

more than just fuel cells
www.proton-motor.de



Proton Power Systems plc Group

Fuel Cell solutions for maritime and harbour applications

Proton Motor Fuel Cell GmbH

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The Company Proton Motor



Proton Power Systems plc Group

Proton Motor Fuel Cell GmbH is a leading manufacturer of fuel cell stacks and fuel cell systems for maritime, mobile and stationary applications

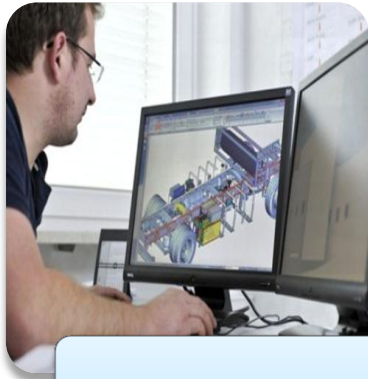


- Fuel cell development started in 1994 at Magnet Motor
- In 1998 Proton Motor was established
- PM is 100% subsidiary of Proton Power Systems and since 2006 also listed on the London Stock Exchange
- PM is the only German manufacturer of PEM fuel cells in upper power range



- Administration, development and production is located in Puchheim
- > 60 employees in development, production, sales, service and administration
- Production and administration on a total area of 5700 m²
- Laboratory and test field is qualified for using hydrogen

Engineering Competences



Development



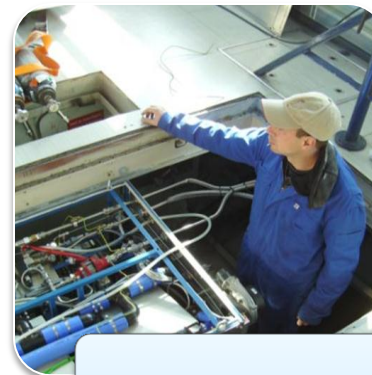
Engineering



Integration



Commissioning



Service

Maritime

Boats & Ships



Propulsion System;
Auxiliary Power
Unit (APU)

Power range:
5 kW up to several
hundred kW



Mobility

Utility vehicle



Range extender
and hybrid power-
trains; APUs for
trucks

Power range:
7kW .. 80 kW



Busses



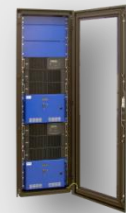
Range extender
and hybrid power-
trains;

