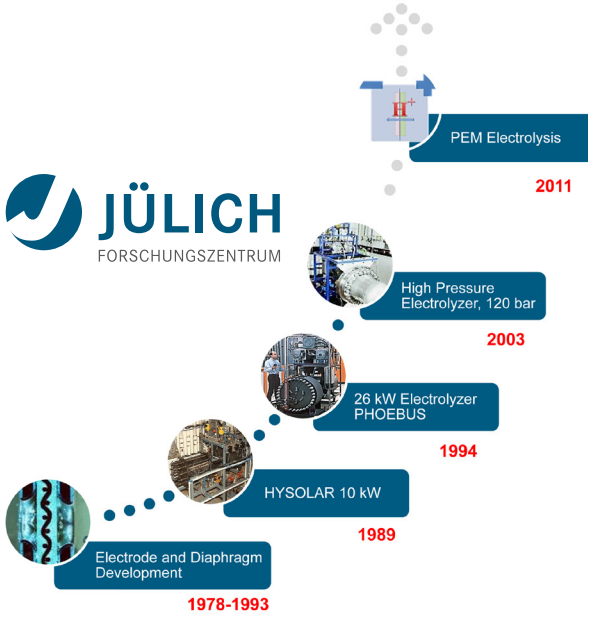


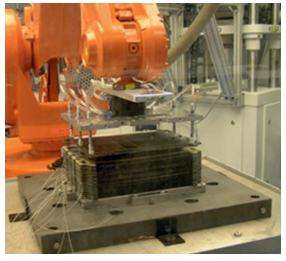
Join our PEM Electrolysis activities in the following fields:

Development and evaluation of catalysts

- Higher activity
- Higher durability
- Noble metal free/lower loading
- Catalyst support structures

Development and evaluation of membranes

Production techniques for cell and stack components



Stack design and development

- Current collectors
- Bipolar plates
- Heat and water management

Co-operation

The development and evaluation of catalyst systems, catalyst coated membranes, current collectors, and bipolar plates, for the implementation of PEM electrolysis, extending up to complete systems (stacks) will be a core competence of the Institute of Energy and Climate Research – Fuel Cells (IEK-3) together with cooperation partners.

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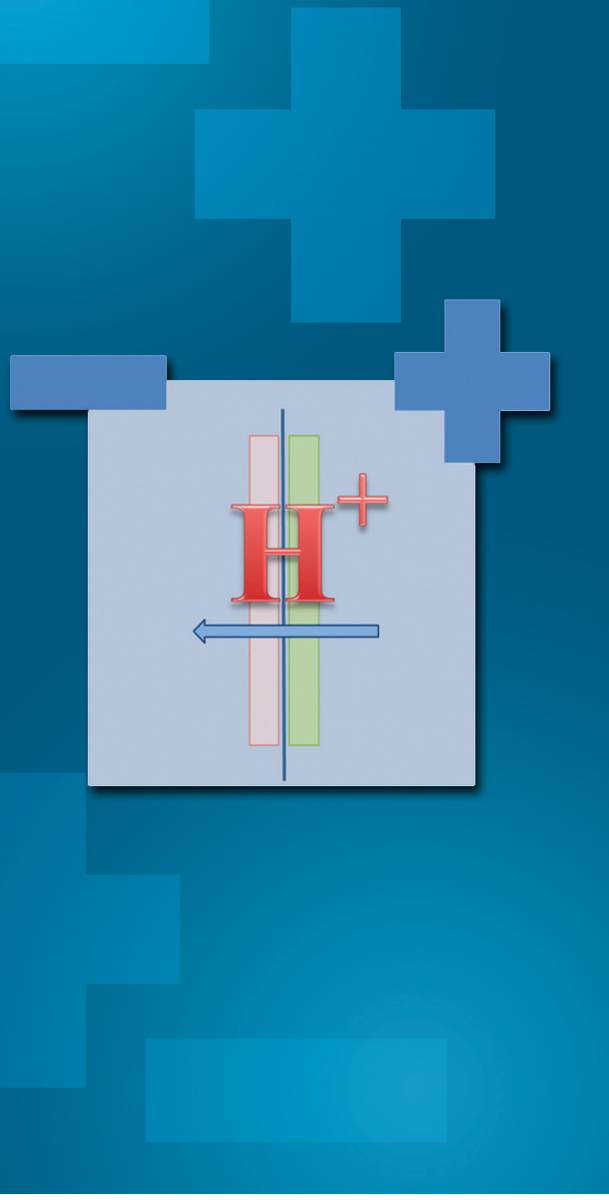


PEM Electrolysis

at Forschungszentrum Jülich

JÜLICH
FORSCHUNGSZENTRUM

Introduction

With its new energy concept, the German Federal Government aims to protect the environment through the implementation of a solid, reliable, and affordable renewable energy matrix.

