Hydrogen based Uninterruptible Power Supply

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"Hydrogen based Electrical energy system for Local Power Storage (HELPS)"

OUTLINE OF THE PRESENTATION

- System description
- Hydrogen generation section
- Gas storage section
- Fuel Cell
- Power Electronics
- Results and Discussion
- Conclusions

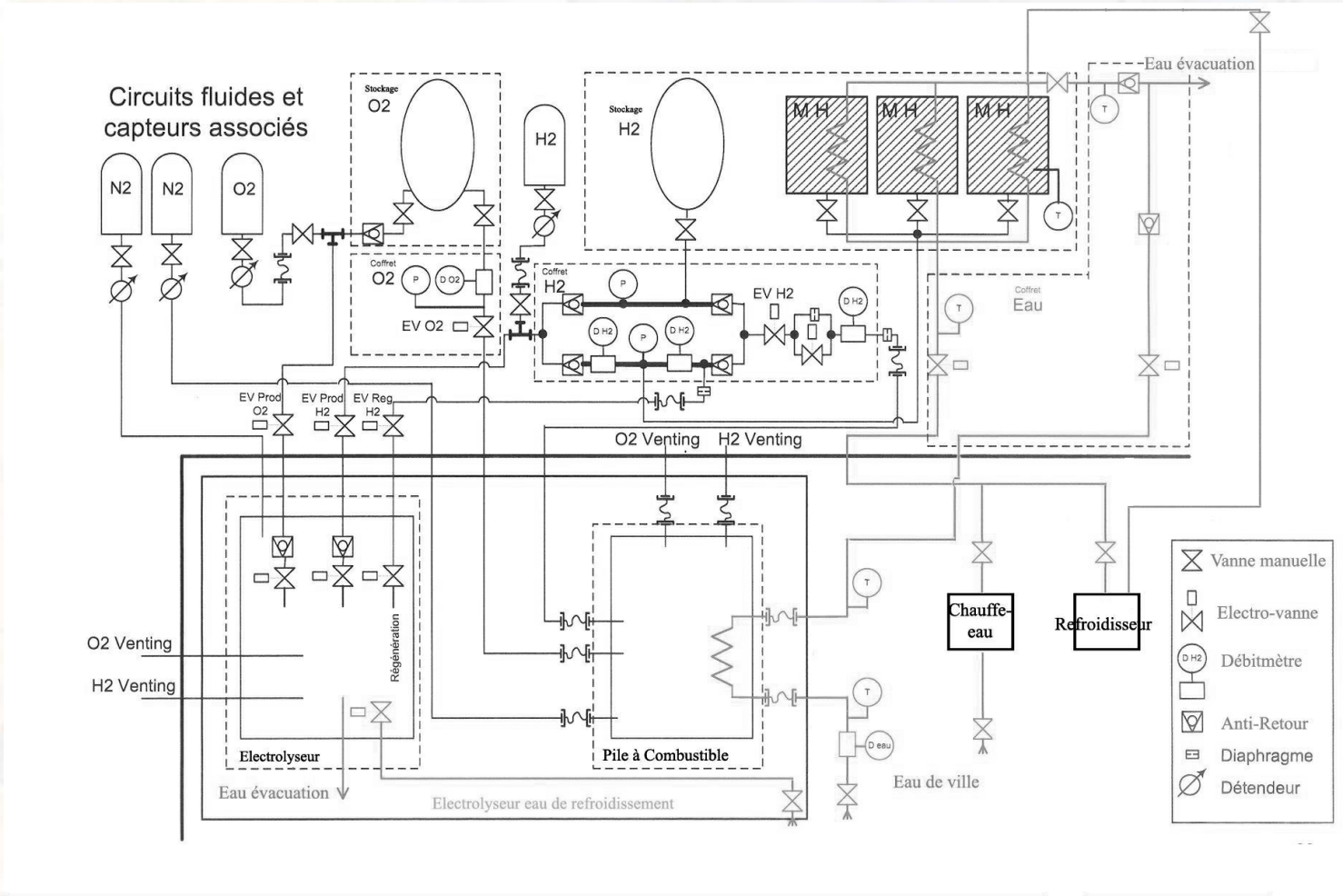
SYSTEM DESCRIPTION (I)

