Technologická agentura České republiky

ÚJV

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Innovative technology of alkaline electrolysis

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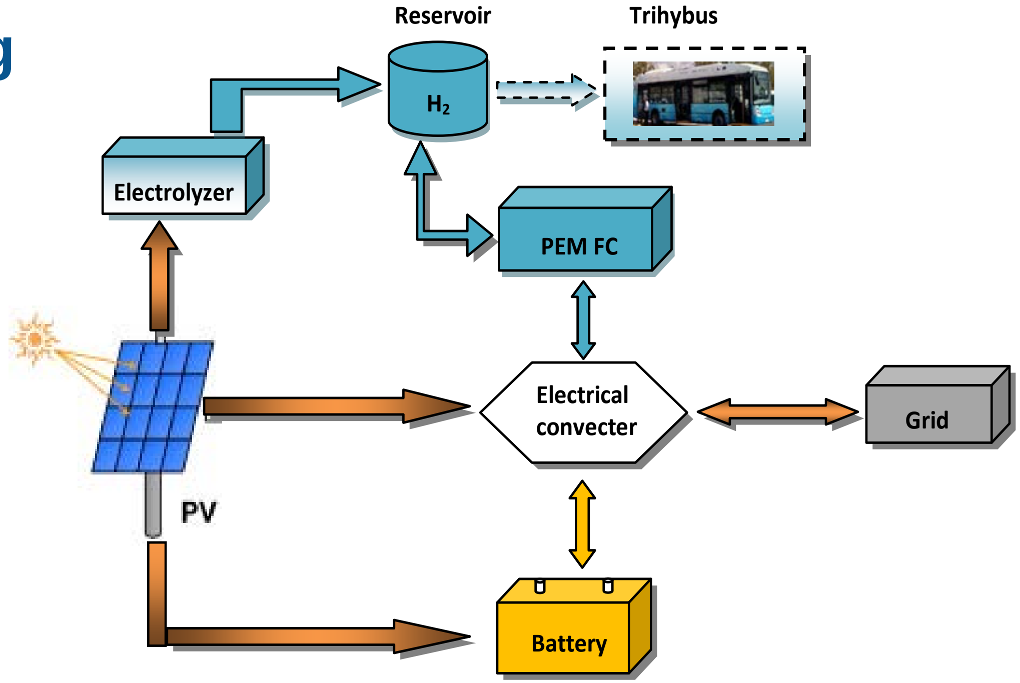
Aim of the project

- Hydrogen as a tool for regulating photovoltaic energy in island mode
- The proportion of pilot plant has been designed for the energy consumption of the average household



- Main components

Photovoltaic panels (13 kWp, 60 panels)

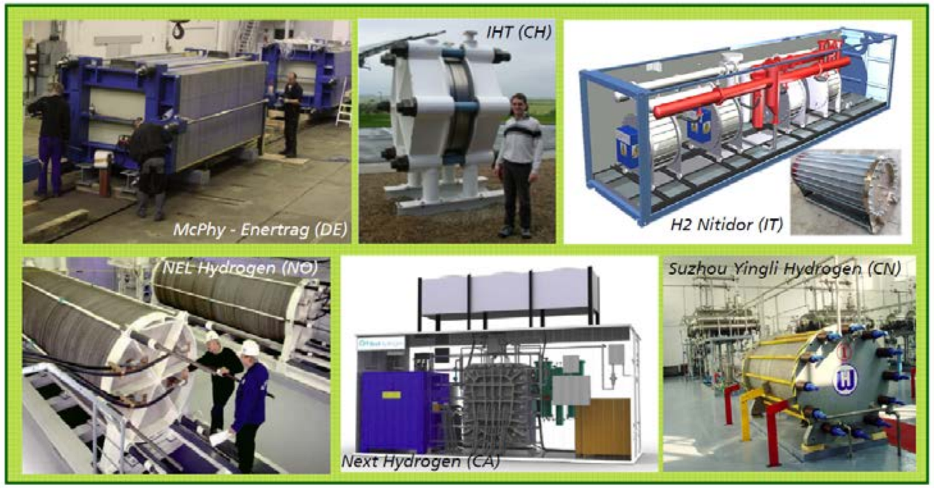
PEM electrolyzer (7 kW, Hogen)

Low pressure H_2 tank (10 m^3)

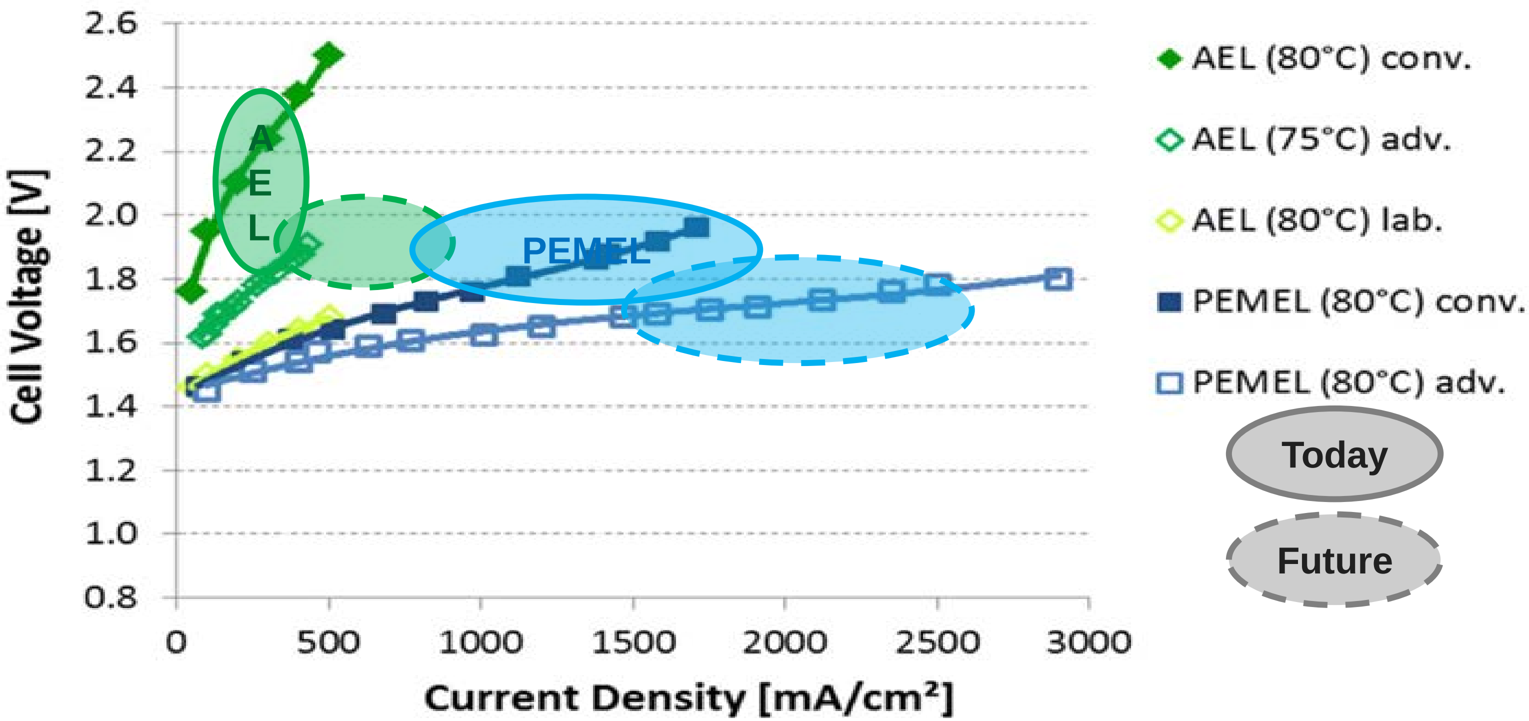
PEM fuel cell (4 kW, Fronius)