Targets* for the share of electricity produced from renewable sources.

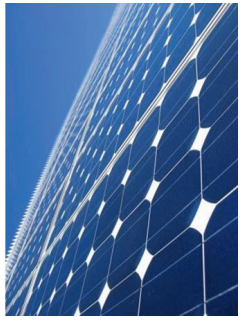
*Energiekonzept – Sept. 2010

– 2020: 35 %

– 2030: 50 %

– 2040: 65 %

– 2050: 80 %



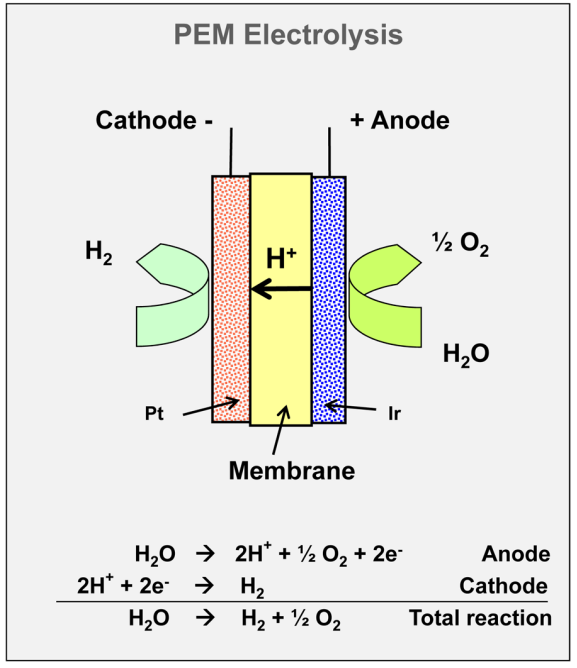
Renewable Energy Sources (Wind, Solar)

- Well developed technologies
- Environmental friendly (zero emissions)
- Stochastic (intermittent)
- Introduce fluctuation into the energy grid
- Needs an energy storage system

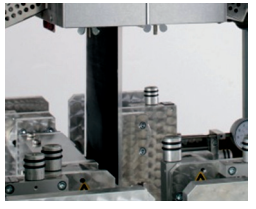
The increasing expansion of renewable energies in Germany is coupled with a rapid rise in the share of intermittent wind and solar energy in the grid. Building up energy storage capacity with hydrogen produced by water electrolysis from renewable energies can solve the problem of power fluctuation.

Operating and design

PEM Electrolysis was developed by General Electrics in 1960s with good advances in the following 10 - 20 years. In the last years, a renewed interest has become more pronounced for its development, and will receive a strong focus on the research activities at the Institute of Energy and Climate Research – Fuel Cells (IEK-3).



- Electrolyte: PFSA membranes (Nafion®, Fumapem®, < 200 µm)
- Catalysts: Platinum group metals (Pt, Ir, Ru)
- Current collectors: Sintered Ti, carbon paper, ...
- Bipolar plates: Gold plated titanium



Metal Bipolar Plates and CCM

Advantages

- PEM electrolyzers can operate at high current densities ≥ 2 A/cm².
- LHV efficiencies range from 60 % to 75 %.
- Compact stack design allows high pressure operation up to 85 bar.
- Hydrogen purity, typically above 99.999 vol.%.
- Very low gas permeability (low risk of formation of flammable mixtures) - operation at very low current densities.
- Dynamic operation under varying input powers.
- Simpler system structure.

State of the art		
Anode	Catalysts	Ir (IrO_2), Ru (RuO_2), TiO_2 (support)
	Loading	2 - 6 mg/cm²
Cathode	Catalysts	Pt black or Pt/C
	Loading	1 - 2 mg/cm²
Current densities	0.6 – 2 A/cm²	
Potentials	1.6 – 2.2 V	
Temperature	50 – 80 °C	
Pressure	30 – 85 bar	
Efficiency (LHV)	≤ 75 %	
Partial Load Capability	10 – 100 %	
Specific Energy Consumption (System)	4.5 – 7.5 kWh/Nm³ (H_2)	
Lifetime (Stack)	< 20,000 hours	

Challenges

- Reduction/substitution of noble catalysts
- Development of low cost current collectors and bipolar plates
- Improvement of long-term stability/durability
- Improvement of overall membrane characteristics
- Development of stack concepts (MW range)