Danish Power Systems®

Production of HT-PEM fuel cells
Danish-Korean Fuel Cell Seminar, KDfuelcell, KIST, Seoul, 18-19. November 2013

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Scope

Why are we here…the history

The technology…

Where are we heading…

Where is the market…

Askov wind power test centre

- Poul la Cour (1846-1908)
- Government funded centre
- The two test windmills are from 1891 and 1897
- Direct Current
- Hydrogen storage
- Hydrogen light

Energy in Denmark

- Sustainable energy has been a major priority for several decades
- No nuclear power
- Windmill covers 28 % of the electricity production (2011) – and 40.7 % is from renewable sources
- Siemens Wind Power (Denmark) and Vestas are world leaders in wind technology
- High ambitions* in Denmark :
  - 50 % wind for electricity in 2020
  - 100 % renewable energy for electricity and heat by 2035
  - 100 % of all energy from sustainable sources by 2050
- Fuels cells is expected to play a role in the future energy supply
- Transportation issues are very important for society and difficult to solve
- Huge market potential – needs several supplier

*Danish Government, October 2011: http://www.stm.dk/publikationer/Et_Danmark_der_staar_sammen_11/Regeringsgrundlag_okt_2011.pdf

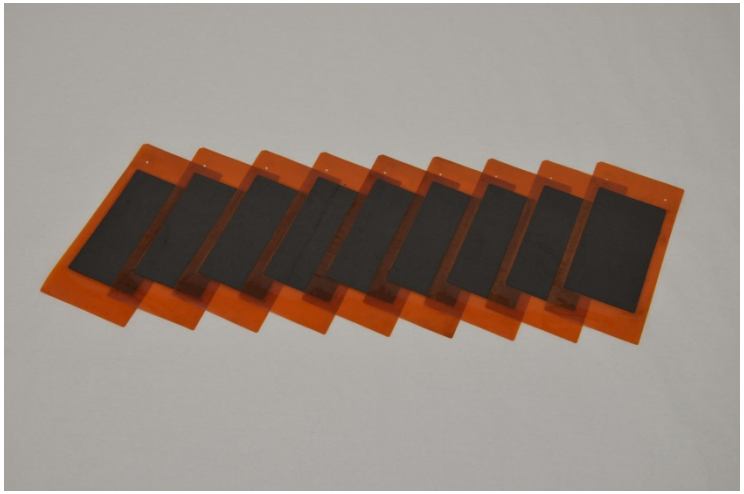
DPS facts

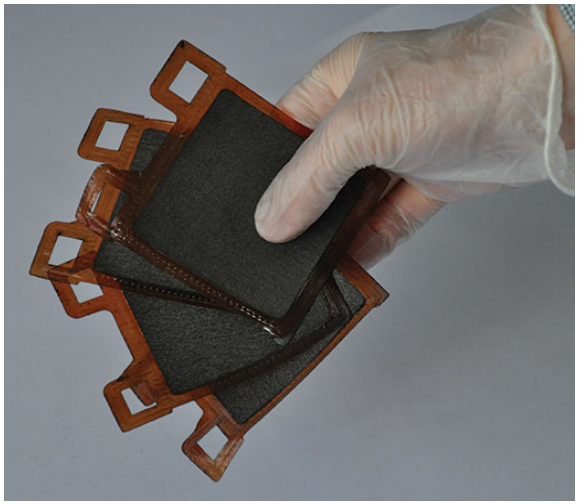
- DPS produce and develop the energy efficient HTPEM technology which utilizes renewable fuels. HTPEM is high temperature polymer electrolyte fuel cells.
- DPS is an independent and privately owned company.
- DPS was founded as a spin-off from DTU in 1994 - working in the areas of energy technology and chemistry.
- Since 2010 DPS has focused on the actual single fuel cell unit (MEA)
- 10 employees and an international set-up.
- Strong network with international and Danish companies, universities and organizations.
- Member of the Danish Partnership for Hydrogen and Fuel Cells.

The role of DPS

The strategy of Danish Power Systems is to develop and manufacture MEAs:

- to produce MEAs with lower cost and higher performance than others
- to scale up production
- to be driver of the establishment of a manufacturing company





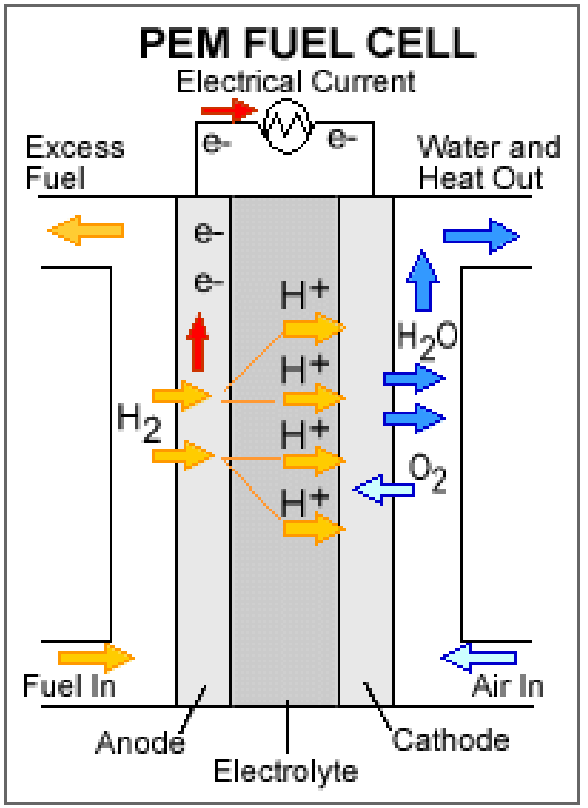
Technology

The HTPEM technology has a number of very attractive features – **fuel flexibility** is a very significant advantages. It works at 160 °C.