Main Technical Features of Water Electrolysis - Overview

Parameters	Akaline Electrolysis	Membrane Electrolysis
Electrolyte	Liquid alkaline KOH, NaOH	Solid acid polymer
Electrodes	Ni/Fe electrodes	Nobel metals (Pt, Ir, ..)
Temperature	50 – 80 °C	< 90 °C
Pressure	< 30 bar	< 200 bar
Purity H_2 O_2	Class 4 (99.99) ~ 96 %	Class 4 to 6 99.3 – 99.7 %
Modul size (commercial)	Max. 760 Nm^3 H_2/hr (3.6 MW_{el})	Max. 30 Nm^3 H_2/hr (170 kW_{el})



Performance and Life-Time of Electrolysis Stacks



Durability is given for steady state operation at LT

- AEL life-time

  Older systems: > 100,000 h / 9-15 years

  Newer concepts: 50 - 70,000 h

- PEMEL life-time

  Comparable to AEL if well designed

  But mostly < 40,000 h / 5-10 yrs

  Degradation mechanism not fully understood

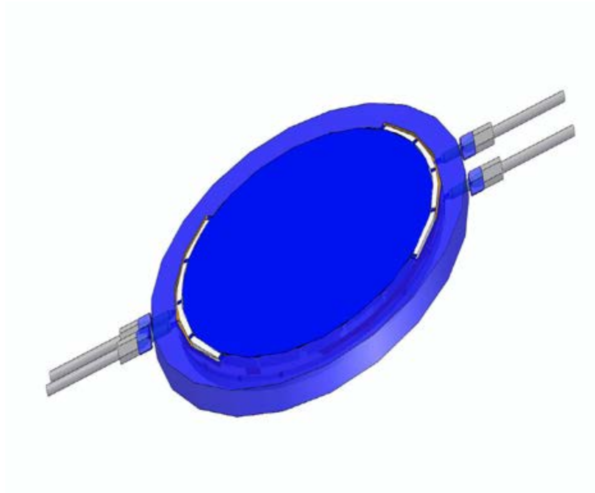
Where Do We Have R&D Demand in the Next Years?

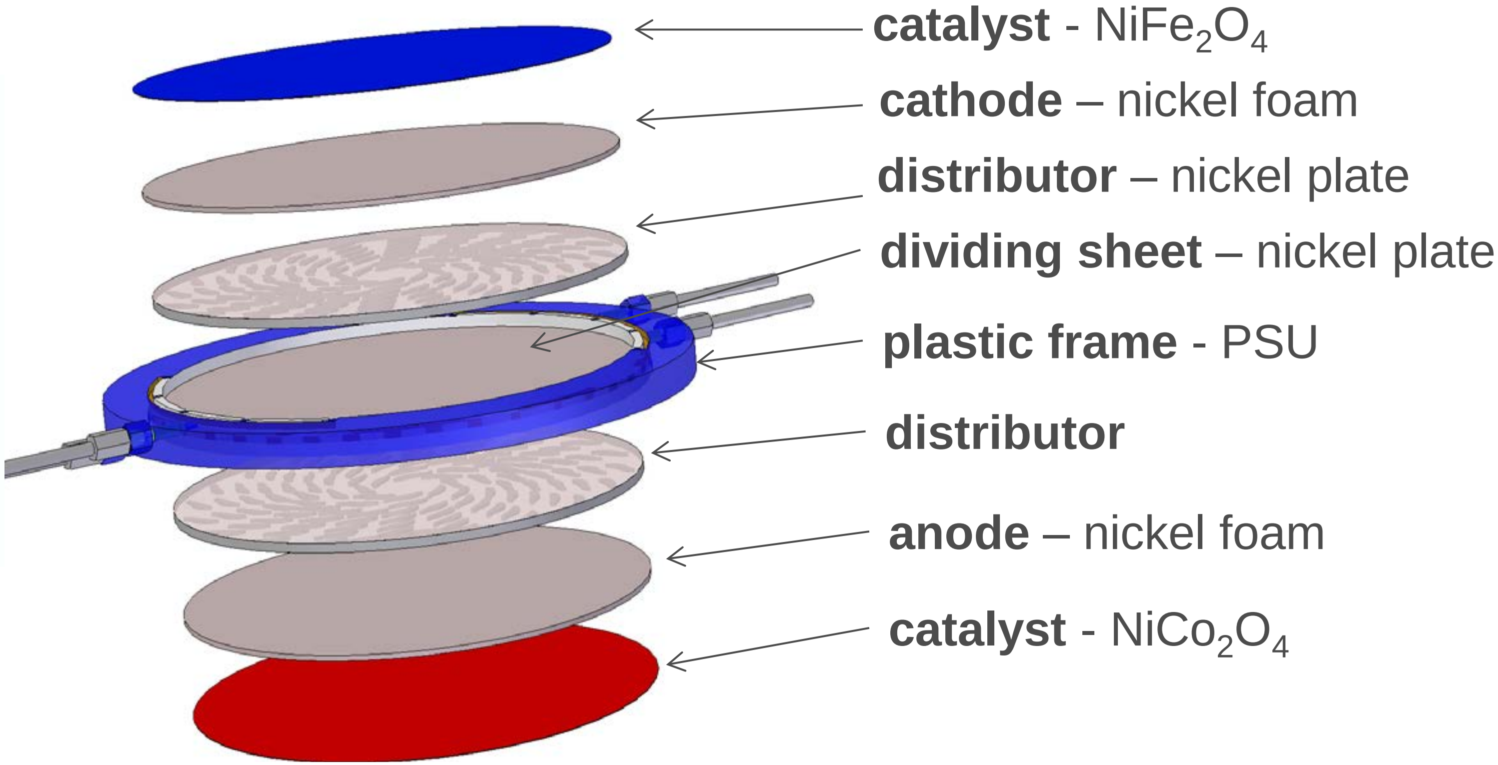
- **AEL**
  - Increasing current density
  - Increasing pressure tightness
  - Faster dynamics of the complete system (BOP)
  - Higher part load range
  - Decreasing production costs through economies of scale

