

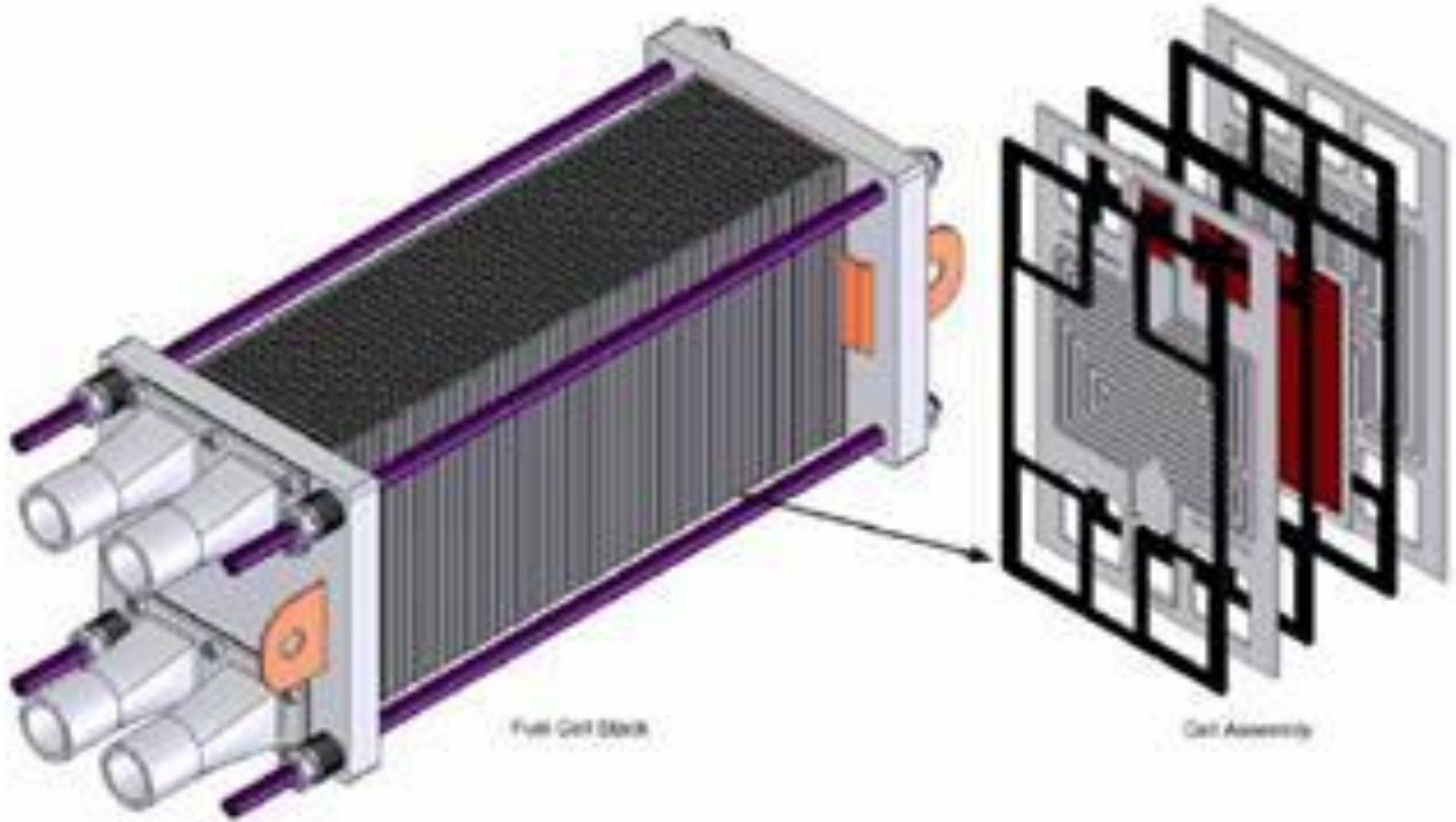
Low-cost high-efficiency electrical energy storage for renewable energy

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Goals

- **The immediate goals are to develop and characterize a 0.15 kW (0.45 kW peak) laboratory demonstrator of an advanced, low-cost electric-energy-storage system (ESS) based on our existing novel fuel-cell technology.**
- **Long-term goals are to scale it up to multi MW systems, for load buffer (a fast response system), load leveling and for solar- and wind-energy storage.**
- **It will consist of an array of 50 kW regenerative fuel cell (RFC) stacks**

A Fuel Cell Stack



Commercialization of large electric energy storage systems (ESS) based on electrochemical cells

- The market is huge, **many billions of dollars.**
- **The problem:**
- Today all electric power storage systems are too expensive for load buffer, load leveling and for large solar and wind generators (in the multi MW range).
- The major problem is the **cost of the chemicals** used for the electric energy storage.

