



## ***ARMINES - Ecole des Mines de Paris***



→ 1600 people on 4 sites : Paris, Évry, Fontainebleau, Sophia Antipolis

600 permanent staff,

1000 students (22% from abroad)

Civil engineer (120 / year) : Paris

PhD and Masters (330 /year) : On all sites

→ 19 research centres

- ✓ **52 people, as follows :**
  - 23 senior researchers
  - 8 technical et administrative people
  - 21 PhDs
  
- ✓ **Budget is 2.7 M€ of which 1.5 M€ contracts**
  
- ✓ **Research Activities at Sophia Antipolis**
  - × *Renewable energies*
  - × *Storage and conversion of energy*
  - × *Materials elaboration*
  - × *Plasma conversion*
  - × *Remote sensing*

# DG Research Activities

## Evaluation and prediction :

- solar resource
- wind resource
- load forecasting

Planning tools (SIG)

Distributed  
Generation

## Poly energy systems based on RE :

- PV/diesel
- Wind/diesel
- PV/EL/FC

Fuel cell  
Storage technologies

# ***Focuss on 2 "H<sub>2</sub>" projects***

**1 - Medium term research :**

**EPACOP**

**Smal scale FC/CHP**

**2 - Long term research :**

**PVFC Sys**

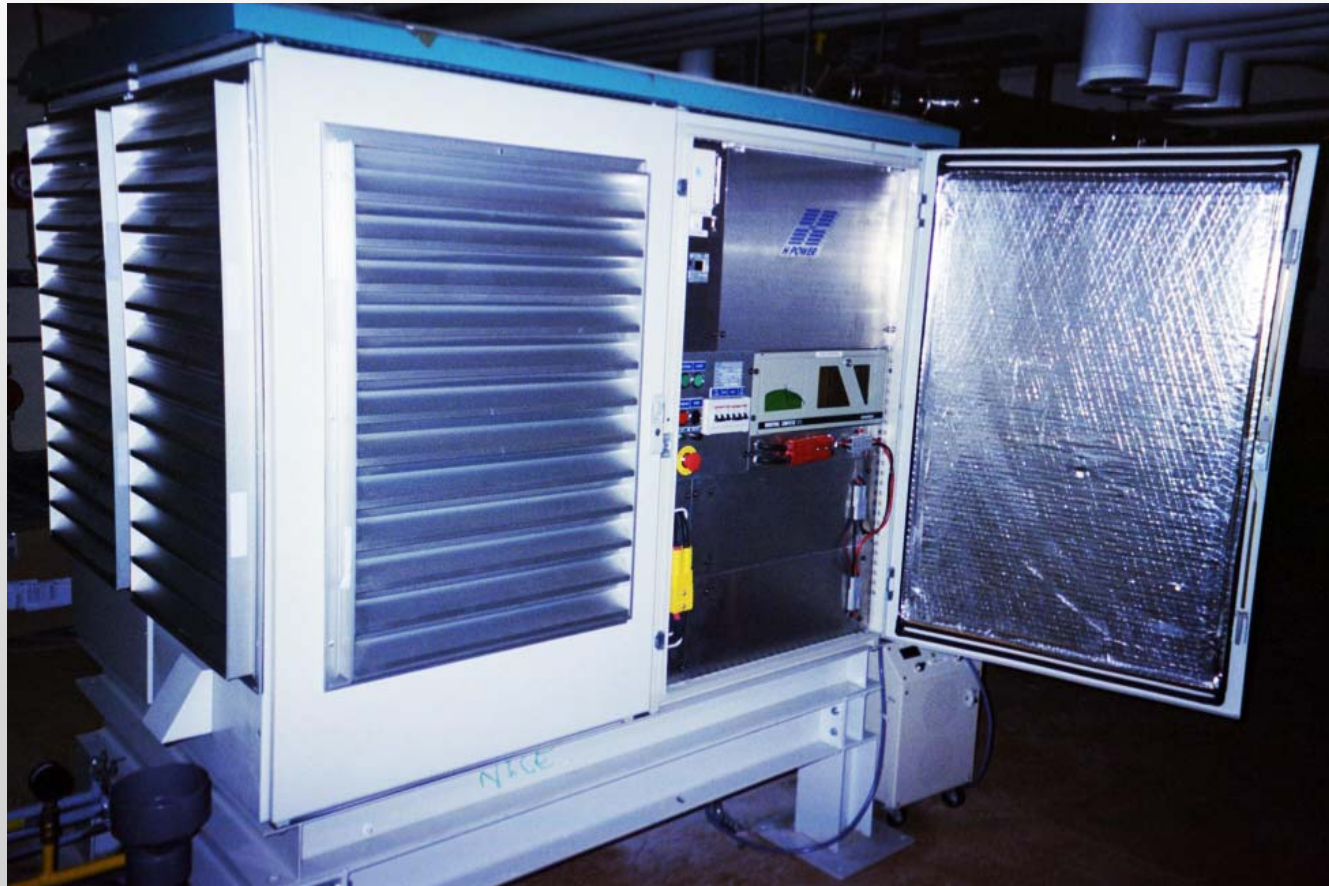
**PV/Hydroliser/FC systems**

# 1 - EPACOP

## *Fuel cell for cogeneration*

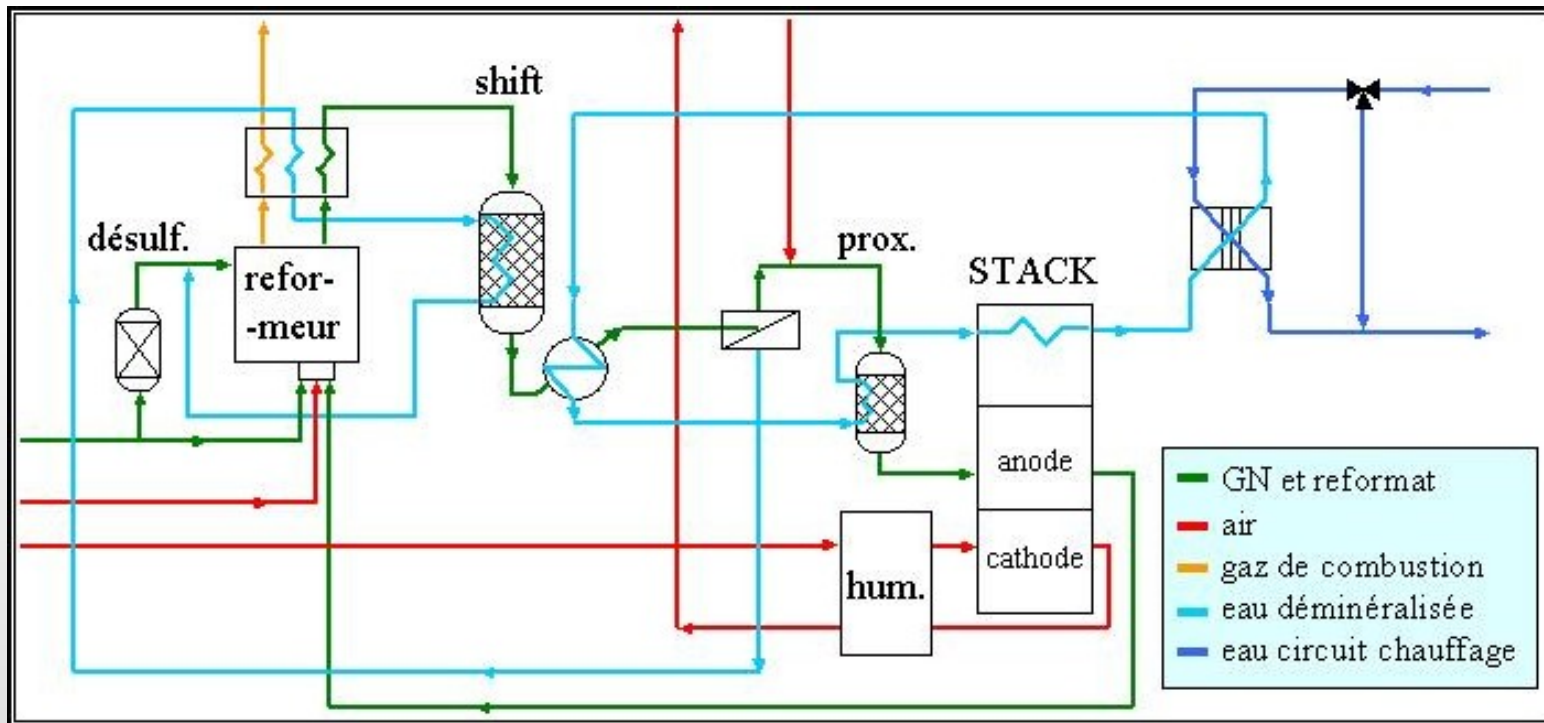


ADEME, CSTB  
CENERG, LSGC, GREEN, LEMTA



**5 demonstrations plants: Nancy, Dunkerque (2), Limoges, Sophia**

# 1 - EPACOP



## *Characteristics :*

*4 kWe*

