



# Hydrogen from Regenerative Energy Power Sources: pressurised alkaline electrolyser with high efficiency and wide operating range The EU-Project „RESelyser“

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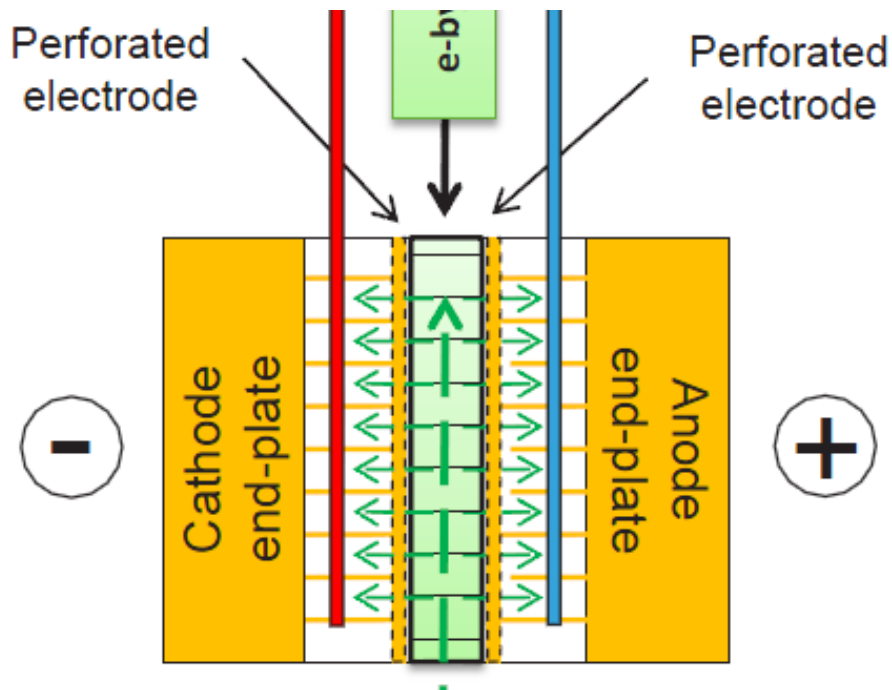
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# Alkaline water electrolysis – advantages and problems

- Well established technique up to large scale systems
- Cheap materials
- Gas purity problems at low load and high pressure
- Electrode stability when electrolyser off
- System adaptation to use with RES