The solution:

- The EnStorage hydrogen - tribromide (RFC) energy storage system is based on TAU patented technology and consists of low cost materials thus it will be an **enable technology** for these applications.

The hydrogen tribromide (HTB) ESS

- It is based on a novel, unique, high performance and low cost membrane (NP-PCM)
- This NP-PCM was developed at TAU and it is protected by patents.

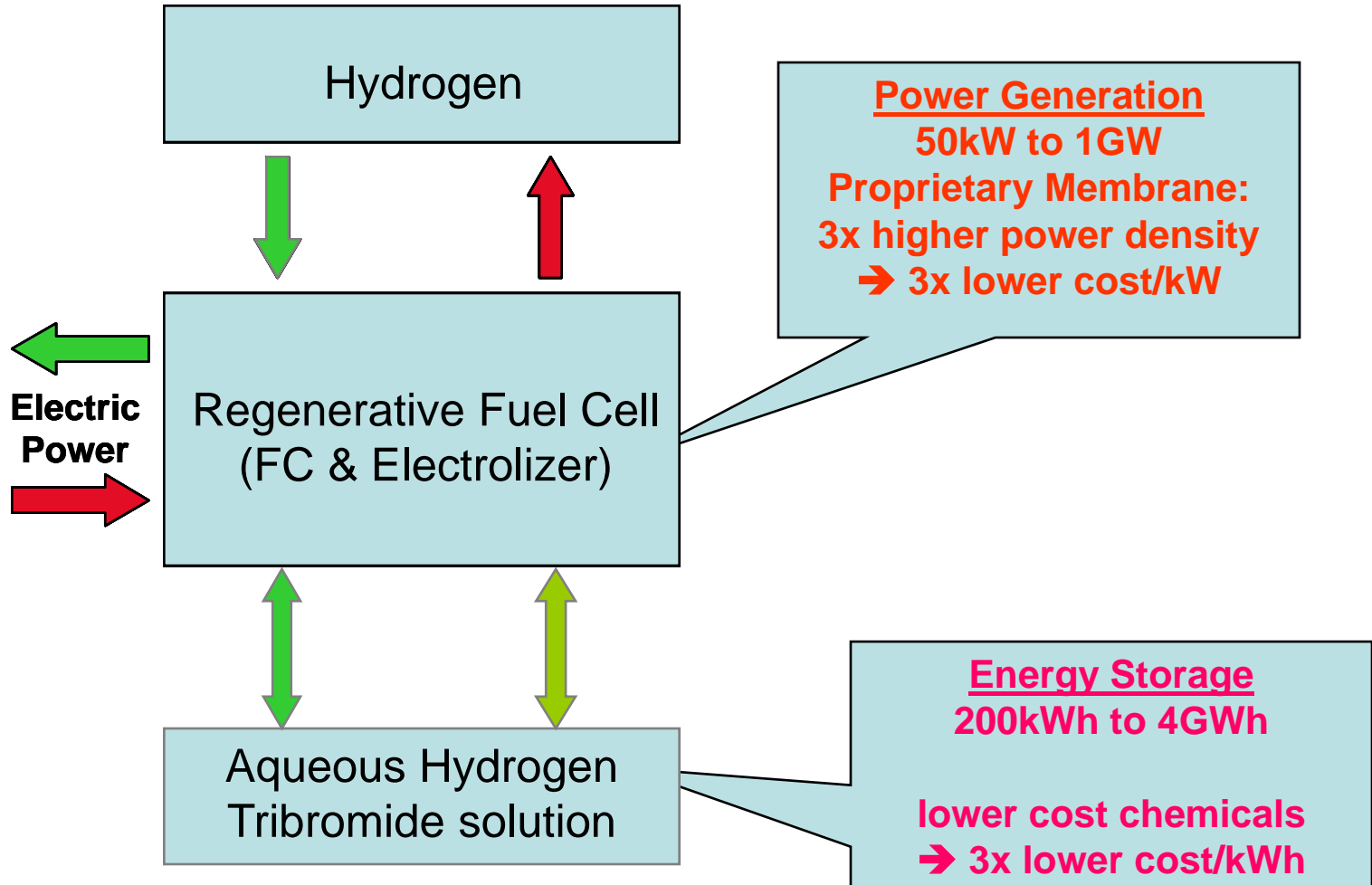
Scaling Up Production (at IPRC) of NP-PCM - Continuous Coater (15m²/h)