- **PEMEL**
  - Increasing life time of materials/ stack
  - Proof of scale up concepts for stack
  - Decreasing costs by substitution or reduction of expensive materials
  - Decreasing production costs through economies of scale

Alkaline zero-gap system

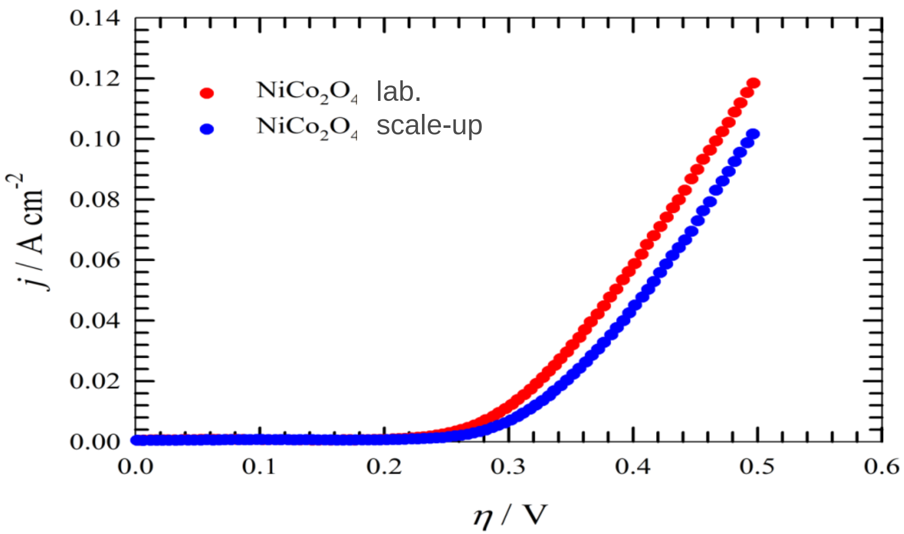
- **the design is based on a zero-gap bipolar cell construction**
- **the operating conditions**
  - 60 °C, 14 barg, electrolyte 10% KOH
- **the cells are made using hydroxide ion conducting membranes based on polyethylene**
  - surface of cell 190 cm^2

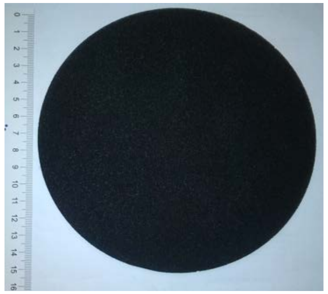
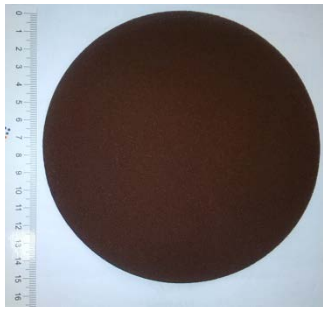