Uninterrupted Power Supply

- 5 kW power supply for maximum 5 hours

• water electrolyser	0.6 Nm^3/h H_2
• hydrogen storage	21 Nm^3 H_2
• oxygen storage	11 Nm^3 O_2
• PEM fuel cell	5 kW
• power electronics	
• automatic control	

SYSTEM DESCRIPTION (II)



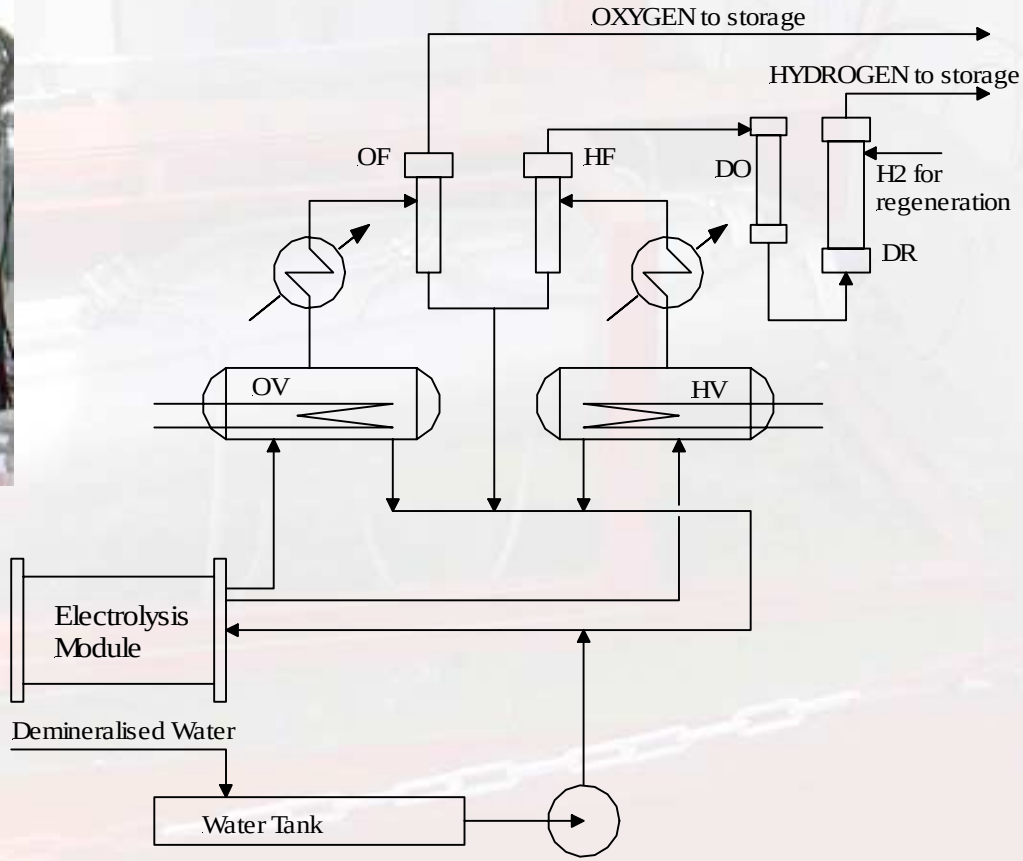
SYSTEM DESCRIPTION (III)

HYDROGEN GENERATION (I)

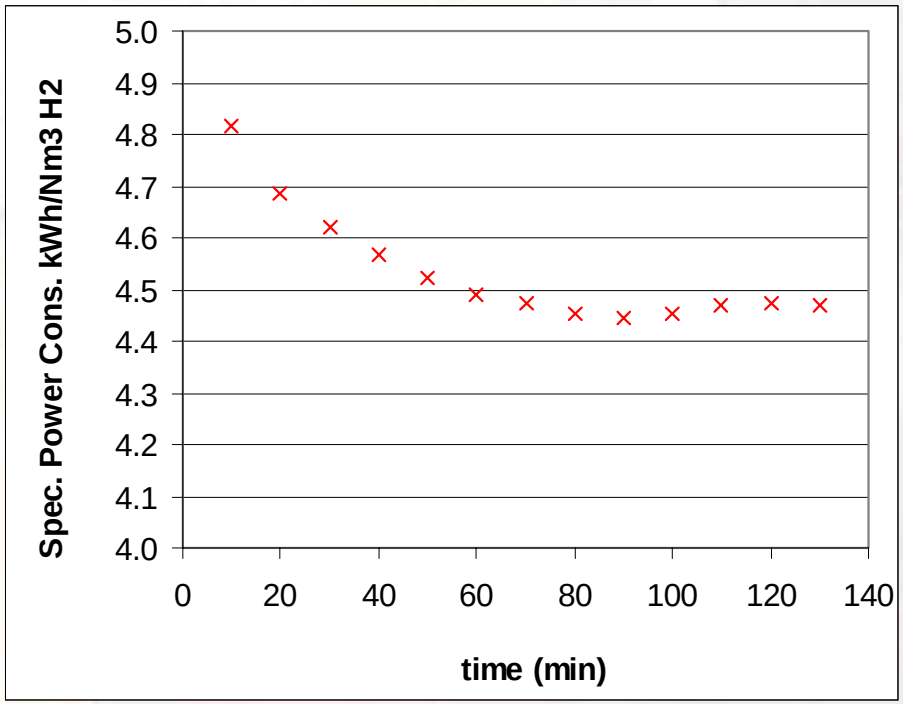
- Advanced, pressurised, alkaline water electrolyser