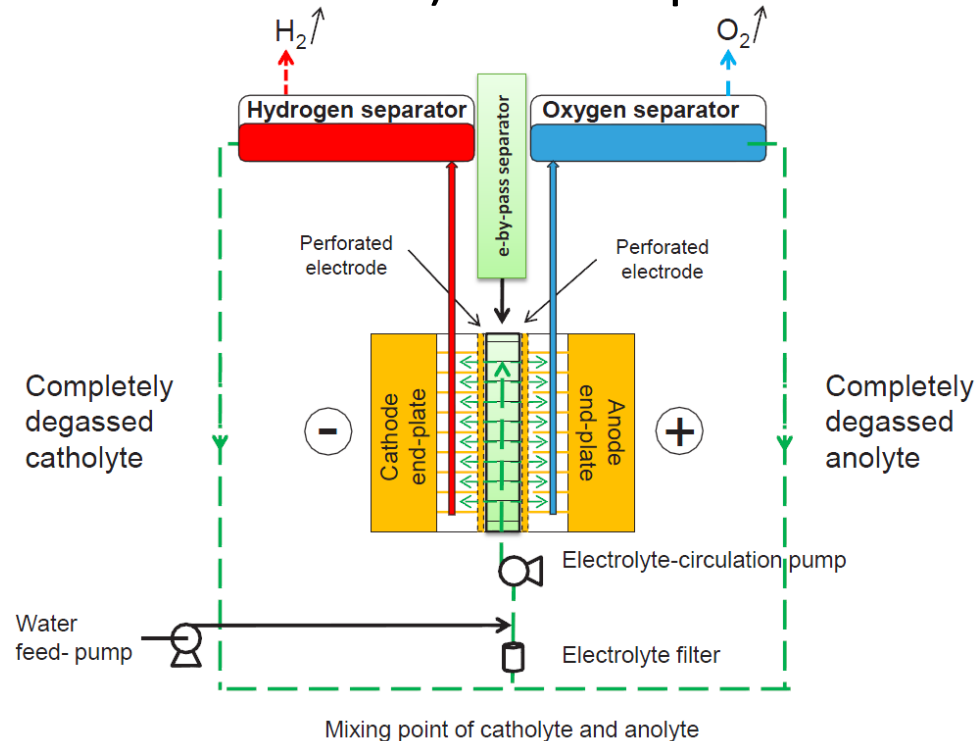
# New approaches to solve the problems

- double layer diaphragm with internal KOH supply (“E-bypass membrane”) and adapted cell concept



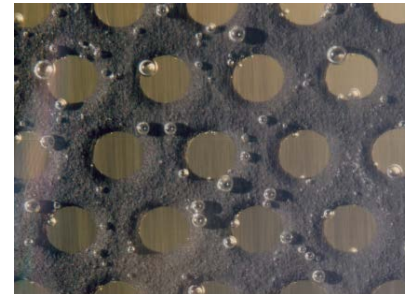
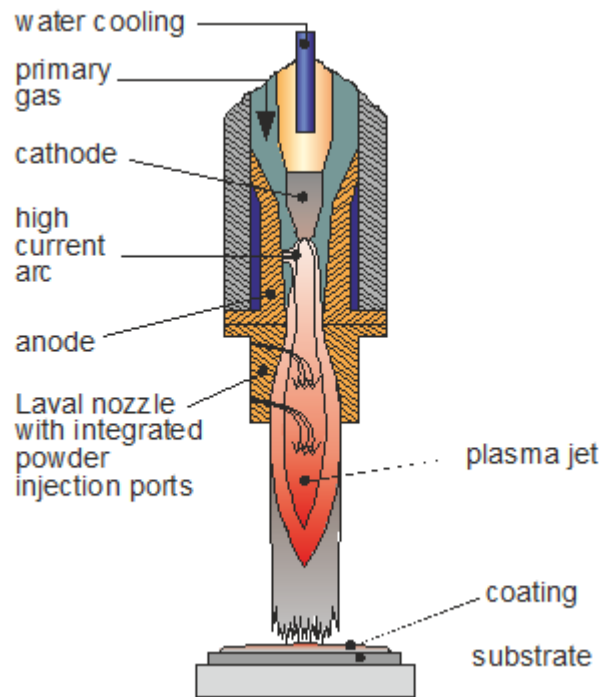
# New approaches to solve the problems

- double layer diaphragm with internal KOH supply (“E-bypass membrane”) and adapted cell concept