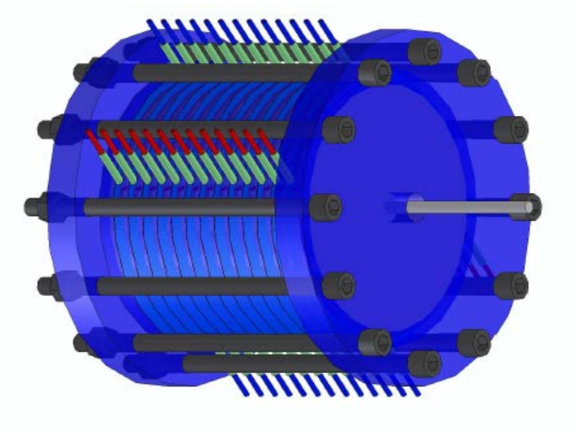
„Cooking“ of non-platinum catalysts

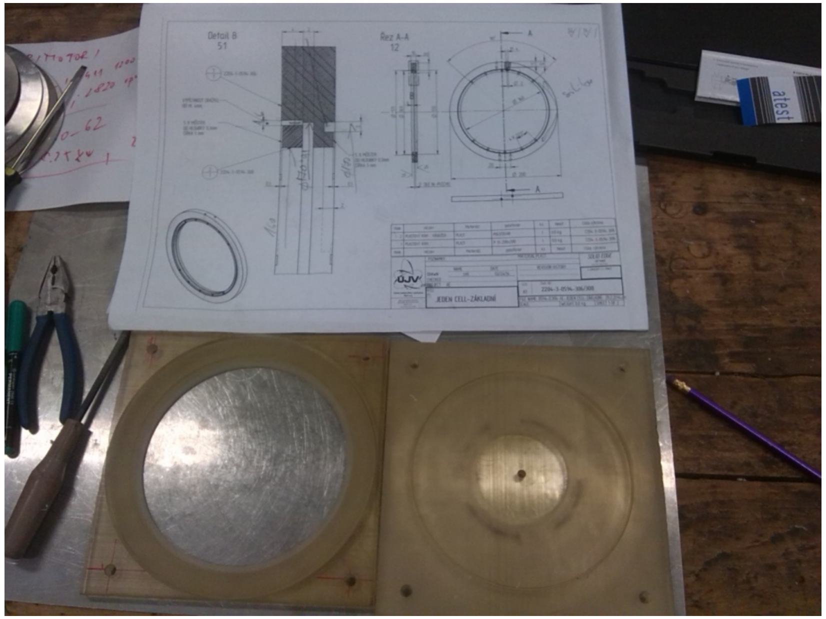


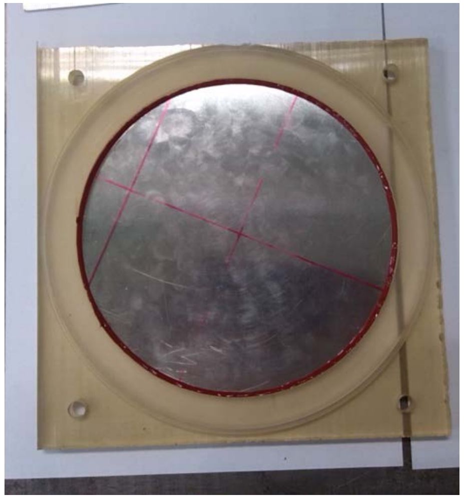