*5.5 kWth*

*HW temp : 60 °C*

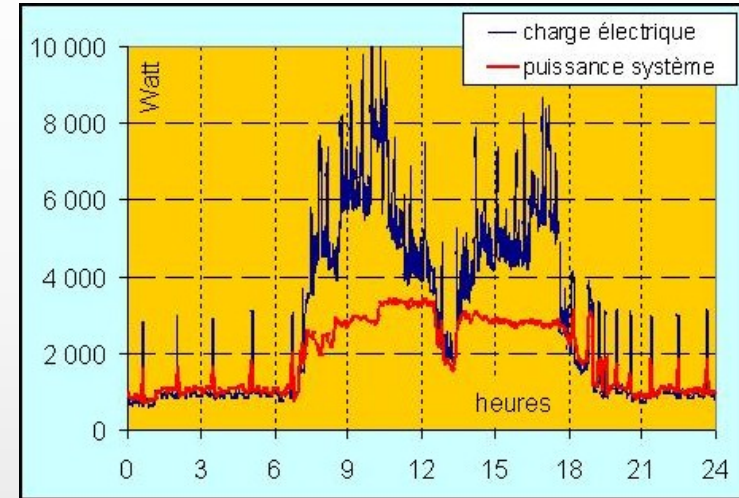
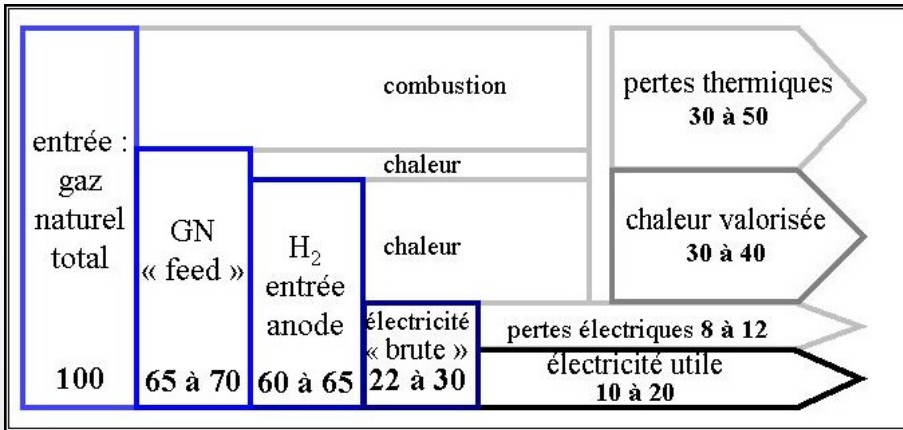
*Noise level : 70 dB*

## *Objectives :*

- Technology validation*
- Behaviour over the life cycle of the systems*
- Technical and economical evaluation*

# 1 - EPACOP

## Actual Results



## WHAT IS TO CONCLUDE ?

1. *The small FC technology is not today ready for the market*
2. *Technology will improve*
3. *Costs will decrease (when ? How much ?)*
4. *Not for the short term*

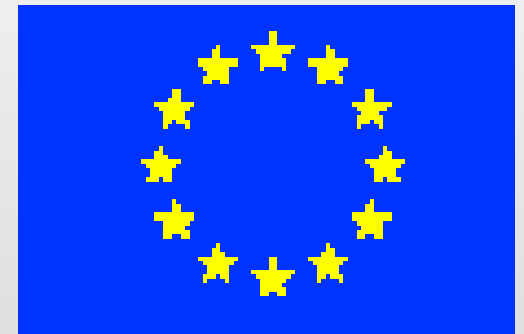
# 2 - PVFCSYS

*European Project  
(ERK-CT1999-00017)*

Two demonstrations:

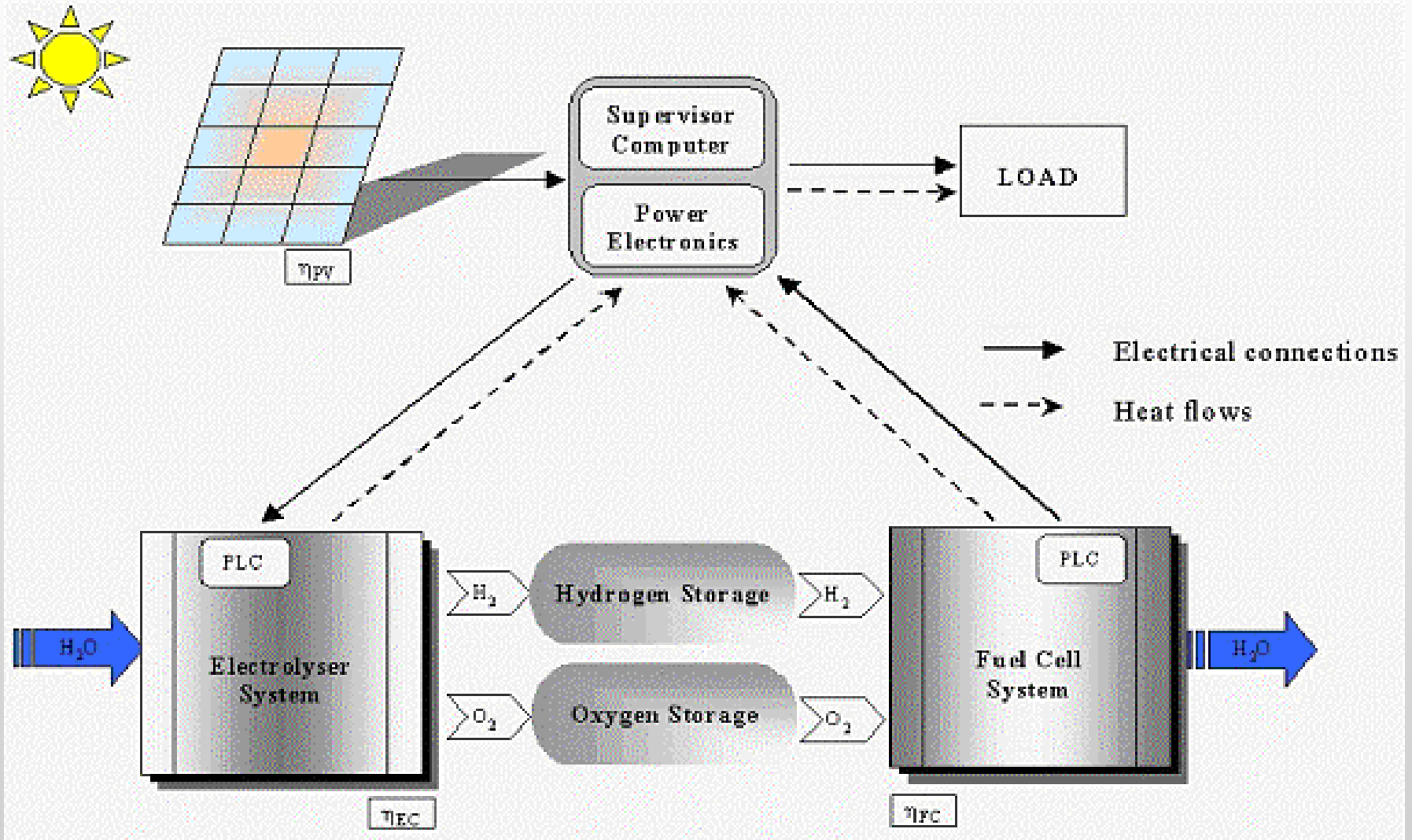
- test bench at Sophia Antipolis (CENERG, F)
- Pilot site at Agrate (ST, I)

