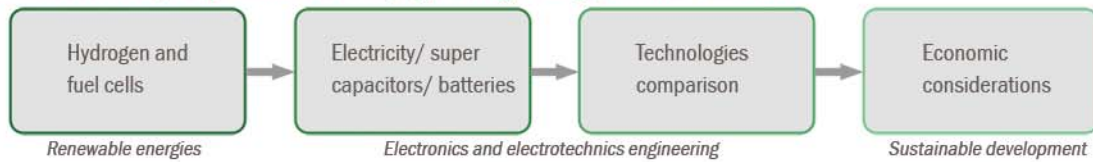
Understanding...



Hydrogen energy

Hydrogen paradigm demonstration, comparison with battery-type energy storage, materials selection...

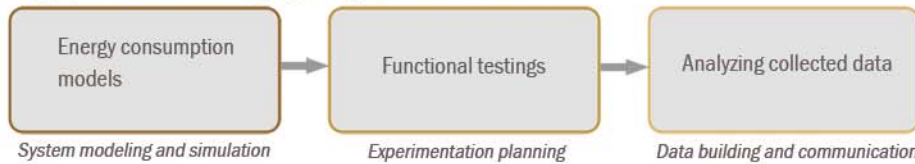
Analyzing...



Energy expenditure performance analysis

Distinguishing power and energy, system dimensioning regarding specific needs...

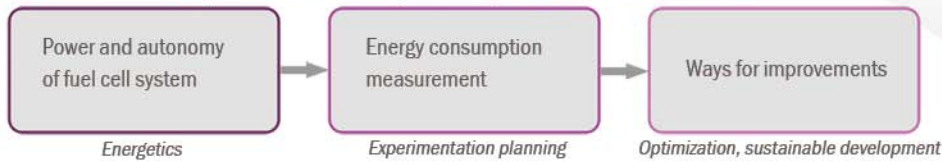
Testing...



System optimization

Study the interest of hybrid system architecture, possible evolutions, possibility to do without capacitors...

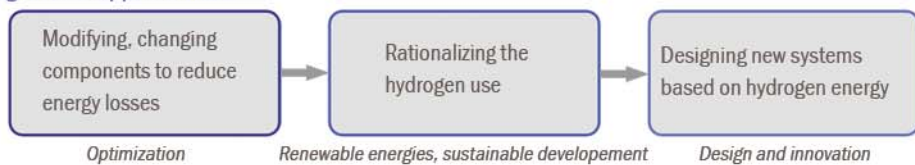
Improving...



Technology projects

System improving, designing for new applications...

Designing...



Included slide show presentation content:

- **Hydrogen** - physics and chemistry, comparison with other fuels, production techniques;
- **Energy production and storage** - electricity production, renewable energies, the energy storage problem, fuel cells advantages and drawbacks;
- **Fuel cells** - operating principles, fuel cells families, PEM fuel cells detailed, influence of operating/ designing parameters and optimization;
- **Fuel cells applications** - application fields, batteries, hybrid architectures, application examples and markets;
- **Eco-design, Energy efficiency and sustainable development** - construction materials used, energy efficiency explained, energy and greenhouse gases emission, energy efficiency quantification (applied to power tools applications).



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