Manufacturer: Casale Chemicals, Switzerland
Capacity: 0.05 kg/h (0.6 Nm^3/h) H_2
Pressure: 15 bar (g)
Hydrogen purity 99.98% v. (after purification)
< 10 ppm O_2
atm. Dew point – 40 ^oC
Oxygen purity: 99.6% v.
Specific power consumption:
4.5 – 5.2 kWh/Nm^3 H_2 (at 80^oC / 30^oC)

HYDROGEN GENERATION (II)



HYDROGEN GENERATION (III)



GAS STORAGE - HYDROGEN

- Metal hydride tanks
  - Manufacturer: Labtech SA, Bulgaria
  - Alloy: $LaMm_{1-x}Ce_xNi_5$
  - Storage capacity: 21 Nm^3 H_2
  - H_2 flow to PEMFC: 4.1 Nm^3/h H_2
  - H_2 pressure to PEMFC : 3 bar (g)
  - Specific storage capacity: 0.6 %w.

- Conventional pressurised tank
  - Volume: 0.06 m^3
  - Storage capacity: 1 Nm^3 H_2

GAS STORAGE - OXYGEN

- High pressure, 18-cylinder stack

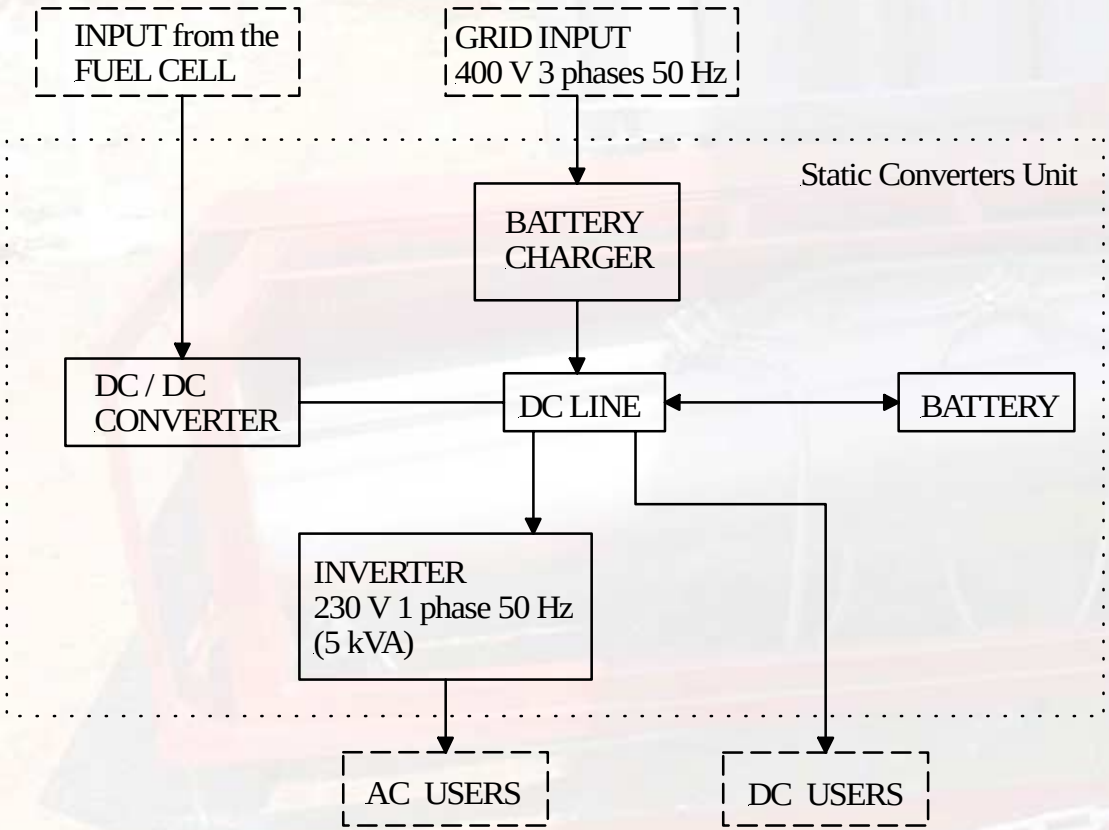
Volume: 0.9 m^3
Capacity: 11 Nm^3 H_2

FUEL CELL

- Proton Exchange Membrane fuel cell

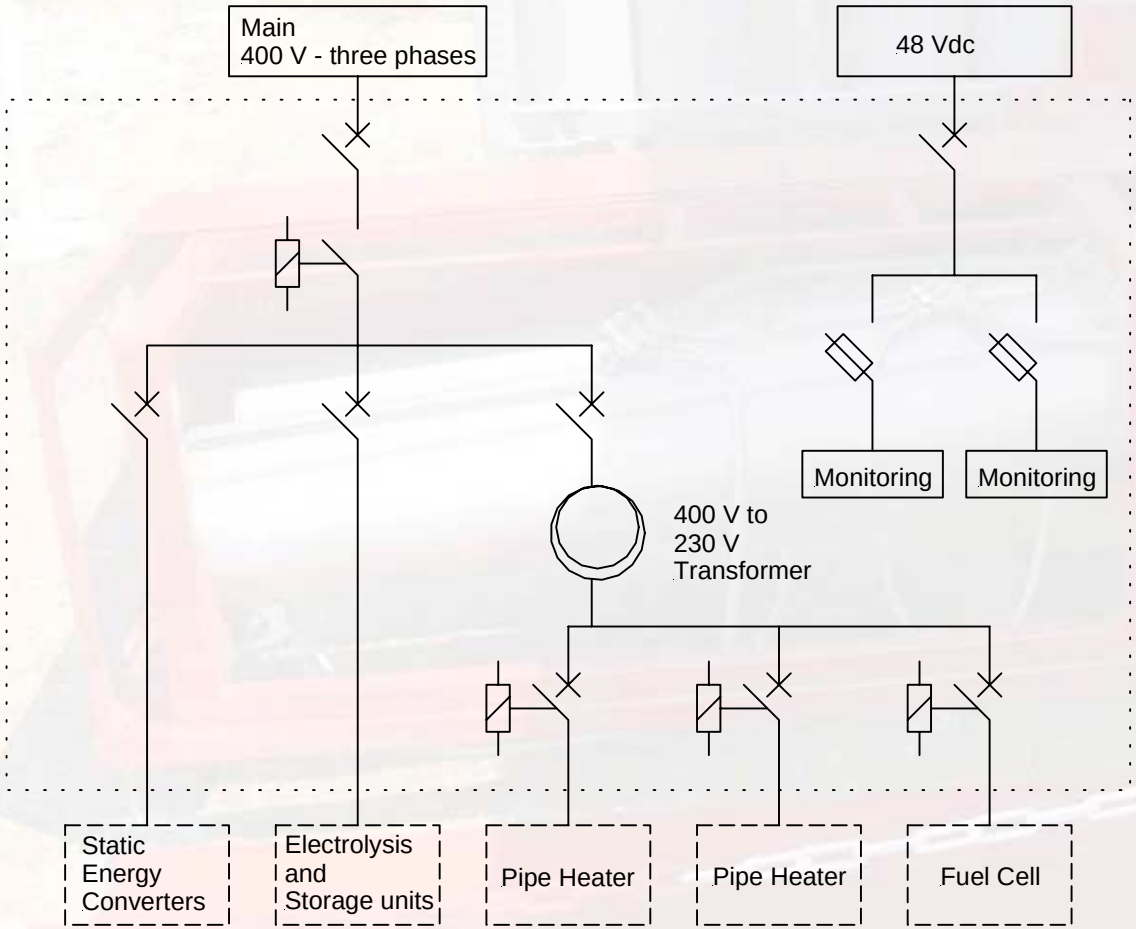
Manufacturer:	Helion (Technicatome)
Operation:	hydrogen/oxygen, dead-end
Electrical power output:	5 kW
Hydrogen input at full power:	4.1 Nm^3/h H_2
Operating pressure:	2 bar (g)