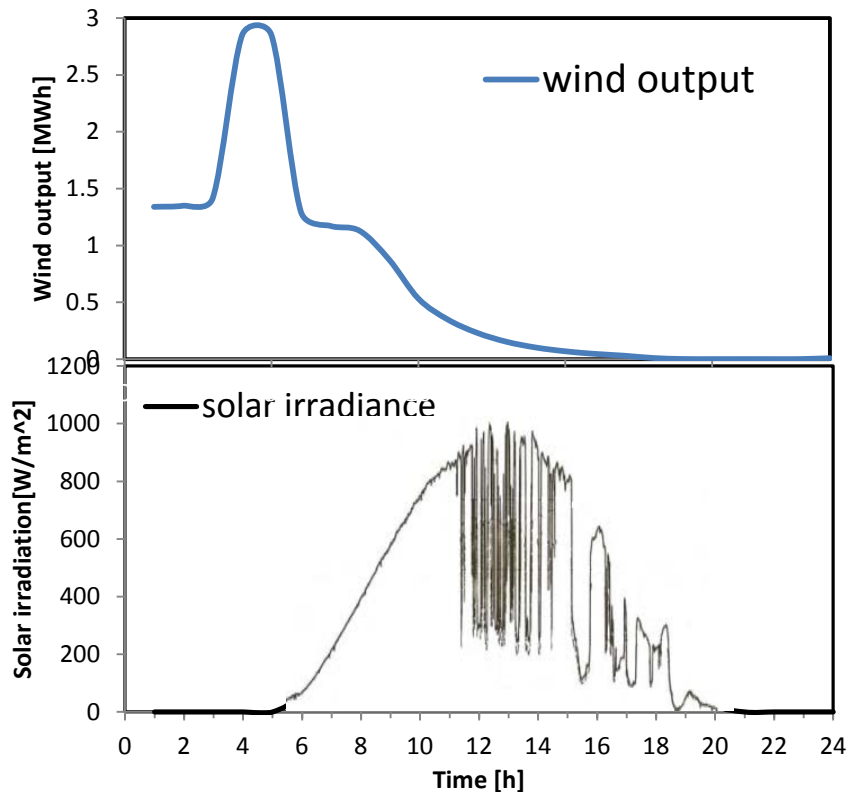
# New approaches to solve the problems

- Coated nickel electrodes for low overpotentials and long-term stability with RES load profile. Coating by plasma spraying



# New approaches to solve the problems

- System design adapted to RES power profile



Example solar and wind power profile on a cloudy May day in Southern Germany

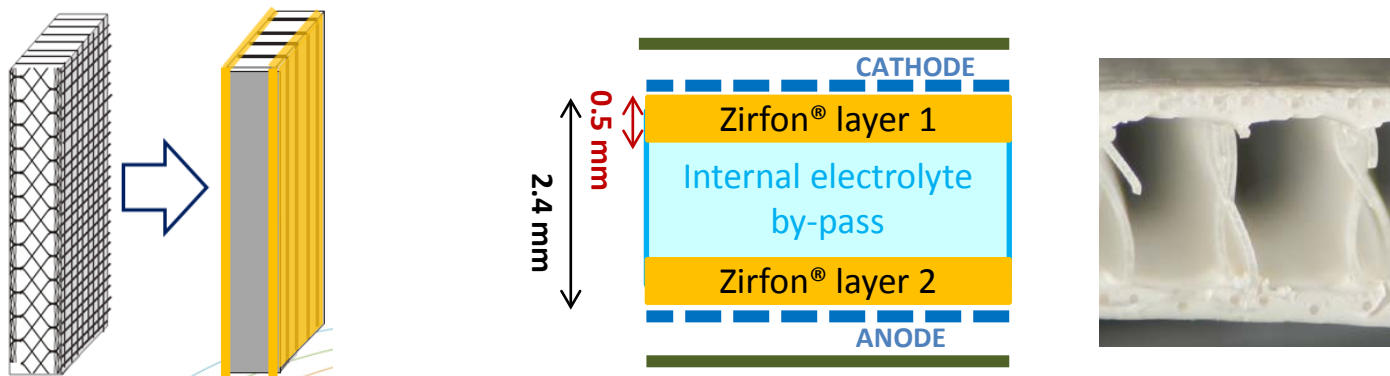
Data source: DLR Stetter, Brinner

# First results

**Diaphragm:** double side coated PP spacer-fabric.

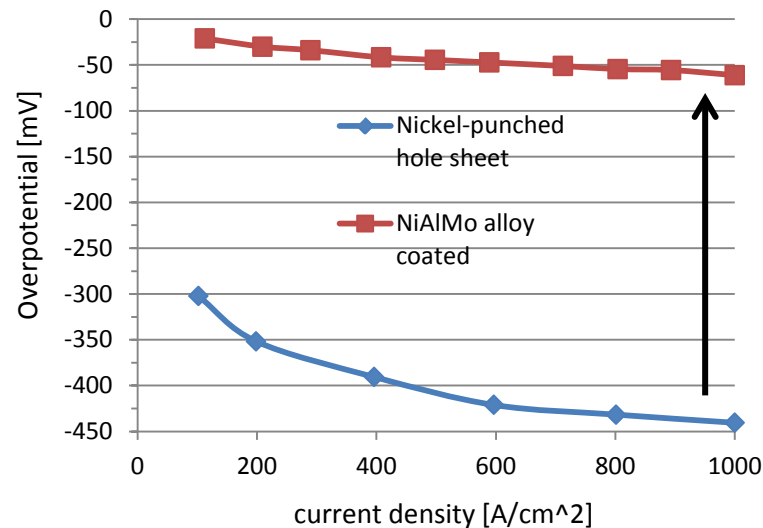
First version:

- total thickness ca. 2.4 mm.
- Zirfon<sup>®</sup> (ZrO<sub>2</sub>/polymer composite) dual layer, individual layer thickness ca. 0.5 mm.
- interposed free electrolyte channel, 1.4 mm.