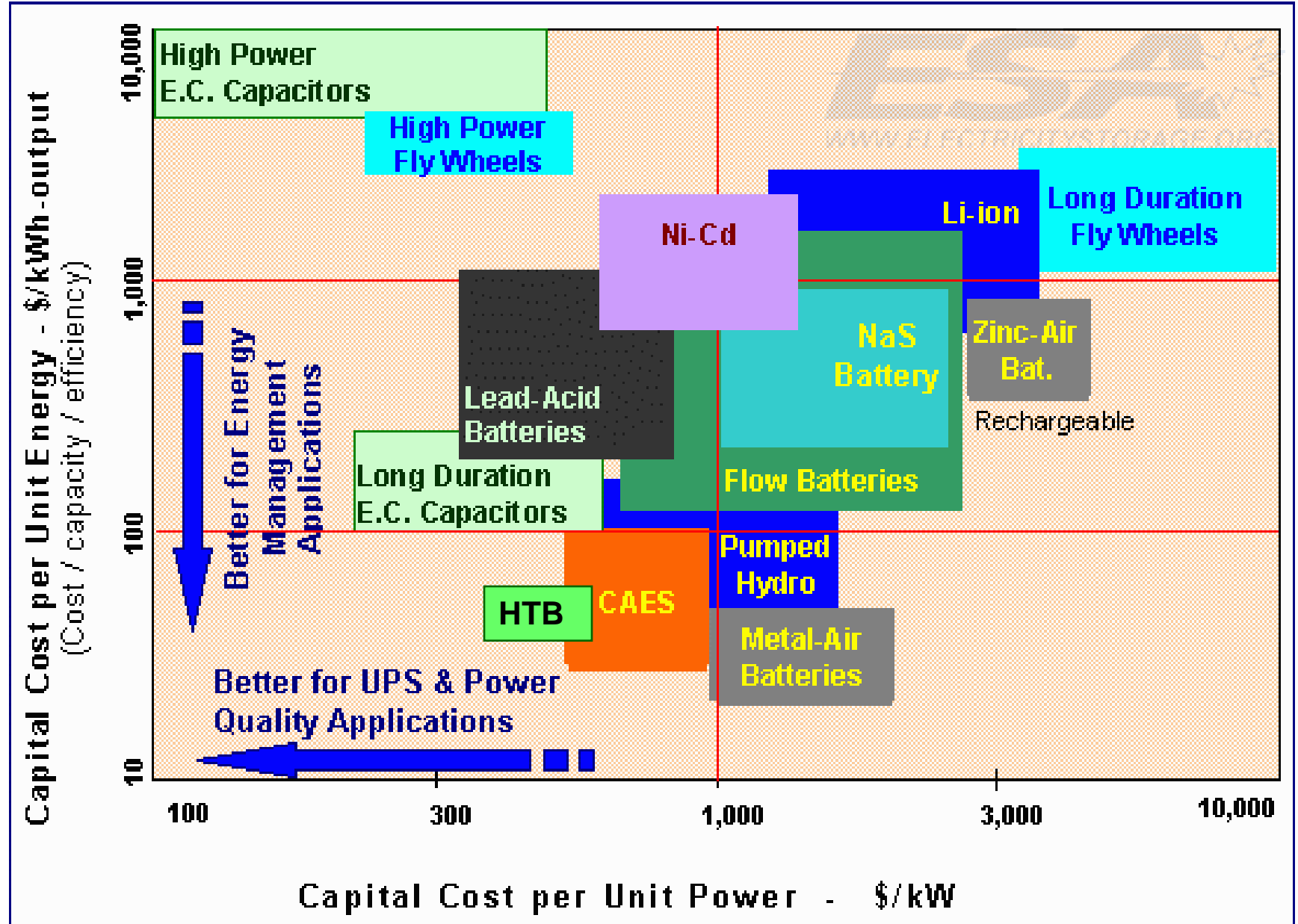


**33cm wide 2G NP-PCM
(Enough for a 50kW stack)**



EnStorage ESS system