POWER ELECTRONICS (I)



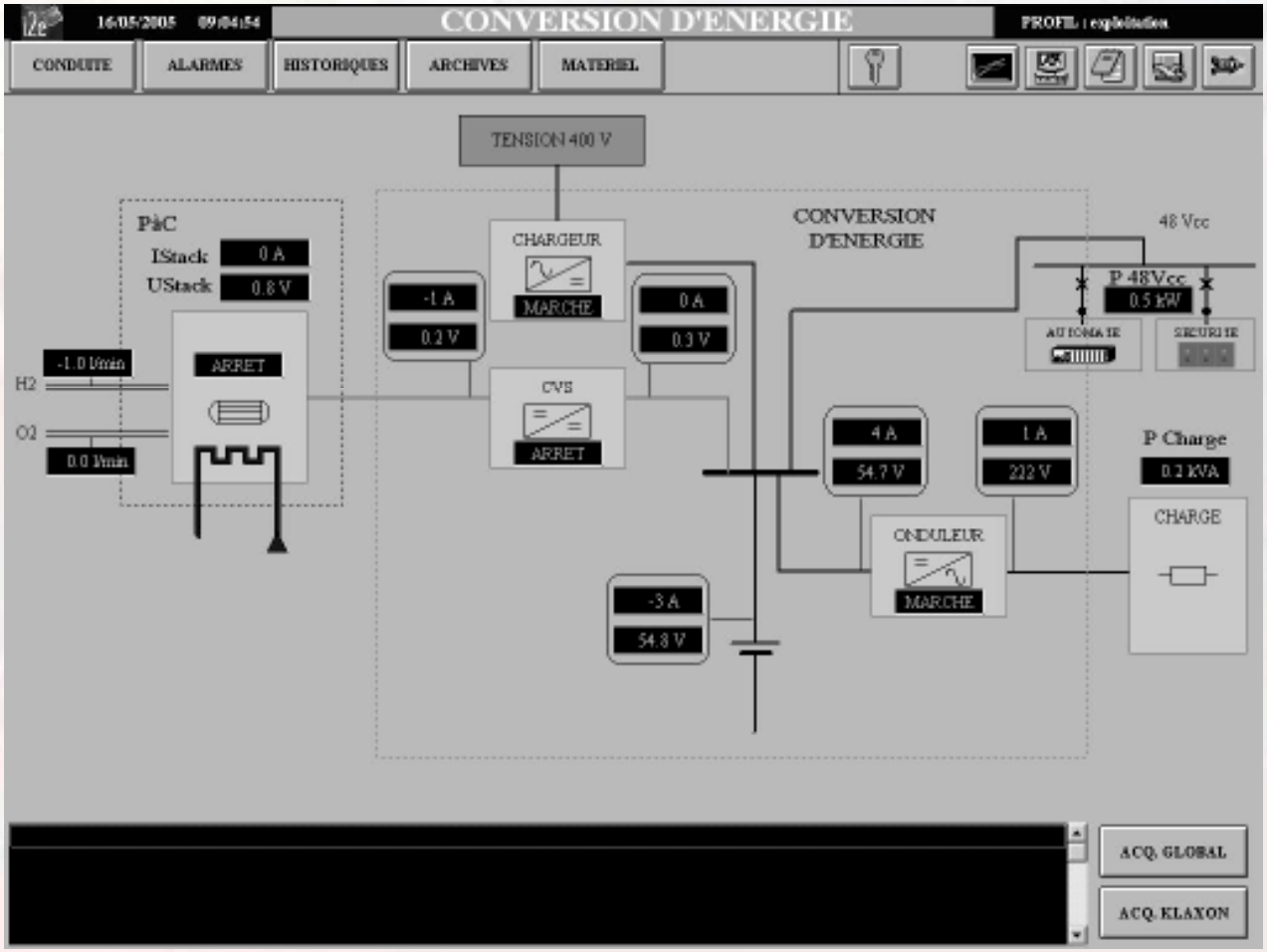
- Static converters

POWER ELECTRONICS (II)