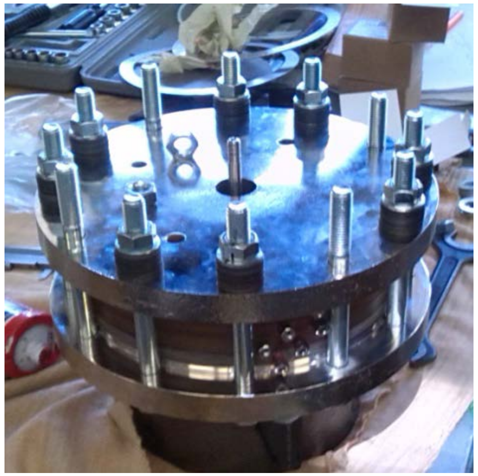



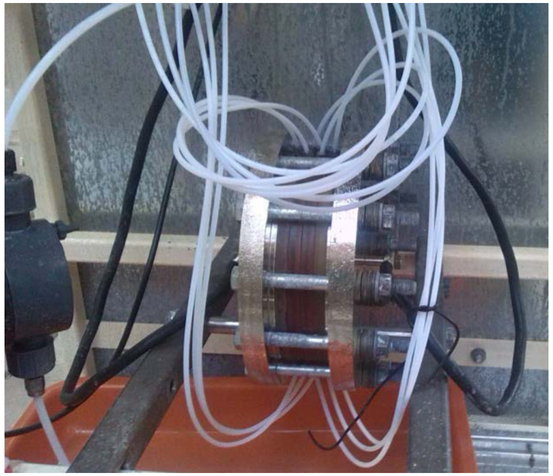

Alkaline stack



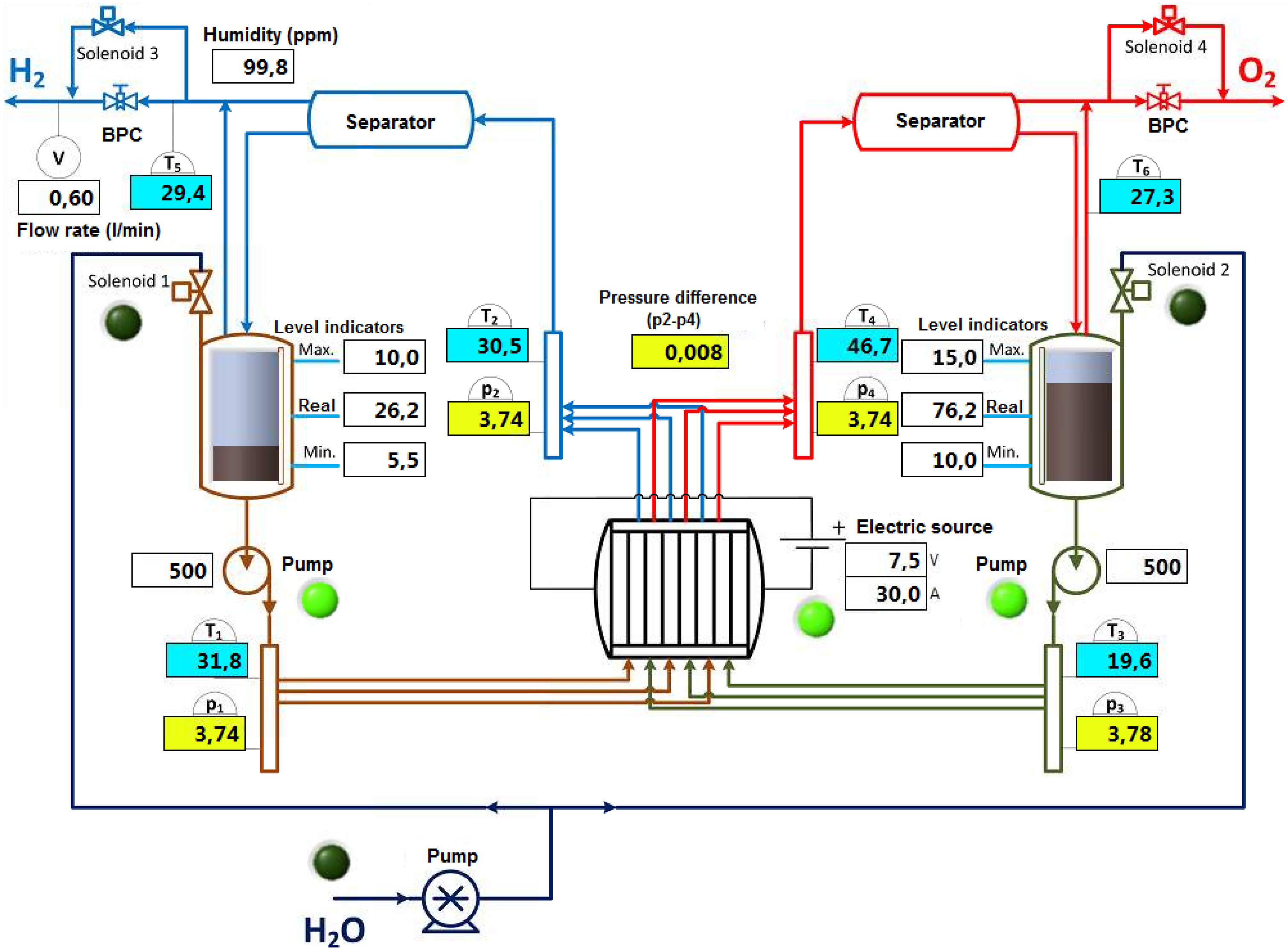