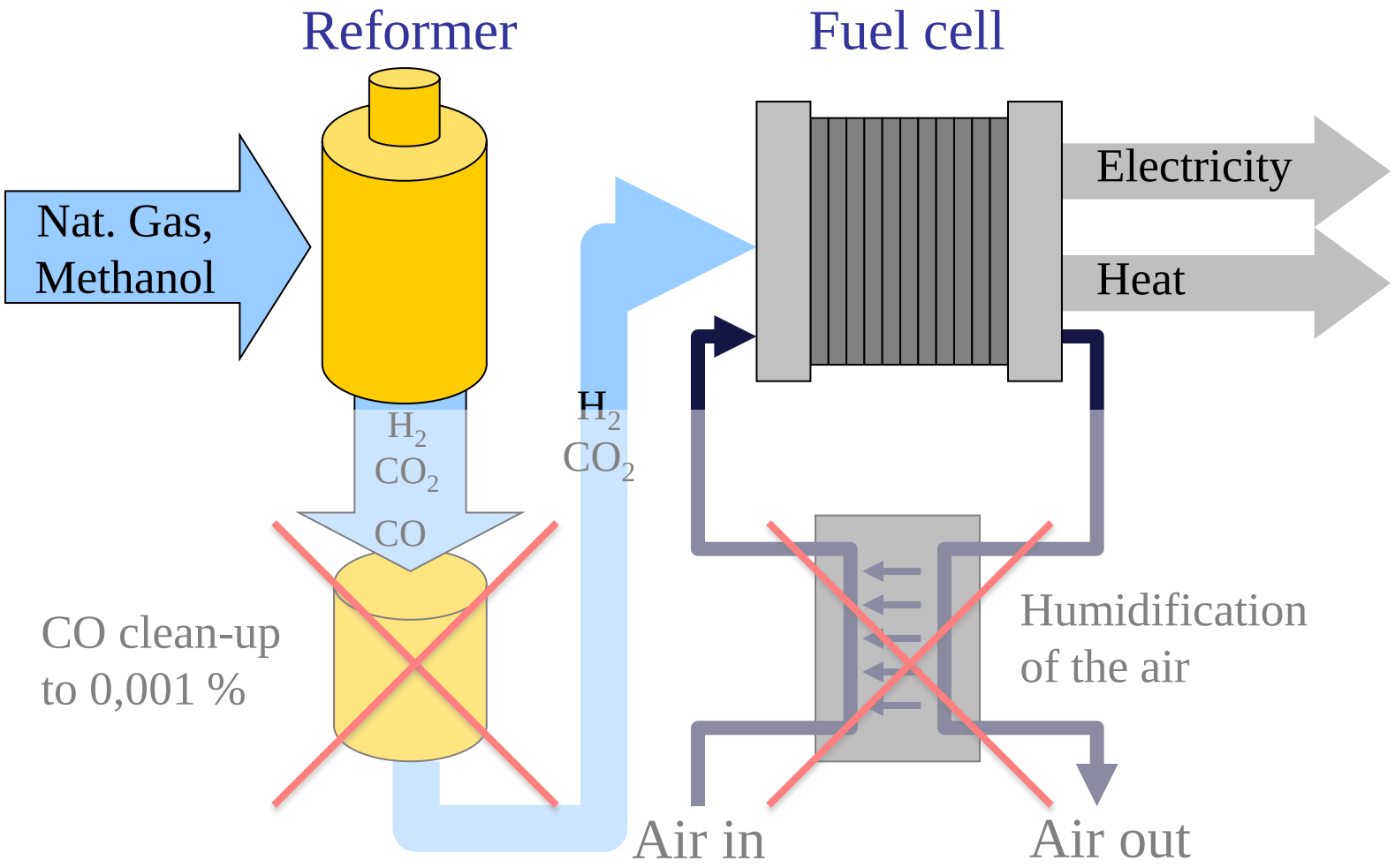
It can work with pure hydrogen but also **methanol** and **LPG**.

Bio-methanol is **CO_2 neutral** and compatible with existing infrastructure and traffic patterns of society today – thus:

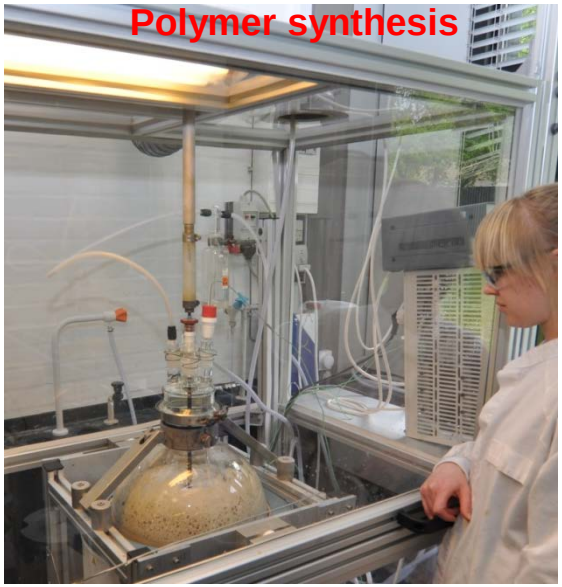
- ✓ Access to cheap, clean, unlimited and renewable energy
- ✓ Implementation “today”
- ✓ Very limited cost of transition for society