**Web site: <http://pvfcsys.cma.fr>**



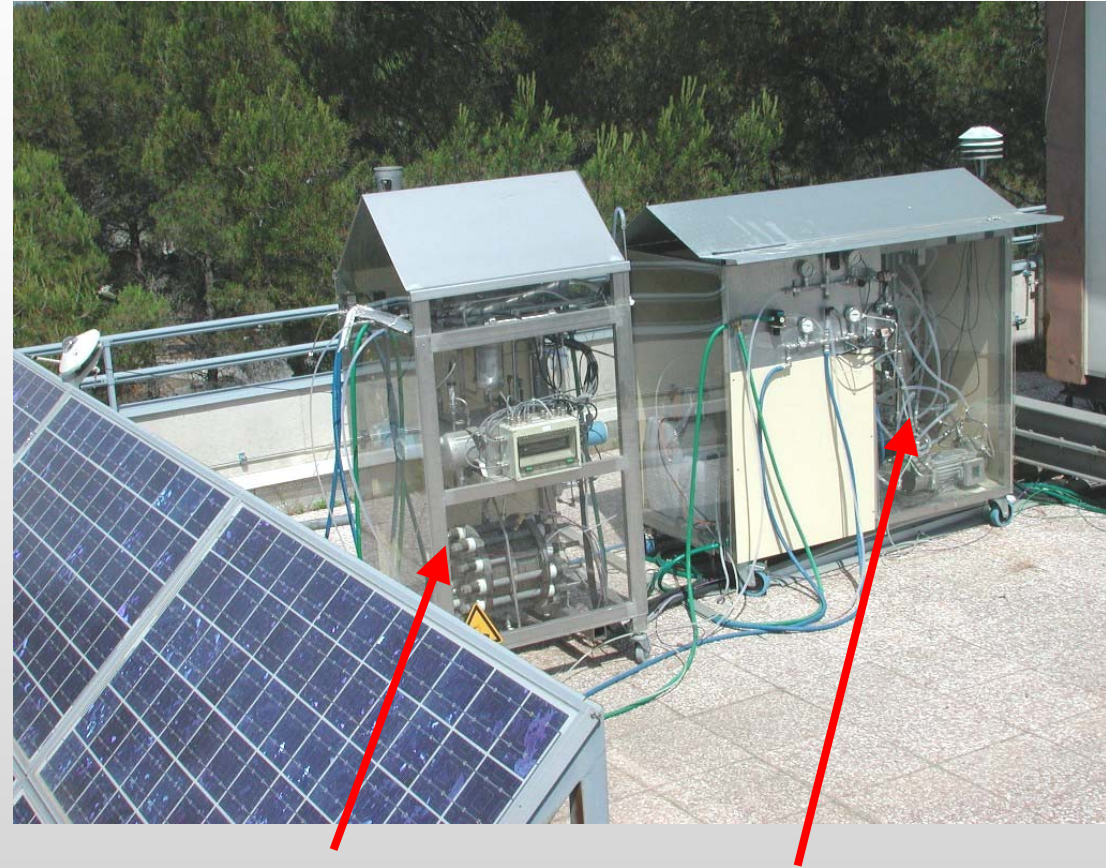
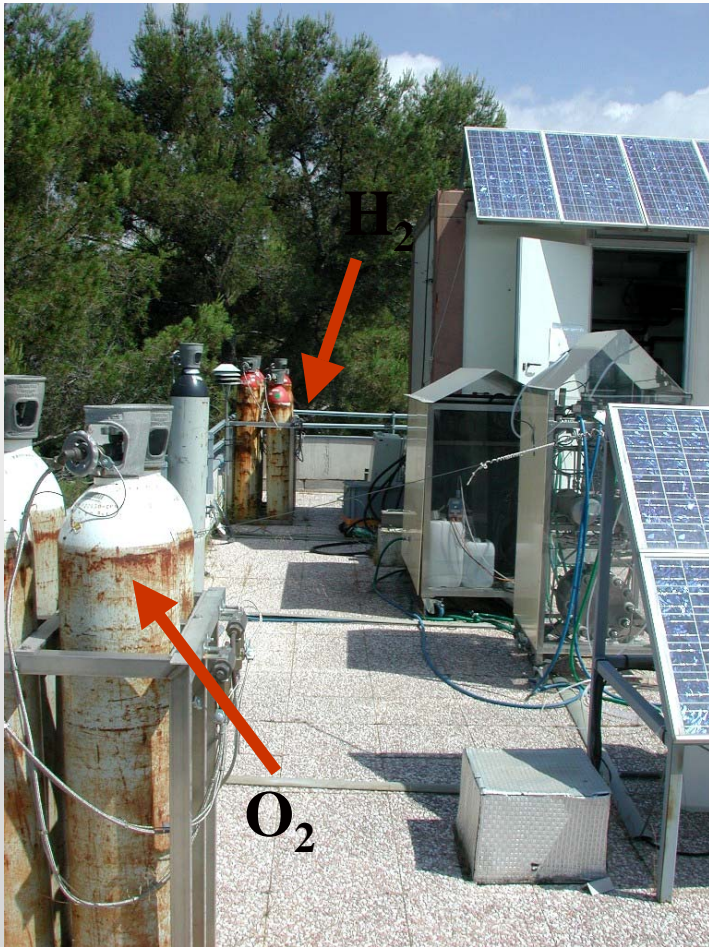
# 2 - PVFCSYS