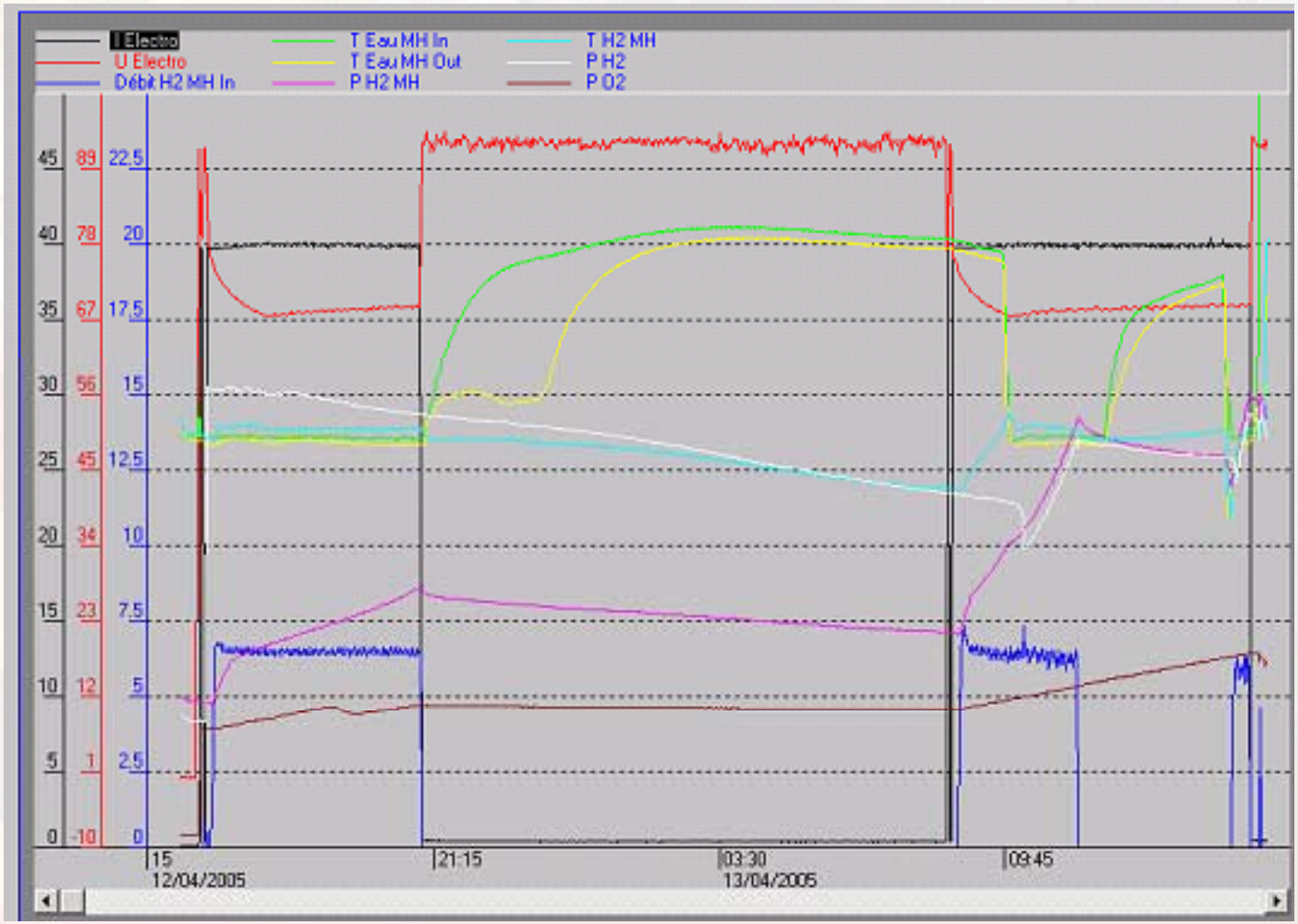


- Switch board & Monitoring unit