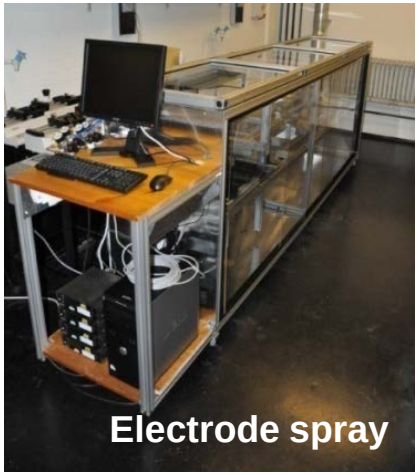


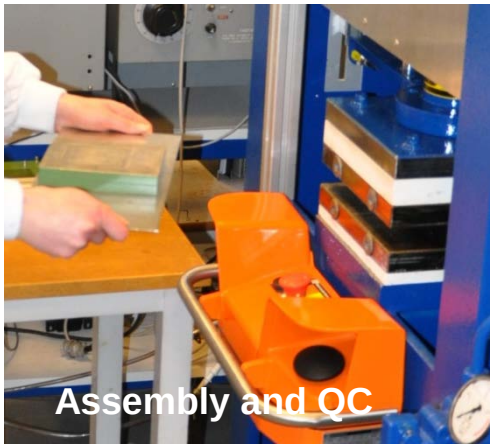
Simple HTPEM system



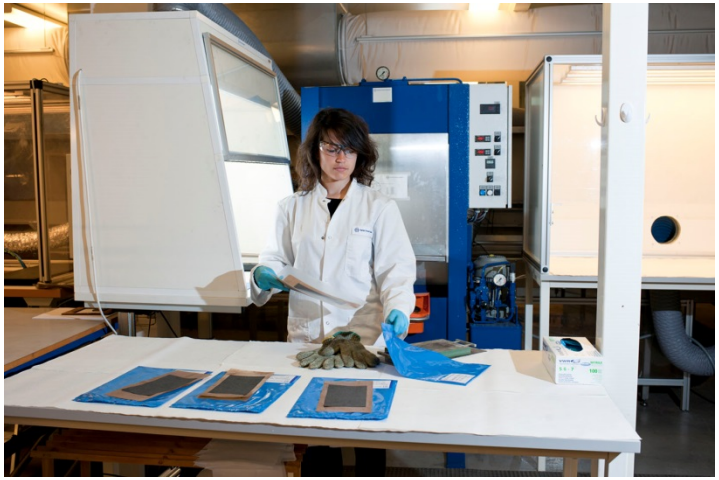
Production – components manufacturing

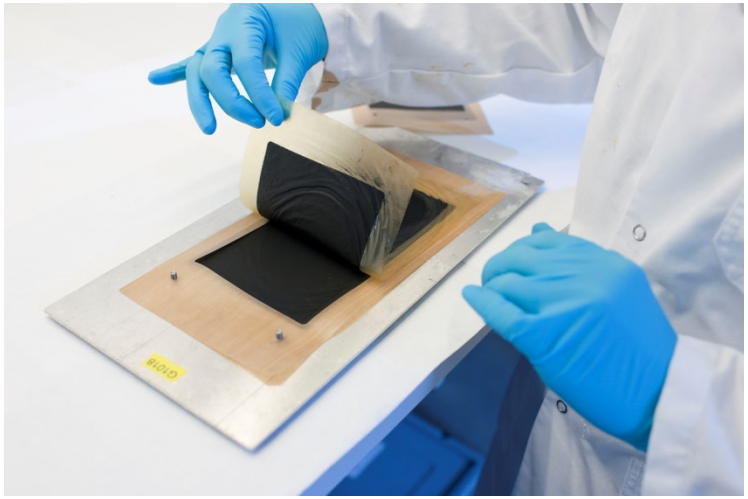






Production - MEA assembly

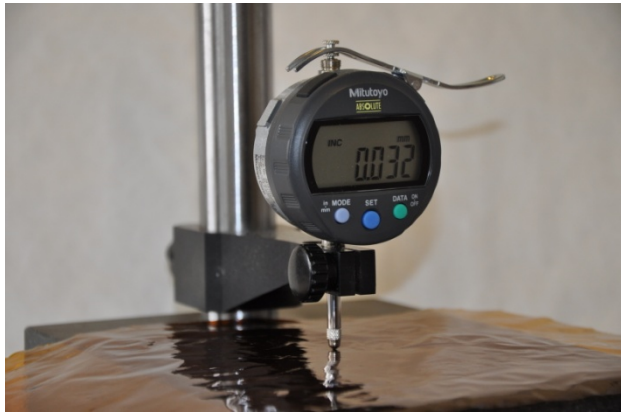




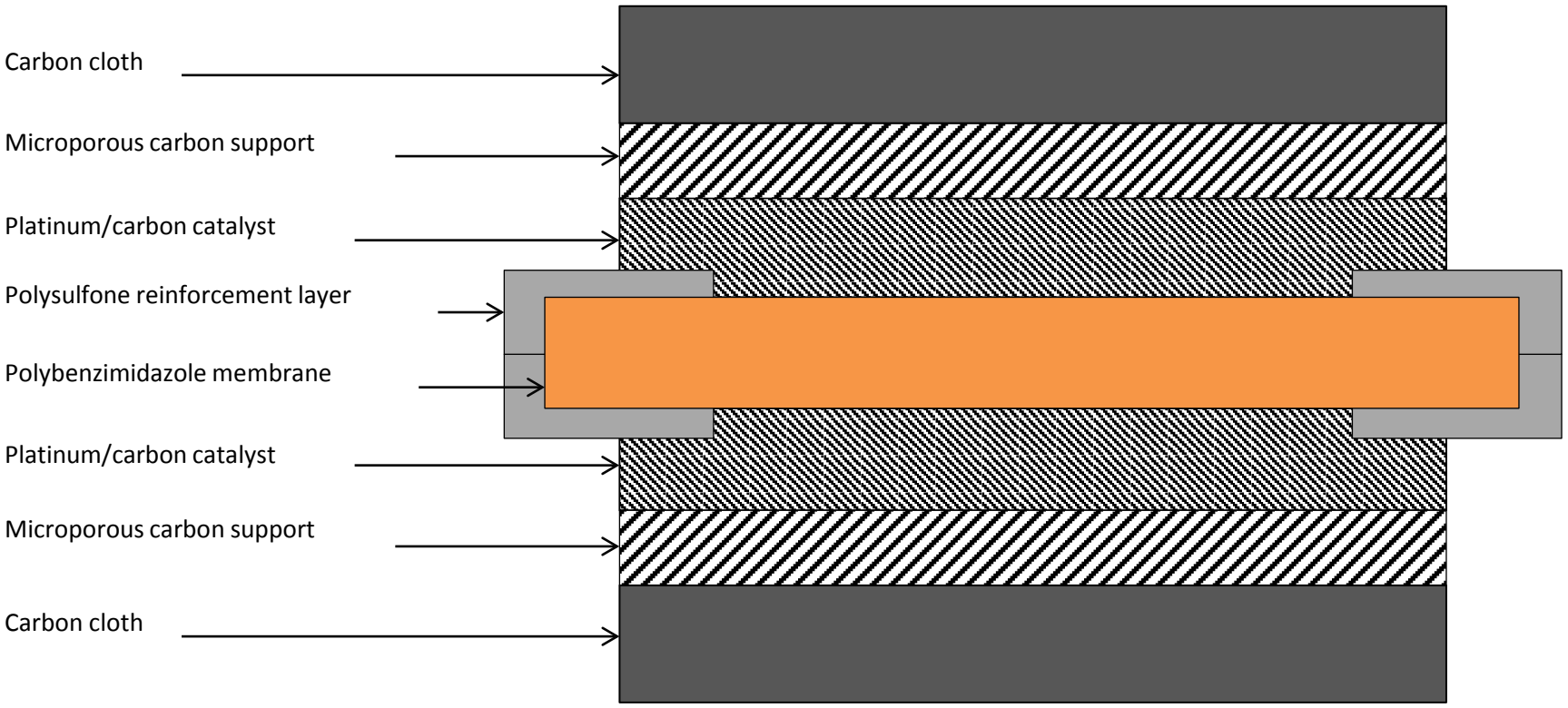
Danish Power Systems®