## Principle



# 2 - PVFCSYS

## Test bench – Sophia Antipolis



400 l hydrogen at 10 bar  
200 l oxygen at 10 bar

3,6 kW alkaline EL Hydrogen systems  
4 kW PEM FC Denora

# 2 - PVFCSYS

## Pilot site – Agrate



3,6 kW PV Phowatt



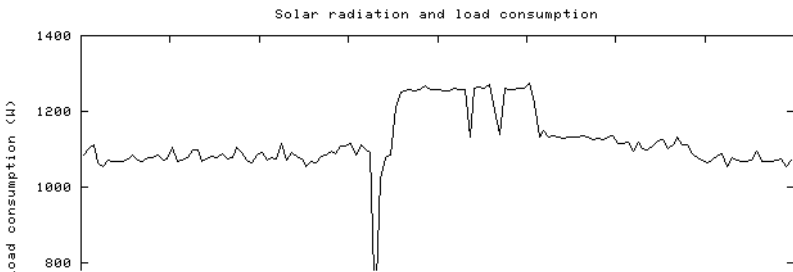
2 kW PEM FC  
Axane



4 m<sup>3</sup> Hydrogen at 10 bar  
Connected to the Hydrogen network



3,4 kW alkaline EL  
Hydrogen systems

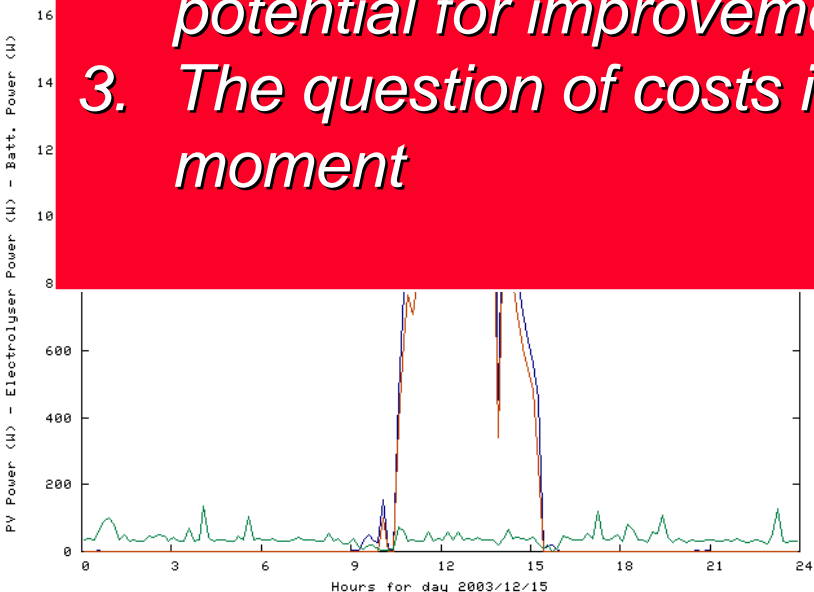


*Hourly values available each day :*

- *Irradiation*

### *WHAT IS TO CONCLUDE ?*

- 1. The two systems exist, they produce hydrogen and kWh's*
- 2. "Infinite" number of technological problems : a huge potential for improvements*
- 3. The question of costs is not to be considered at the moment*



# Other research activities : *Integration*

- ✓ **Modelling of massive distributed generation on LV lines (load flow)**
- ✓ **Decision aid tools for RE systems integration (using GIS platforms)**
- ✓ **European projects :**
  - × *Dispower*
  - × *Microgrids*
  - × *Anemos*
  - × *Respire*
  - × ...