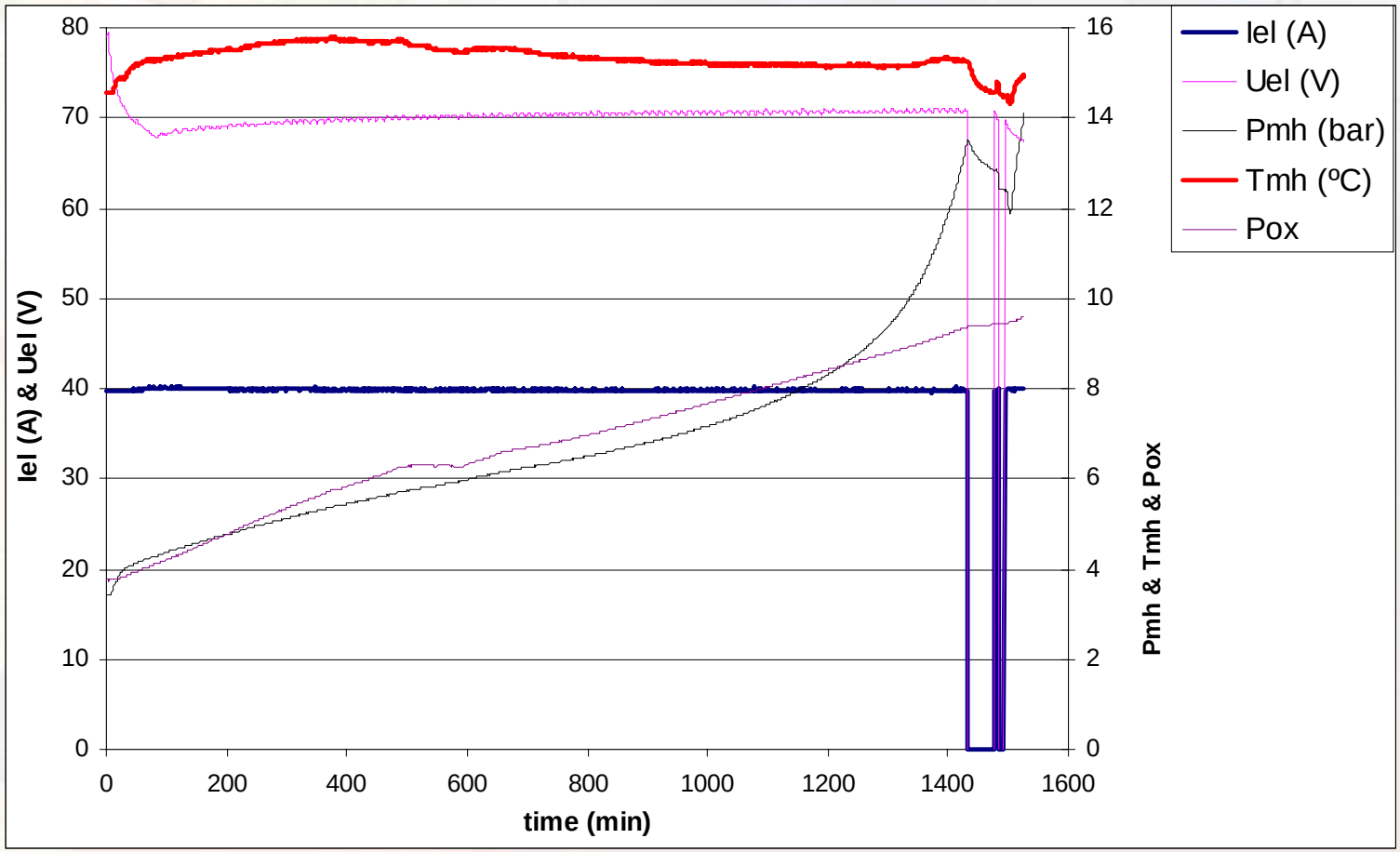
POWER ELECTRONICS (III)