Standard Products:

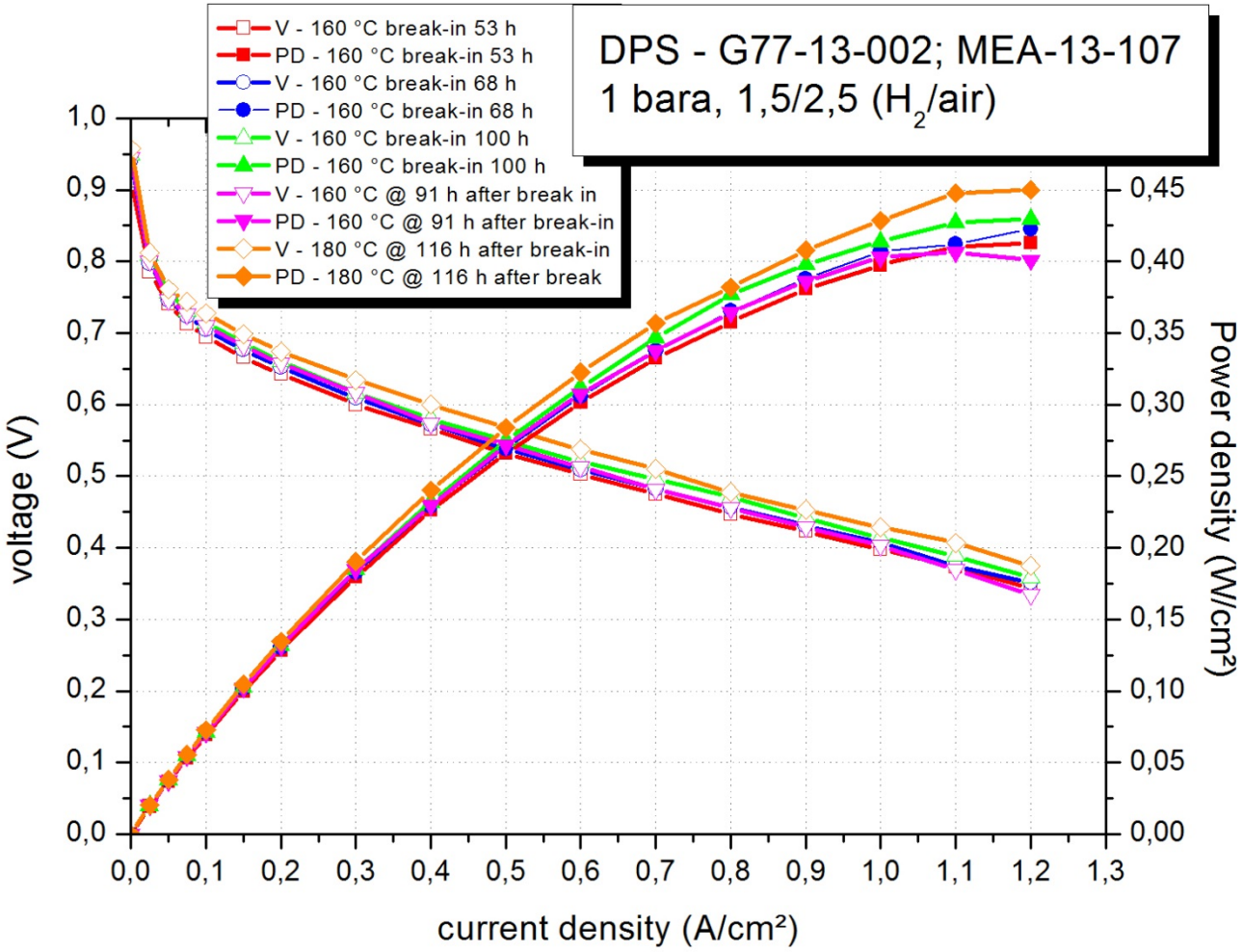
- Dapozol® membranes:
  - M20 – 20 my membranes
  - M40 – 40 my membranes
  - M60 – 60 my membranes
  - M80 – 80 my membranes
- Dapozol® MEAs:
  - G33 – 3 x 3 cm active area
  - G55 – 5 x 5 cm active area
  - G77 – 7 x 7 cm active area
  - G717 – 7 x 17 cm active area
  - G1018 – 10 x 18 cm active area
  - Customized sizes