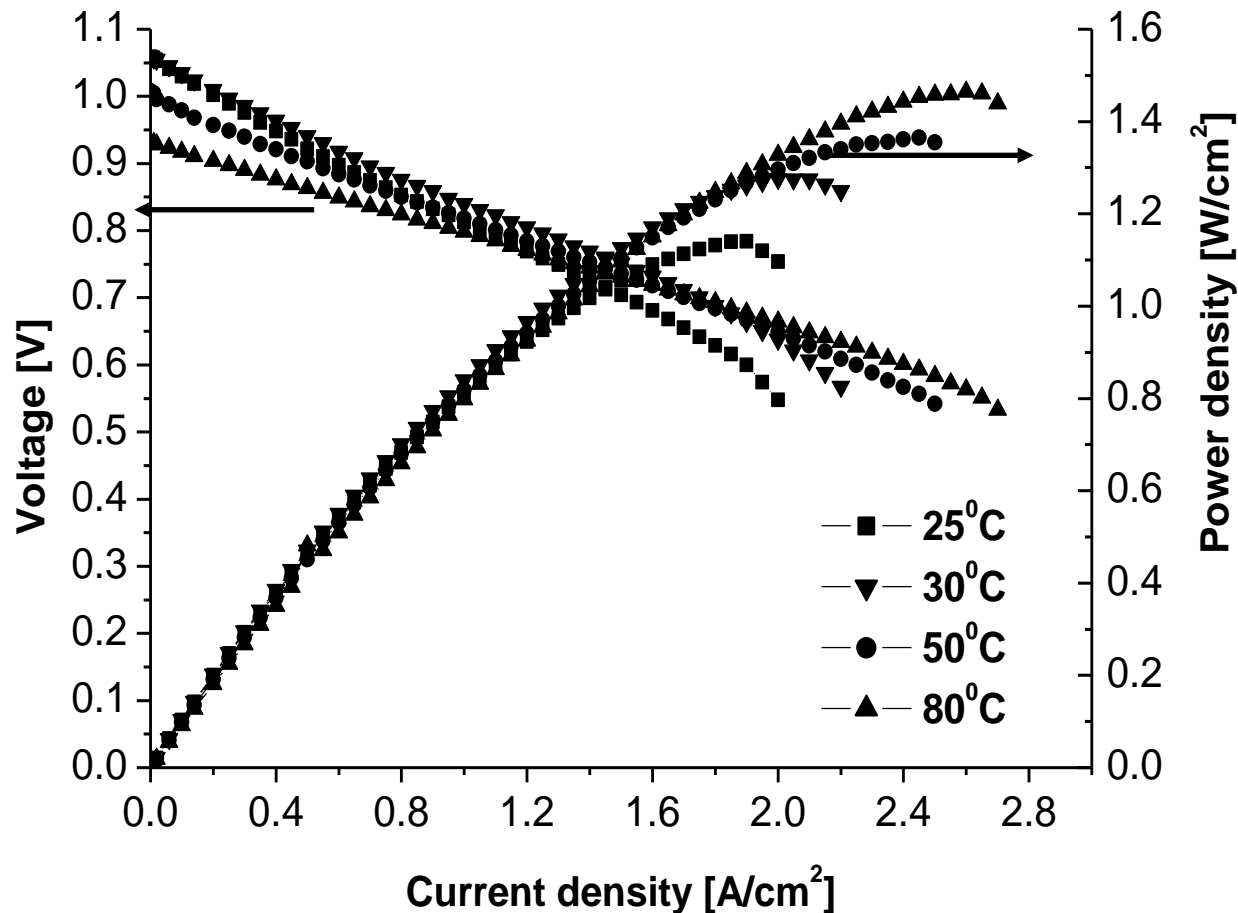




Preliminary results with HTB ESS

TAU NP-PCM based H₂/Br₂ FC - Effect of temperature on the performance .

