



100%
Energie

Zero
Emission



Hydrogen Fuel Cells – Sustainable solution for the future

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Source: <http://xn--energie-fr-immer-rzb.de/#!/wasserstoff>



Source: https://sinnovations.org/wp-content/uploads/2020/03/Circular_economy_schema.png

- Hydrogen will be a sustainable energy carrier, if it produced via renewable energy
- Hydrogen can be used in many sectors (sector coupling)
- Hydrogen Fuel Cells are a perfect energy converter with zero emissions
- Important is that also the circular of economy of fuel cells will be taken into account

Stationary



Automotive



Maritime



Rail



German manufacturer of fuel cell stacks and fuel cell systems to provide solutions for clean energy supply and clean mobility.

Located: Puchheim (Bavaria)

CEO: Faiz Nahab PhD

Employees: approx. 100



- 1994: Start of fuel cell development
- 1998: Founding of Proton Motor Fuel Cell GmbH
- 2006: Stock market launch of Proton Motor Power Systems
- 2007: Relocation from Starnberg to Munich
- 2015: Integration SPower GmbH into Proton Motor
- 2018: 20 years Fuel Cells Made in Germany
- 2019: Installation of Stacking robot

Proton Motor History




Start development of Fuel Cell Technology

1994



Bayernbus set into operation

2000



Fuel Cell Ship "Alsterwasser" in operation

2008



Road approval Newton with HyRange®

2011



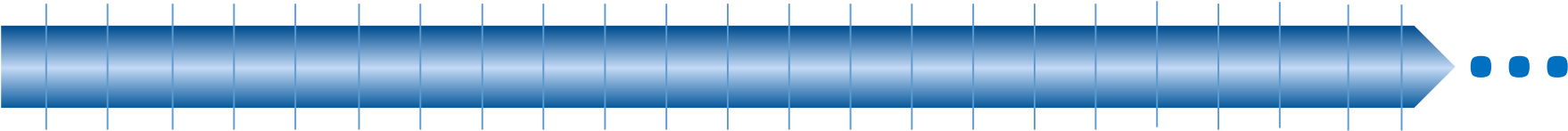
Presentation of FC REEV vehicle

2016




FC-System for garbage collector truck from ETrucks

2019




1998

Foundation Proton Motor Fuel Cell GmbH




2001

World first Fuel Cell Fork Lift




2009

World first Triple Hybrid City Bus



2016

EPS-System BOS Application



2018

FC-EPS System at DB Netz AG



2020

100 kVA Container for APEX



Modular Highly Integrated Fuel Cell Stack Modules



PM200 Stack Module

Power Range: 2.1 to 14,8 kW_{el} (2 kW steps)

Current range: 0 to 150 A

Efficiency: 47 to 67%

Protection class: IP65

PM400 Stack Module

Power Range: 14.2 to 71,0 kW_{el} (7 kW steps)
up to 213 kW (multi stack systems)
> 200 kW (multi systems concepts)

Current range: 0 to 500 A

Environmental Temp.: -35 to +45 °C

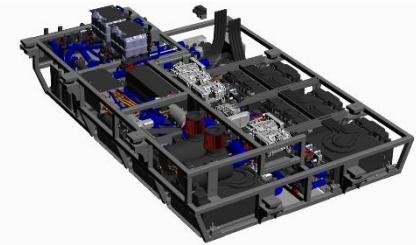
H₂ pressure: 3.5 / 8.0 bar_g

Freeze storage and freeze start capable

Without need for humidification

Liquid cooled

Fuel Cell System Applications



Package Components

H ₂				Electricity
Air				Cooling
				Controls

PM Stack Module inside
2-16 kW / 15-75 kW



Automotive



Application: Garbage Truck

FC Power: 43 kW

**H2 Storage: 20/30 kg
350 bar**

Battery: 136 kWh

Rail



Application: Rail Milling Train

FC Power: 2 x 107 kW

**H2 Storage: To be announced
350 bar**

Battery: To be announced

Maritime



Application: Marine Vessel

FC Power: 144 kW

**H2 Storage: 50 kg
Metal-Hydride**

Battery: To be announced

Grid Stabilisation / Peak Shaving (decentralized hydrogen production)

FC Power: 178kW
Voltage: 400 VAC (Grid dependent)
Customer: APEX
Location: Rostock (Germany)



Grid Independent Power Supply (e.g. for a hydrogen filling station)

FC Power: 129 kW
Battery : 180 kWh
Voltage: 400 VAC (Grid independent)
Customer: Shell
Location: Munich (Germany)