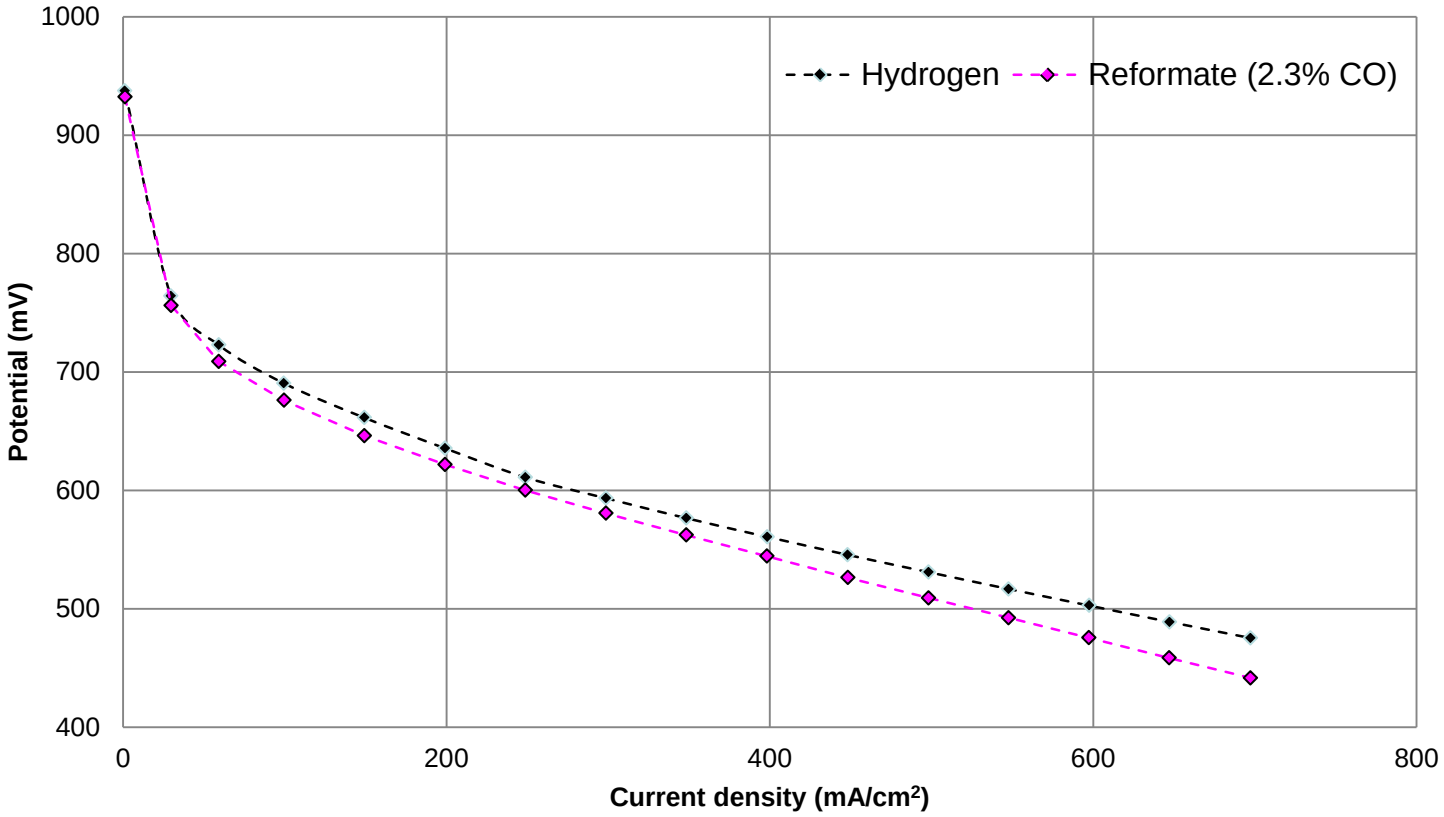
HTPEM fuel cell - principles



DPS MEAs – measured at Uni. Montpellier

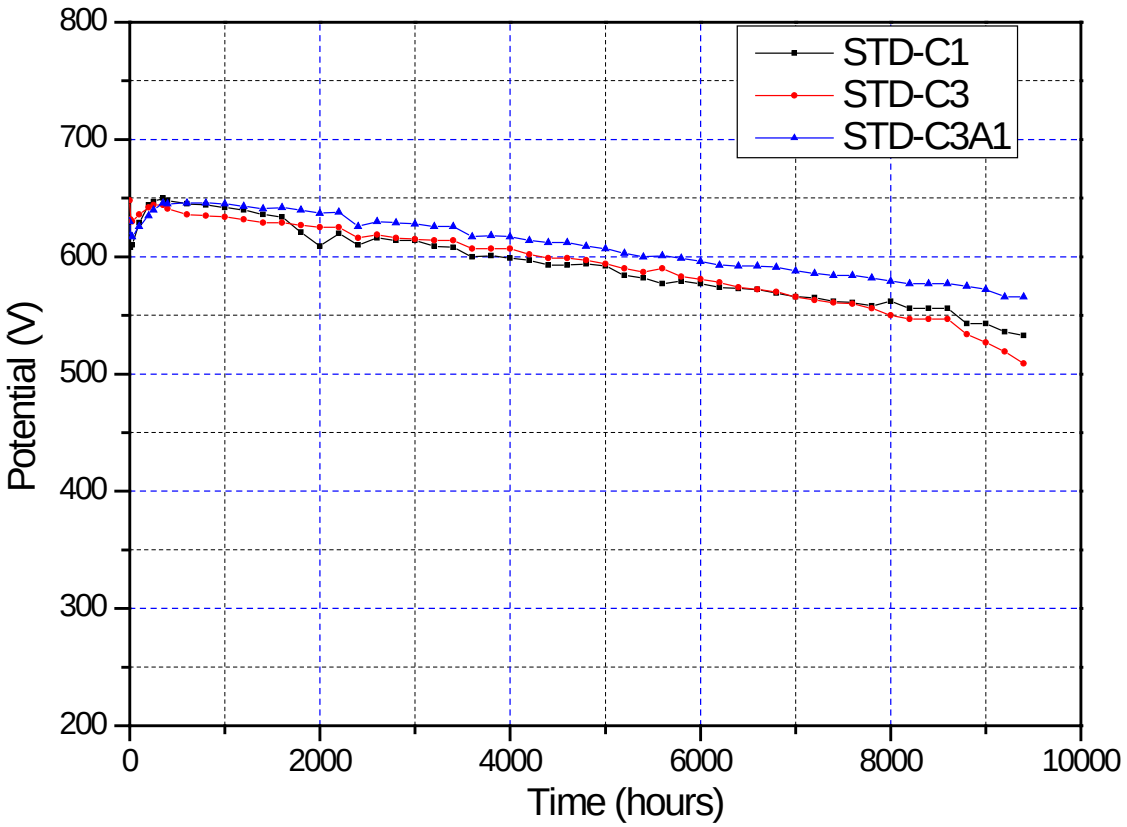


Polarization - hydrogen and reformate



Polarization curve for MEAs tested with