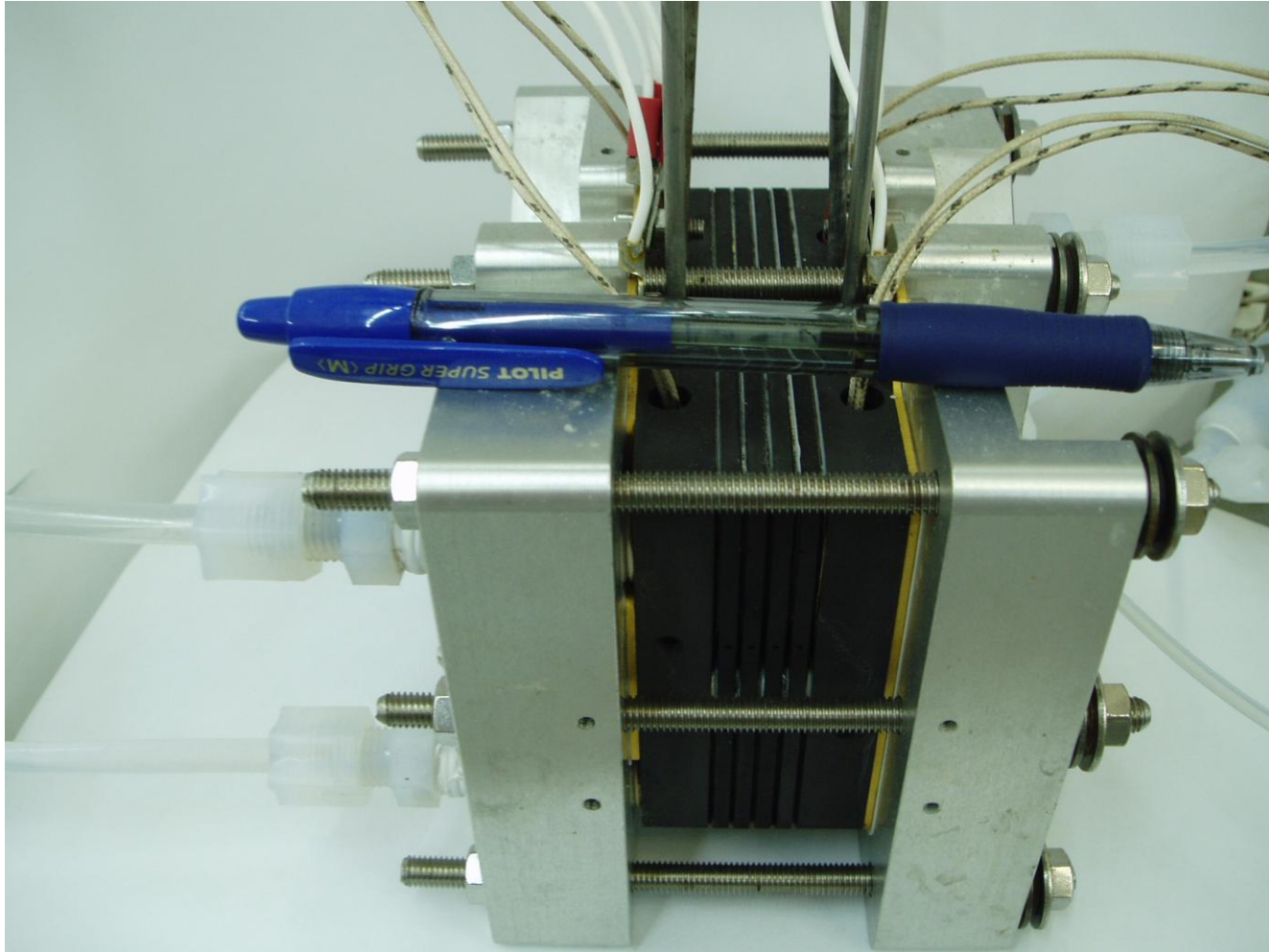
Ambient H₂ pressure, no H₂ humidification, stoich H₂ = 2; 0.6M Br₂, 1M HBr; 100 μ PVDF based NP-PCM. Anode: 1 mgPt/cm² , cathode: 1.5 mgPt/cm²