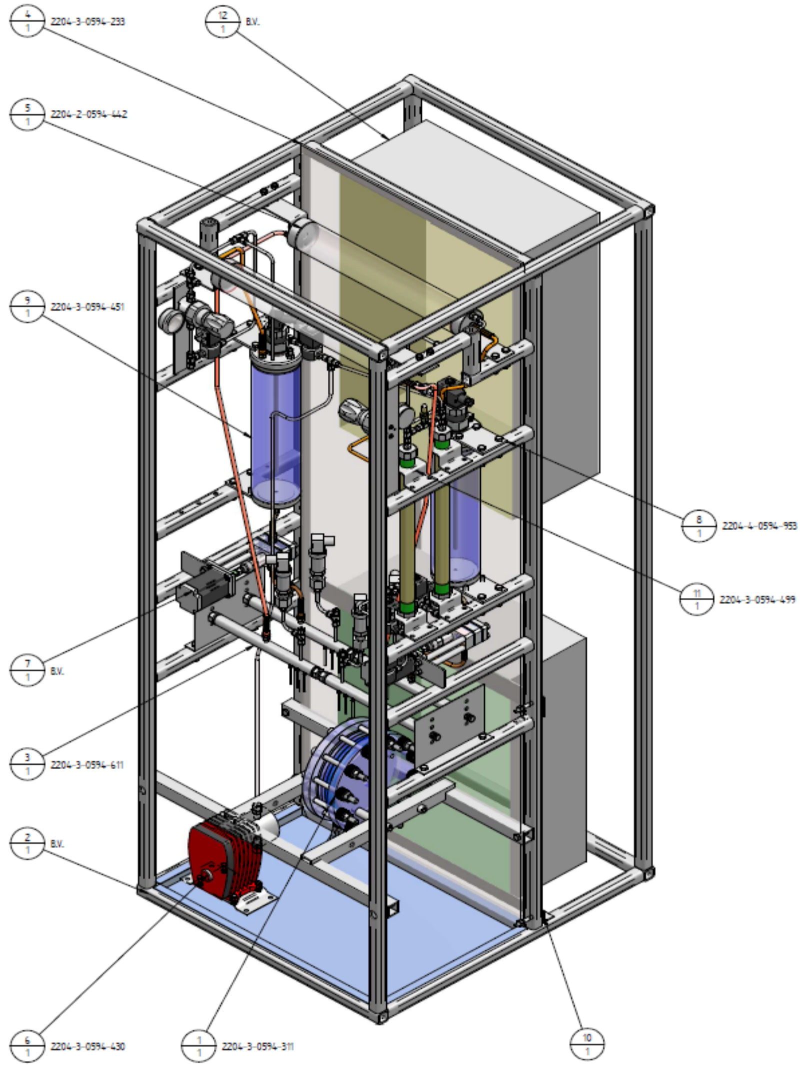


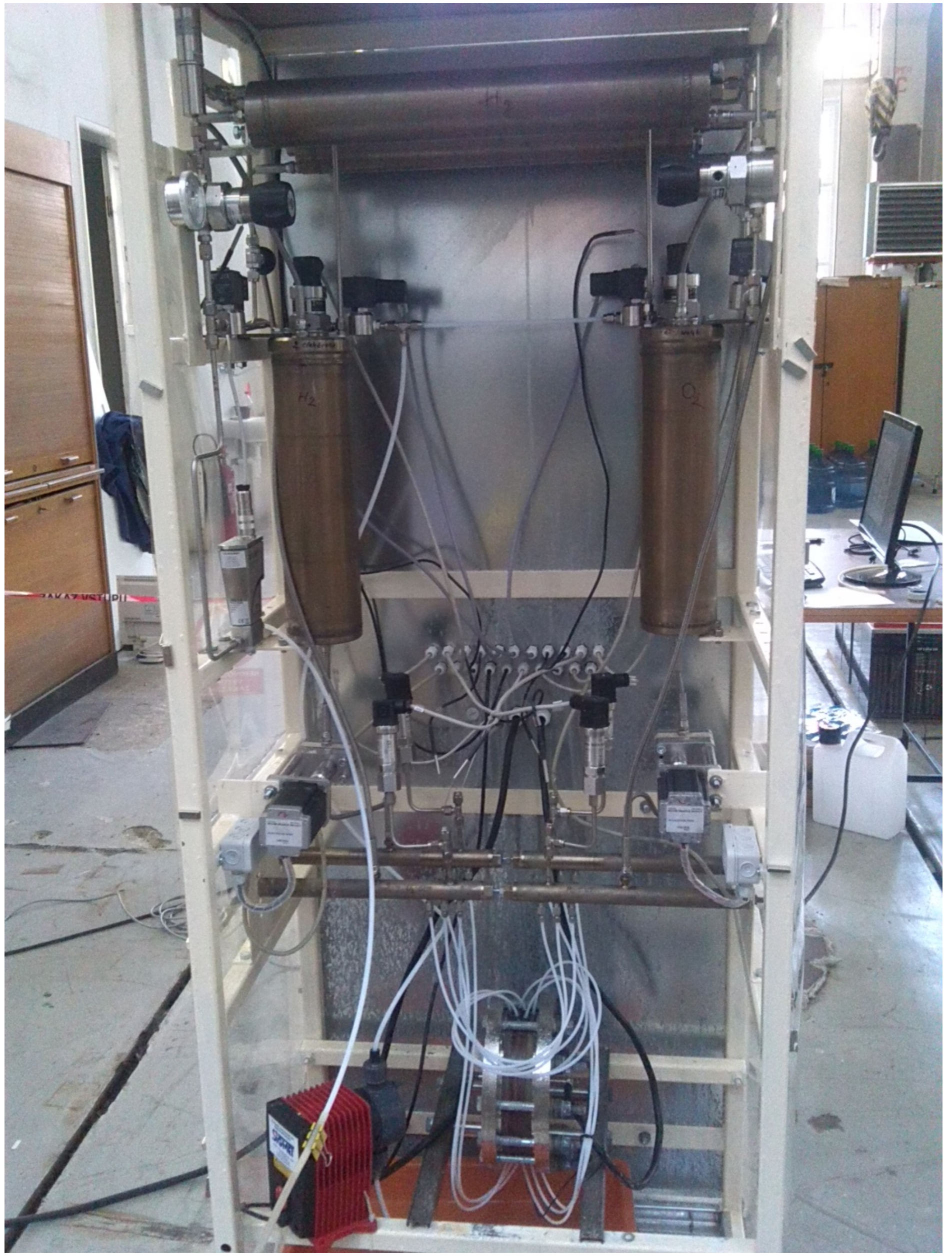


Alkaline system



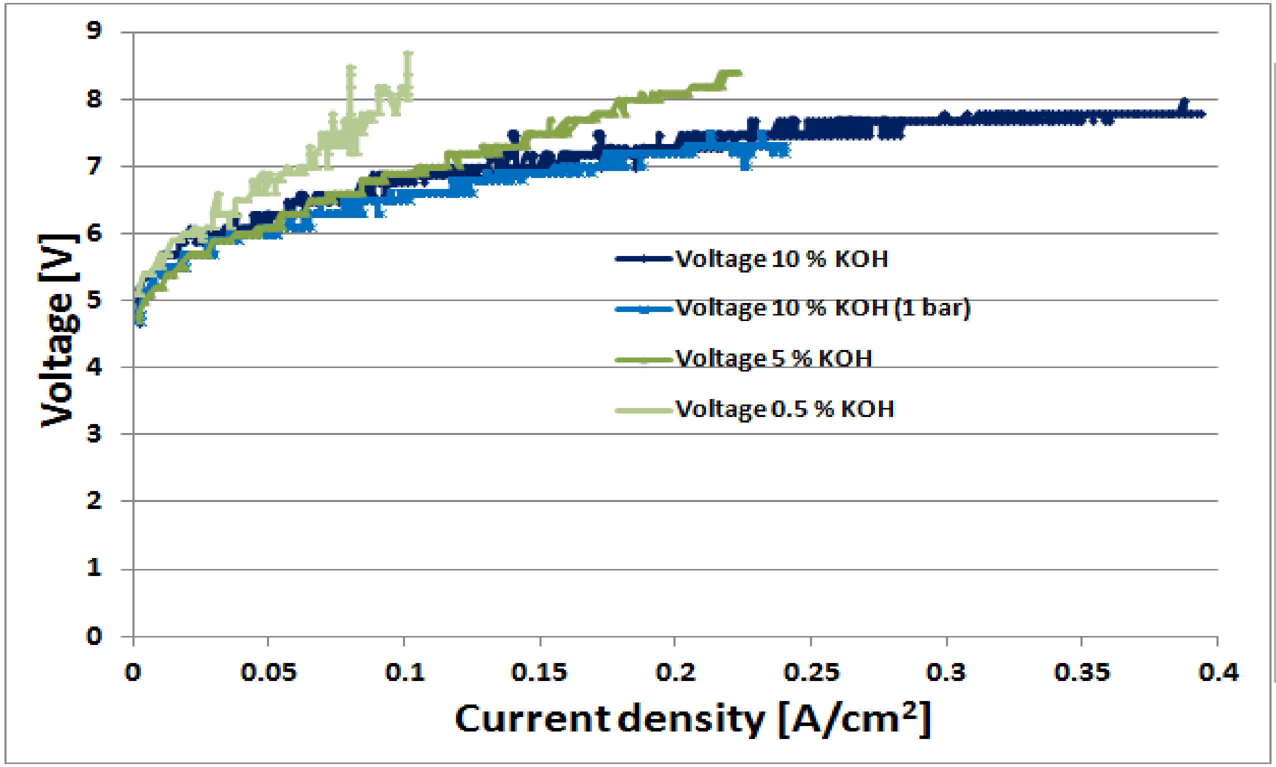
Alkaline system II.