hydrogen and reformate at 160 °C (λ_{H2}=1.25, λ_{air}=2.5 and ambient pressure).

Durability testing (on-going):



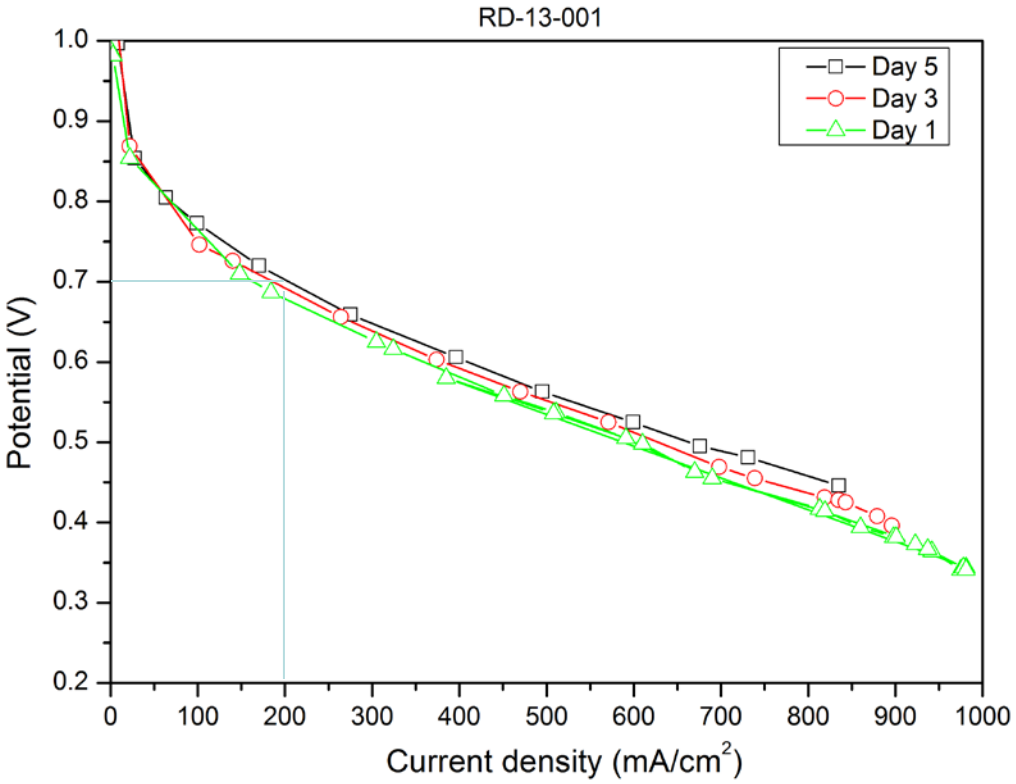
160 °C
240 mA/cm^2
9 cm^2 active area

λ_{H2} = 7
λ_{air} = 12

ΔV = 9 µV/h (avg)