TAU Group Achievements

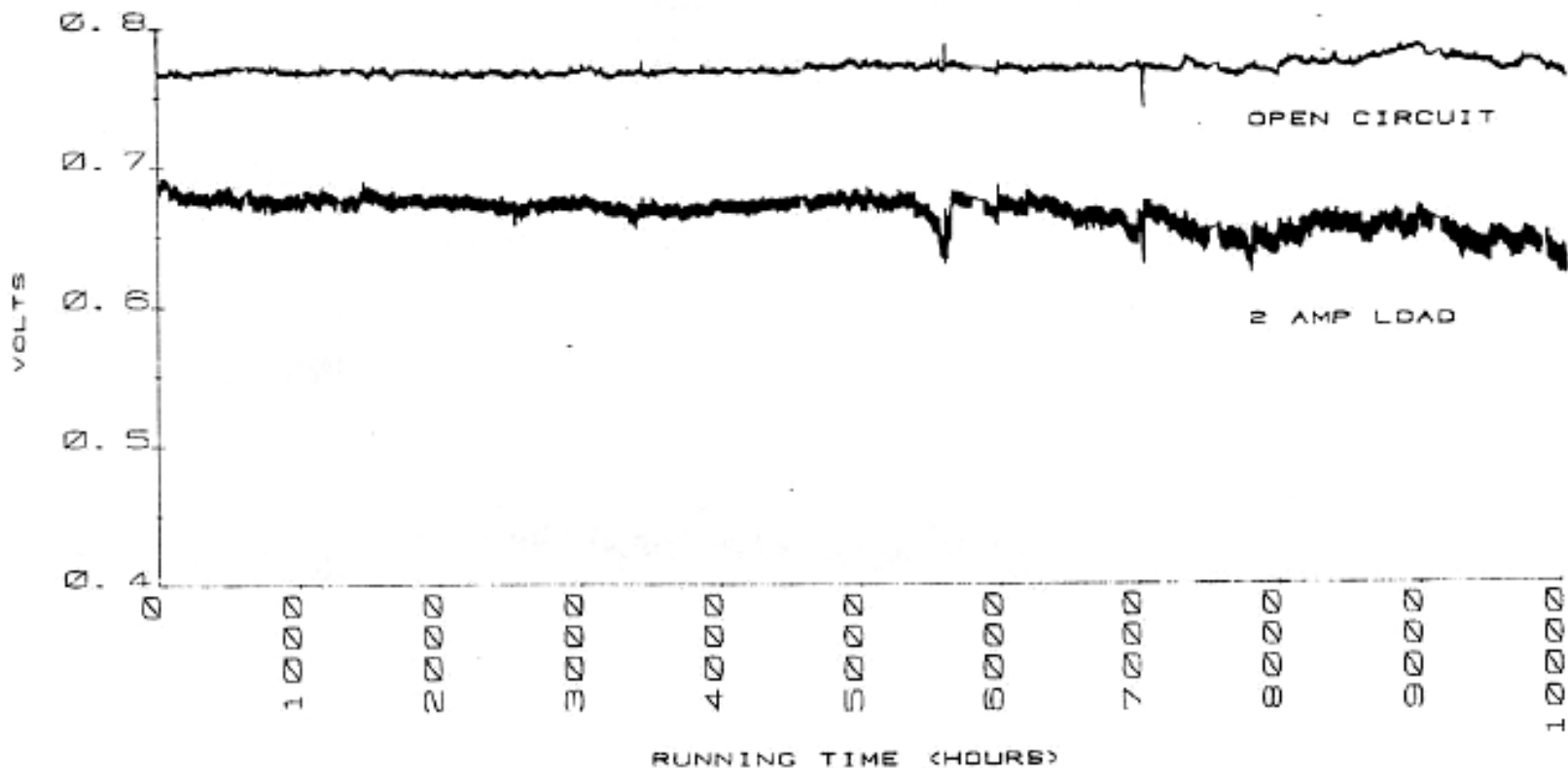
- Development of 100W hydrogen – oxygen RFC
- Development of a low cost high – performance fuel cell membranes (patents filed)
- Discovered of new and safer fuels (patents filed)
- **World power record of:**
 - a, Hydrogen – bromine fuel cell (1.5 W/cm^2)
 - b, Direct methanol fuel cell (0.5 W/cm^2)
 - c, Direct ethylene glycol fuel cell (0.3 W/cm^2)
- Development of a low cost high power hydrogen – air fuel cell (0.85 W/cm^2)
- Development of a small (1 liter) power unit demonstrator for laptop (fed by methanol and can be scaled up to small electric vehicles).

**A Five 50 cm² cells stack gives 50 W (150 W peak)
250 cells stack (90 cm long stack) will produce 2.5 kW (up
to 7.5 kW peak)**



HTB fuel cell durability tests.

Texas Instruments H_2 /Tribromide fuel cell (1984)
polarization vs. running time on a 2 A/in.^2 (1 in.^2)



Summary

- The EnStorage hydrogen tribromide ESS is based on a low cost high performance membrane (NP-PCM) and on low cost energy storage chemicals.
- It is expected to be three time lower cost in comparison with other ESSs (in terms of \$/kW and \$/kWh).
- Thus it will be **an enable technology** (when fully developed) for load buffer (fast response), load leveling and for solar and wind energy storage .