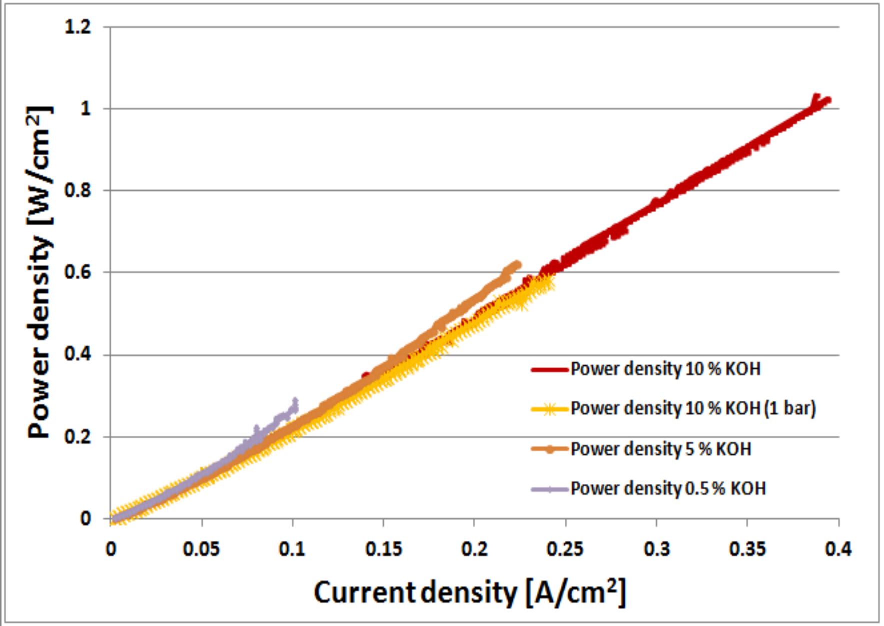




First results

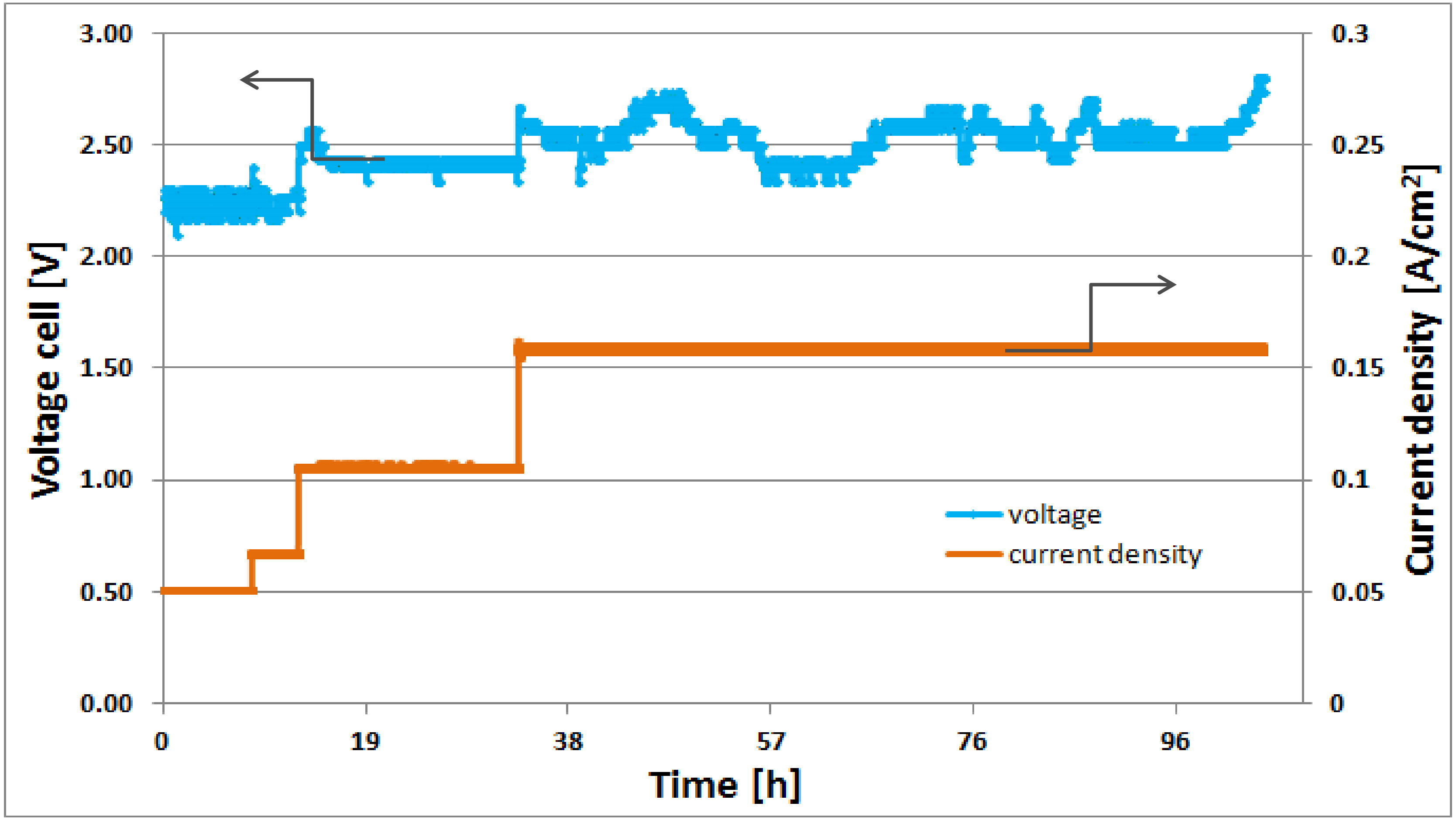
- **Condition:** 3 cells, 40 – 50 °C, 3.7 barg





Short-term operation

- Operation conditions: 3.7 bar, 40 – 50 °C, 5 % KOH
- Production of hydrogen ~ 0.61 l/min