# First results

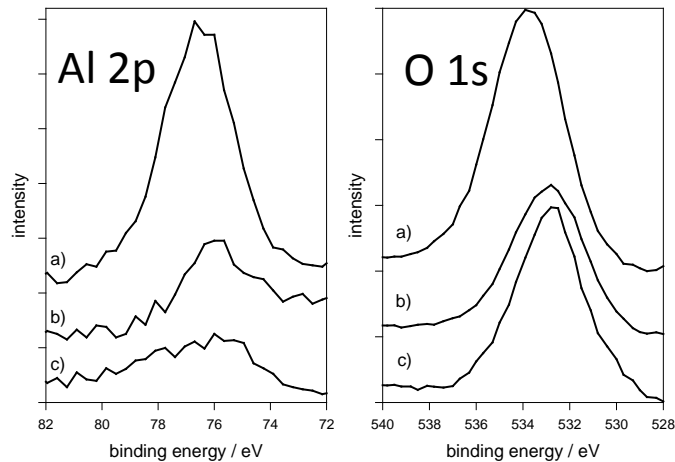
**Cathodes** coated with NiAlMo (Raney-Nickel with Mo)  
for reduced overpotentials and increased stability





# First results

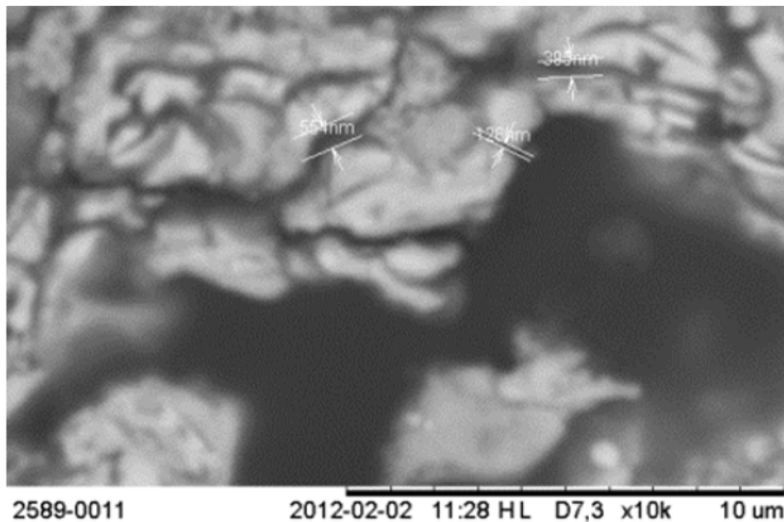
Cathodes coated with NiAlMo (Raney-Nickel with Mo)  
for reduced overpotentials and increased stability



XPS-spectra  
a) newly coated  
b) activated  
c) after long operation

## First results

Cathodes coated with NiAlMo (Raney-Nickel with Mo) for reduced overpotentials and increased stability



Pore size analysis of VPS-coated and activated NiAlMo electrode

3D SEM measurements planned to see evolution of the pore size distribution

## First results

- **Anodes** coated with NiAl (Raney-Nickel) and various Perowkites and Spinell structure oxides.
- NiAl for electrical conductivity and high surface, oxides for increased oxygen production activity
- Preparation by plasma spraying, activation by leaching out the Al

# Summary

- DLR, VITO, Hydrogenics and DTU join their know how and forces to overcome the problems of gas purity and variable load operation of high pressure, low cost liquid alkaline water electrolyzers
- The project RESelyser will run until October 2014
- First steps towards improved diaphragms and electrodes could be demonstrated