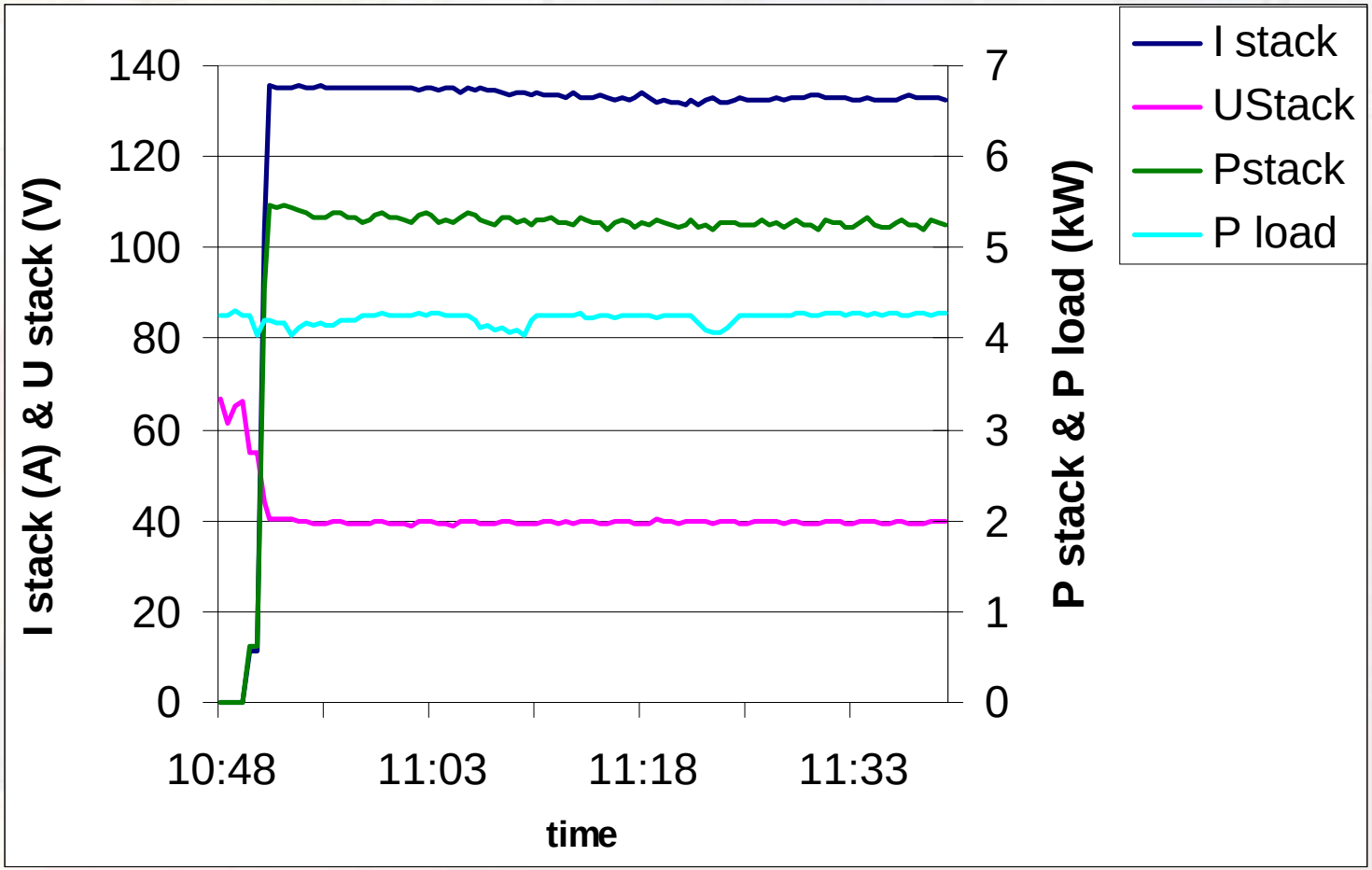
RESULTS AND DISCUSSION (I)



RESULTS AND DISCUSSION (II)



RESULTS AND DISCUSSION (III)



RESULTS AND DISCUSSION (IV)

Overall electrical system efficiency (AC-to-AC) 26%

Electrical energy consumed by electrolyser:	94.5 kWh
Energy stored as:	21 Nm^3 H_2
Electrical energy produced by PEMFC:	25 kWh

	LHV	HHV
Energy content of 21 Nm^3 H_2	63 kWh	73.5 kWh
PEMFC electrical efficiency	40%	34%
Electrolyser efficiency	66.7%	77.8%

RESULTS AND DISCUSSION (V)

Lessons learned:

- The integration of the pressurised electrolyser with the hydrogen and oxygen storage sections is a challenge for the designer
- The state of charge of the metal hydride tanks cannot be monitored
- More studies are necessary regarding the cycling capabilities of the metal hydride tanks under real conditions.

CONCLUSIONS

- The Hydrogen based Uninterruptible Power Supply presented here is very reliable

- In one year, it has been subject to more cycles than expected during the 10-year lifetime assumed for such a system

- It is particularly suitable for high power and long autonomy applications