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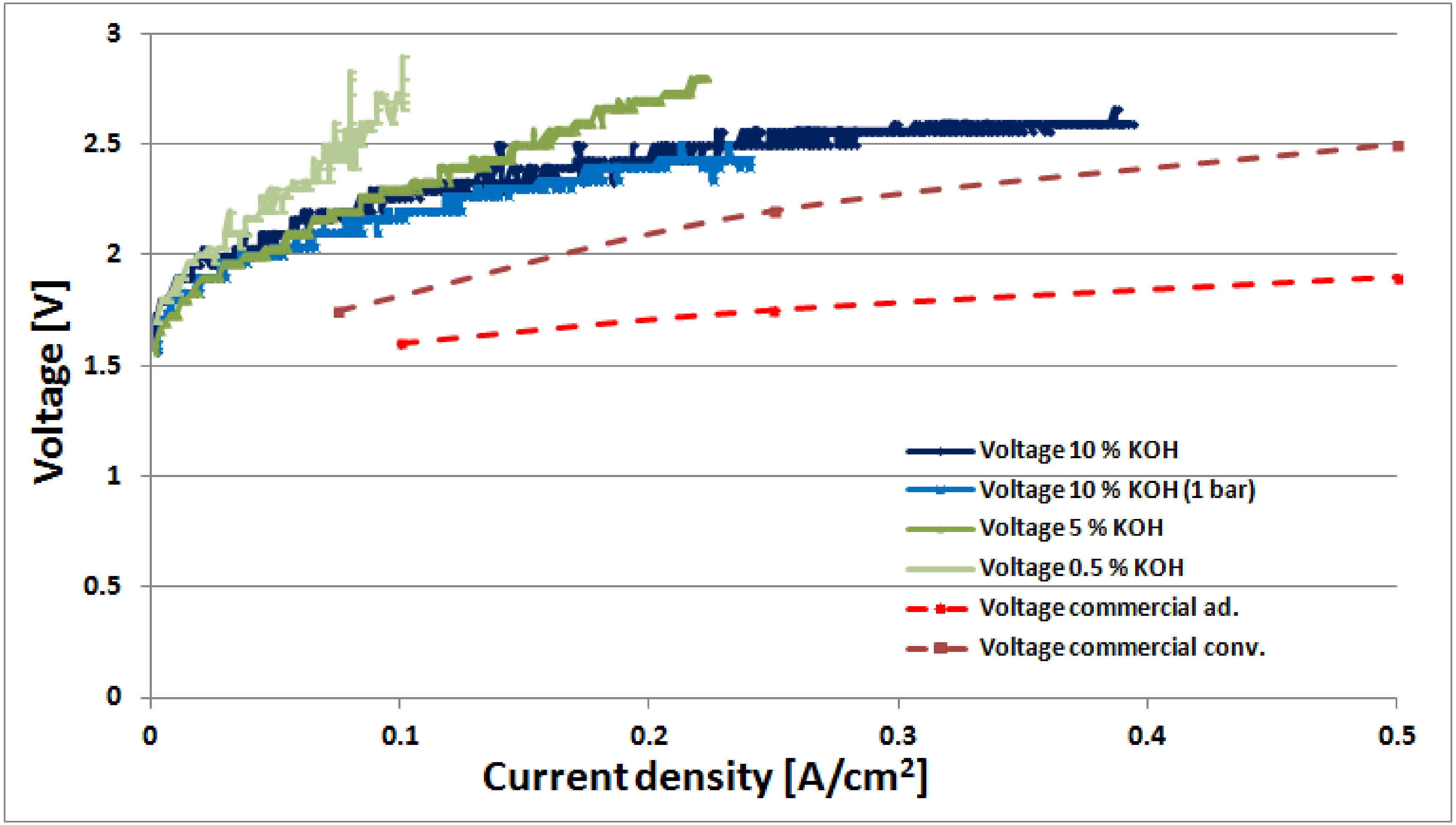
Comparison of own system vs. commercial

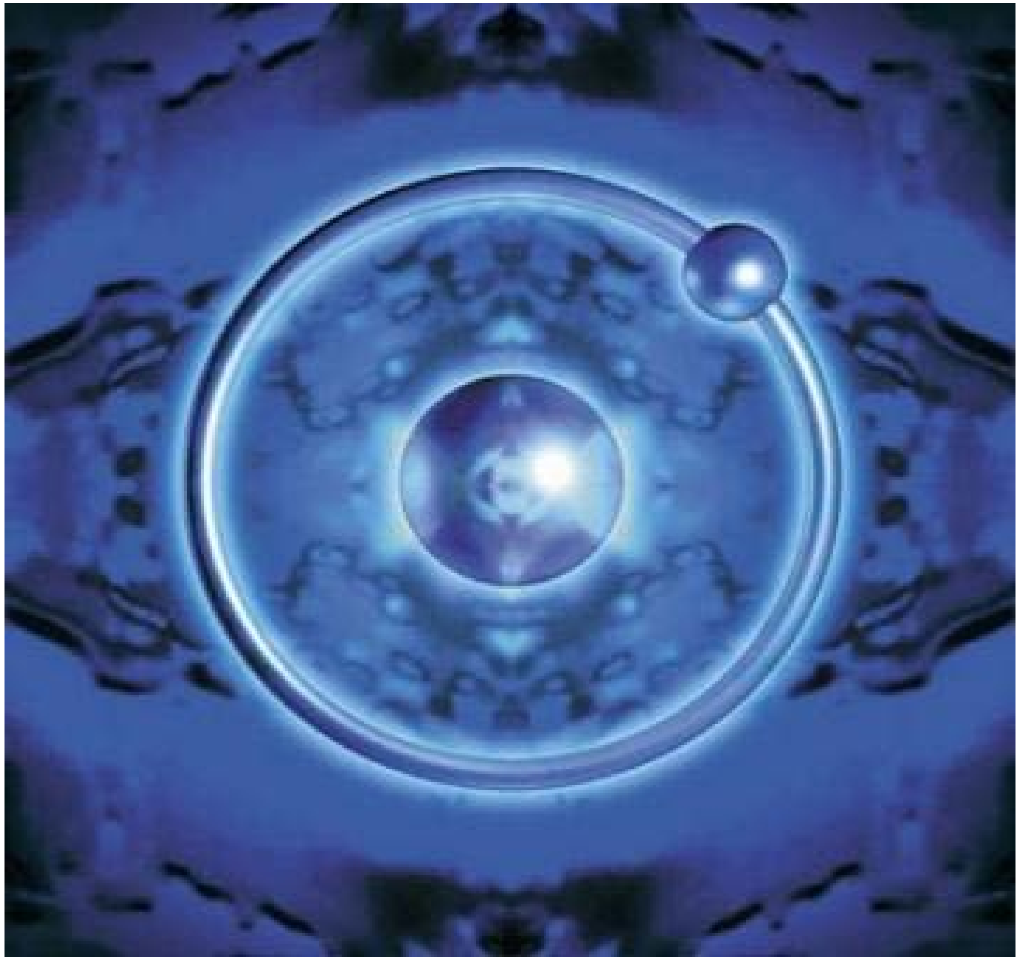
- **Our design**
  - 50 °C
  - 0 – 10 % KOH
- **Commercial**
  - 70 – 80 °C
  - 25 – 50 % KOH



Summary

- The principle of water electrolysis is known for more than 200 years
- Importance of water electrolysis gets larger with growing integration of renewable energy sources
- New market opportunities entail new requirements for water electrolysis systems
- Alkaline electrolyzers are a mature technology in the MW range for industrial use but needs to be adapted to new markets requirements
- PEM electrolysis is available in the small scale as proven technology with several advantages but has to enter the MW class
- Our system was operated more than 100 hours with 5 % KOH. The performance was lower than commercial systems, but is more suitable for variable electrical input.
- There is opportunities for improvement.

Thank you for your attention!



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