UPS / Emergency Power Supply (hydrogen supply)

UPS Telecom

Customer: DB Bahnbau

FC Power: 6 & 8 kW

UPS Road Tunnels

Customer: To be announced

FC Power: 28, 36, 43 kW



Seasonal Energy Shift / Peak Shaving (decentralized hydrogen production)

Houses & Apartments

Projects: Hy2Green (I)

Brütten (CH)

FC Power: 9 kW

Housing Block

Customer: Vonovia

FC Power: 36 kW





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Overview value chain

Fuel Cell Stack and System Components



Fuel Cell Stack



Fuel Cell Stack Module



Fuel Cell System



Fuel Cell System Integration



Components

Stacks &
Stackmodules

Systems

Applications

Example Stack manufacturing

Stacking

Press

Screwing

Leakage
Test

Condi-
tioning

Acceptance
test

Stack

Reuse of the produced thermal and electrical energy to reduce the energy use for production

- Project name: BReCycle - Circular economy concept for fuel cells
- Duration, project / funding volume : March 2020 – March 2023; 1.85 Mio € / 1.30 Mio €
- Funding program: 7. Energieforschungsprogramm „Innovationen für die Energiewende“ from BMWi
- Funding agency: PTJ (Germany)
- Targets:
 - Development of an efficient process for the preparation of fuel cells to generate high-quality material fractions, especially from the electrode coatings
 - Improving recyclability (Design for Circularity)
 - Promotion of the use of secondary materials
- Project partner:

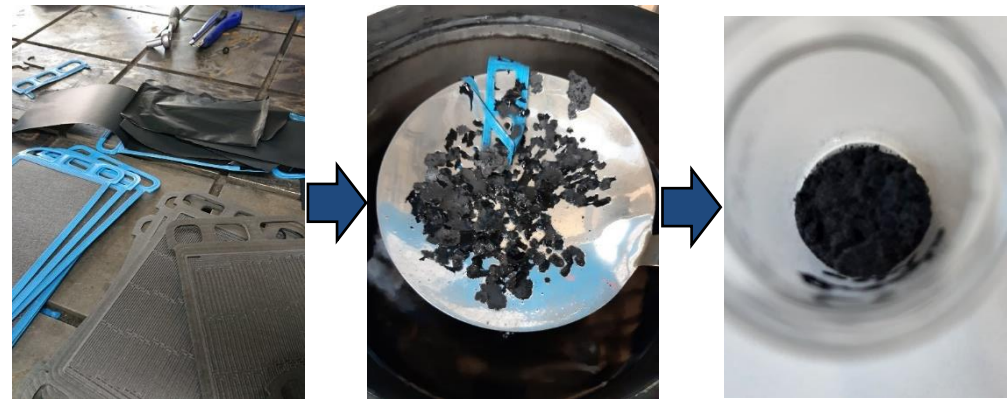


Fraunhofer-Einrichtung für Wertstoffkreisläufe und Ressourcenstrategie IWKS



Ongoing steps:

- Crushing of the cells and separation in the catalyst coating (Pt / C), MEA and GDL
- Separation of Pt / C as a fine fraction by means of wet sieving (630 μm)



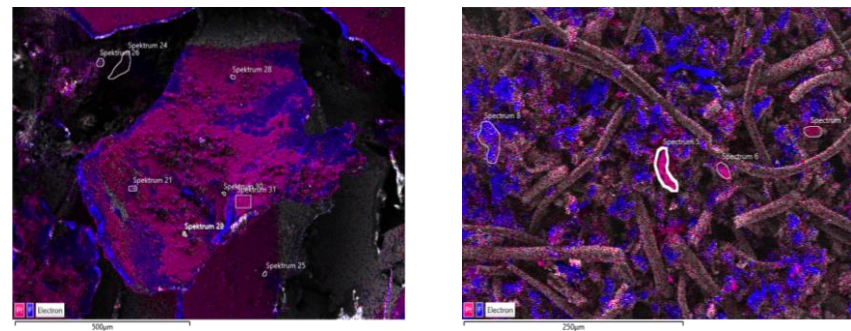
Disassembled cells

Crushing

Pt/C - catalyst

Challenges:

- Remnants of MEA and GDL in fine fraction
- Increase the recovery rate of Pt



REM-EDX of the fine fraction with MEA (left, 1200 μm) and GDL (right, 900 μm) according to EHZ, pink: Pt (catalyst), violet: F (made of Nafion, PTFE)

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