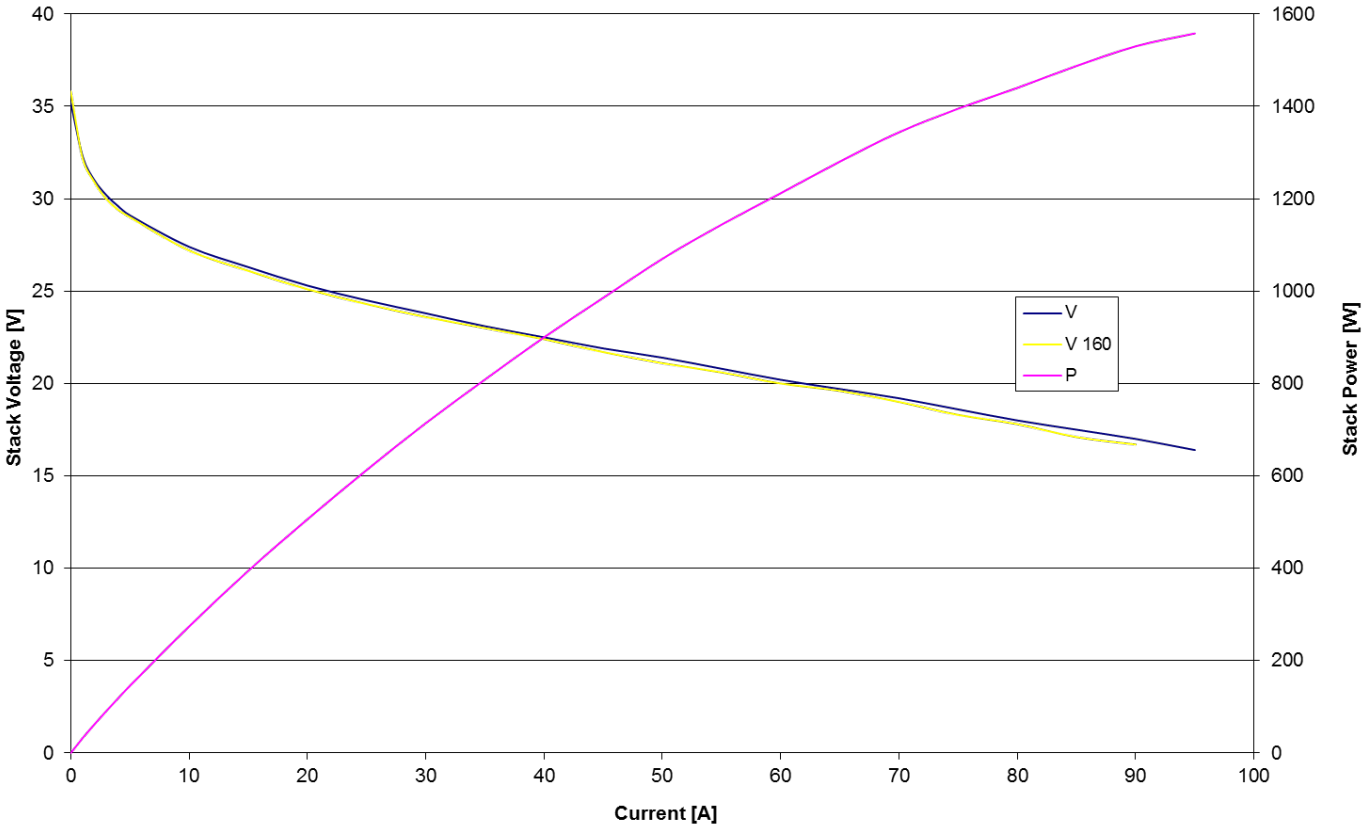
Durability testing

New high performing MEAs

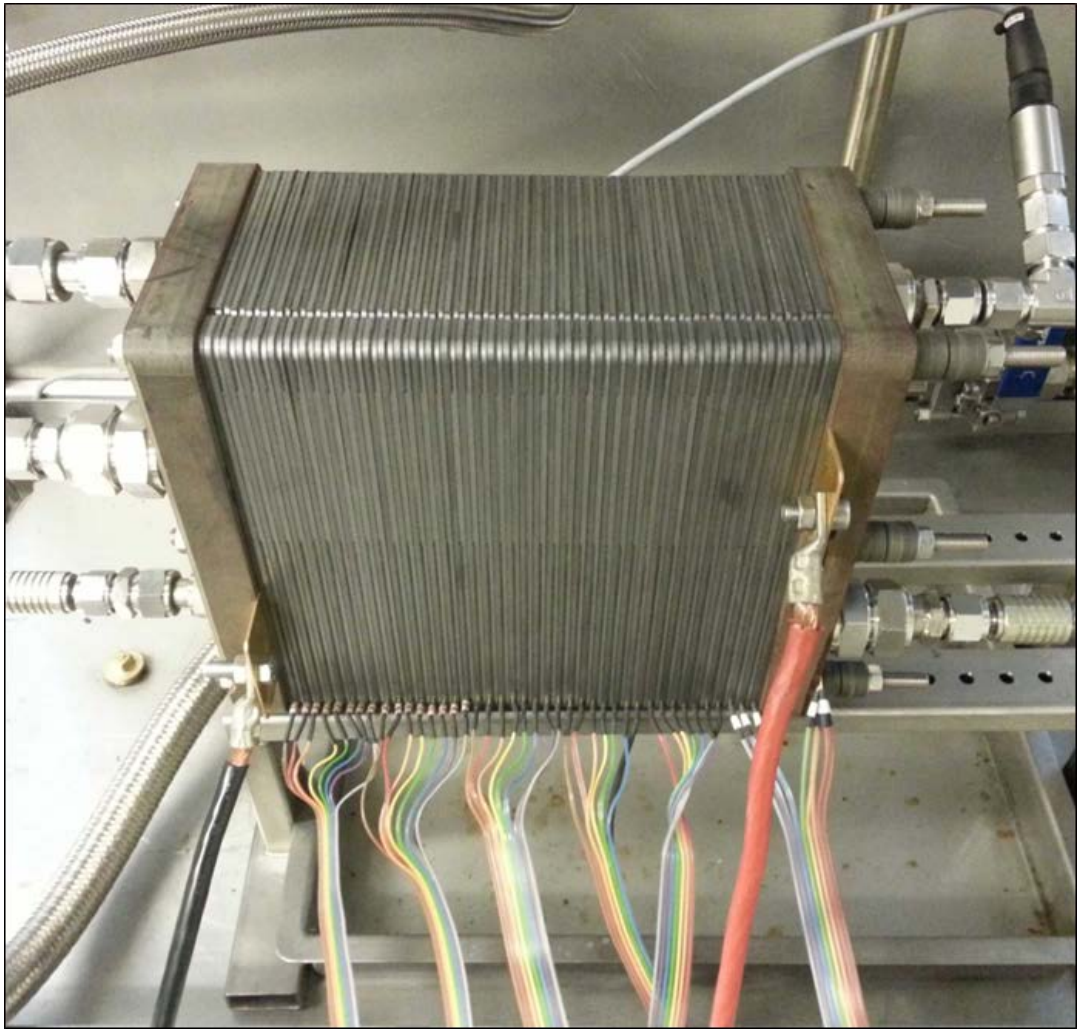


Polarization curves at 160 °C
49 cm² MEA. The Pt loading on the cathode 1.5 mg Pt/cm² (JM HiSpec9100)
The MEA's was measured by AAU.

IRD – stack data (40 MEAs)



IRD 40-cell stack



The commercial part

- Business and markets
- Partners and products

Value chain




	Materials	MEA	Stack	Application
No. of companies:	Multiple	~ 5	~ 20	Multiple
	DPS suppliers	DPS	DPS customers	End-users

Business strategy

Product: HTPEM MEA for fuel cell stacks that works with existing commercial fuels. E.g. LPG and Methanol

First markets: High-end marine and camping fuel cell generators (APU)

Next markets: Utility vehicles

Sales channel: Access through development of partnerships with APU companies

End-user benefits: Significantly improved energy efficiency. Clean air and environment, reduced noise and vibration, no smell

MEA production: 90% cost reduction from today 1€/cm^2 to 0,1€/cm^2 in 2015 – for high volumes using automated production

Prices: APU today 9.000 €/kW – estimated 2.500 €/kW in 2015

Early markets: End-user benefits

Sailors and campers achieve:

- Compliance with legislative restrictions in harbours, on campsites and waterways.
- Freedom of operation due to increased energy capacity.
- Increased comfort – reduced noise, no smell or vibrations.
- An efficient and greener solution.

Coming markets

- Utility vehicles for indoor and outdoor cleaning and transport
- Defence applications
- Combined heat and power systems (CHP and µCHP)
- Passenger vehicles

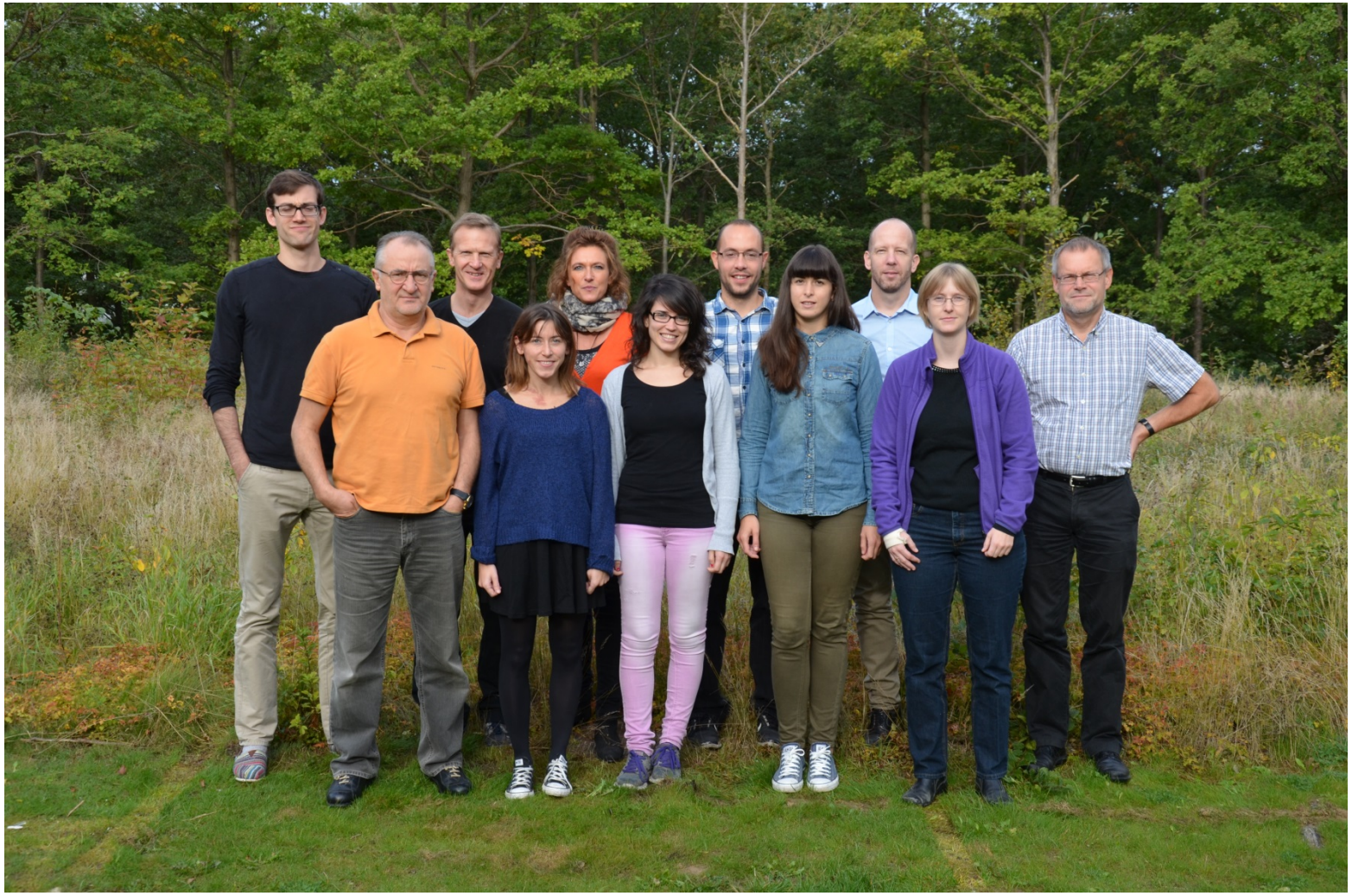
Summary & perspectives:

- HTPEM has a large potential in a number of applications due to system simplicity and fuel flexibility
- MEA performance has been significantly improved
- Scale-up of MEA production is in progress

Collaboration!

Danish Power Systems®

Our team



Acknowledgements

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Thank you!

www.daposy.com