Power range:
7kW .. 80 kW



Stationary

Power supply

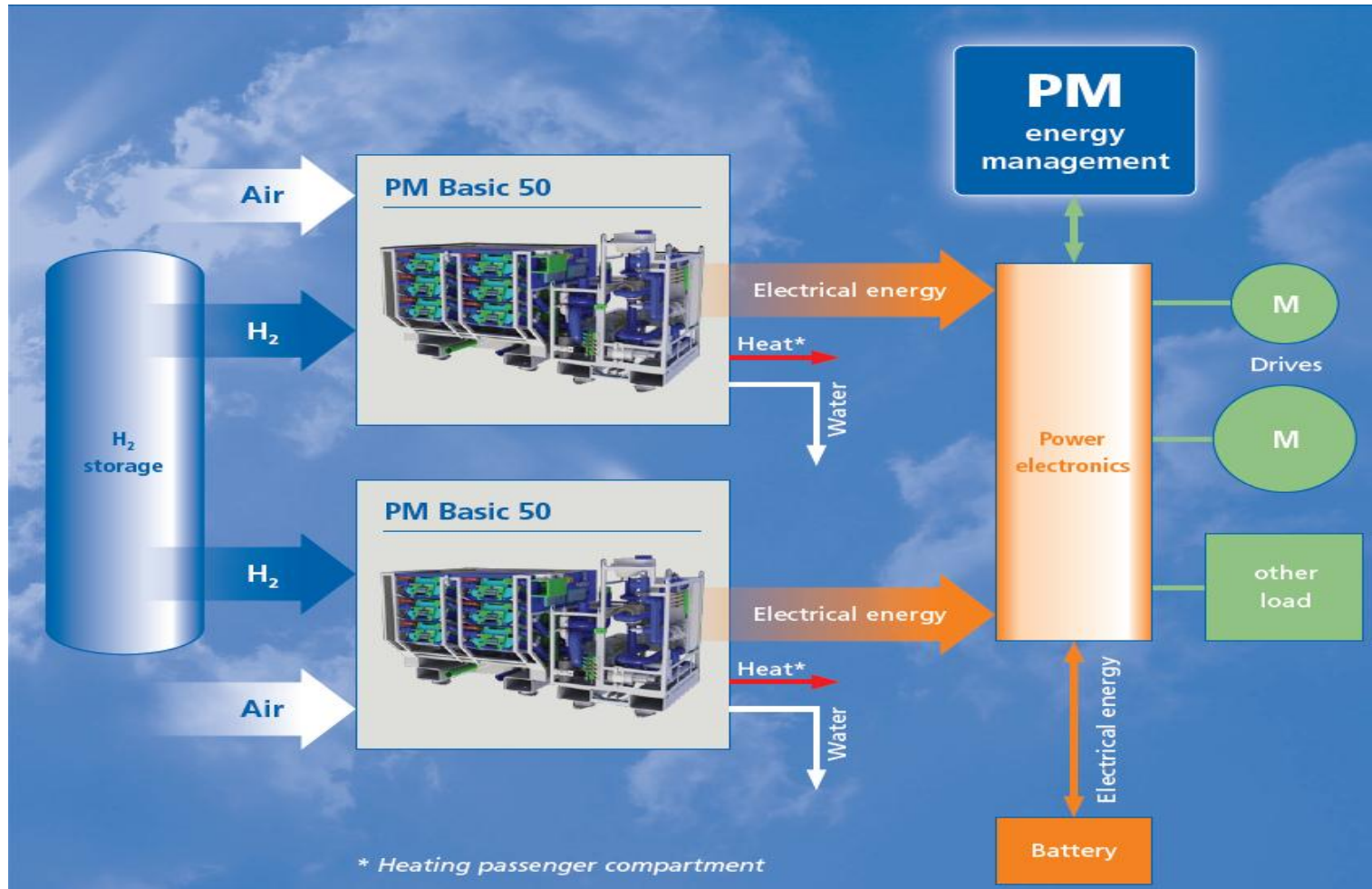


Uninterruptible and
emergency power
supply; Energy
storage

Power range:
5kW up to several
hundred kW

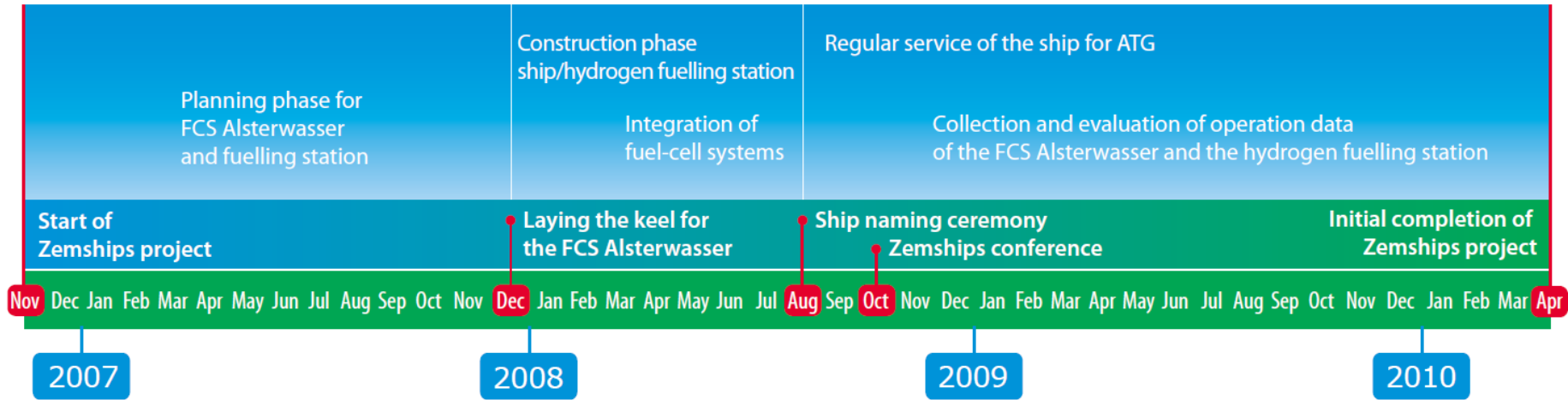


Maritime propulsion system with fuel cell



- Zemships project was the first project in the world to integrate fuel cell technology on board a passenger vessel.
- Under the aegis of Hamburg's Department for Urban Development and the Environment, the following project partners develop the worlds first inland passenger vessel with an fuel cell propulsion system on board and the needed hydrogen infrastructure:
 - ATG Alster Touristik
 - Germanischer Lloyd
 - Hamburger University of Applied Sciences
 - HOCHBAHN
 - hySOLUTIONS
 - Linde Group
 - Proton Motor Fuel Cell GmbH
 - UJV Nuclear Research Institute
- This project demonstrate the suitability for daily use in line operation of the fuel cell technology for inland passenger ships





Since the official end of the project, the FCS Alsterwasser is always in normal line operation, operated by the ATG

Buffer Battery
Lead-Gel,
560 V, 360 Ah

12 Hydrogen tanks
350 bar,
In total 50 kg H₂

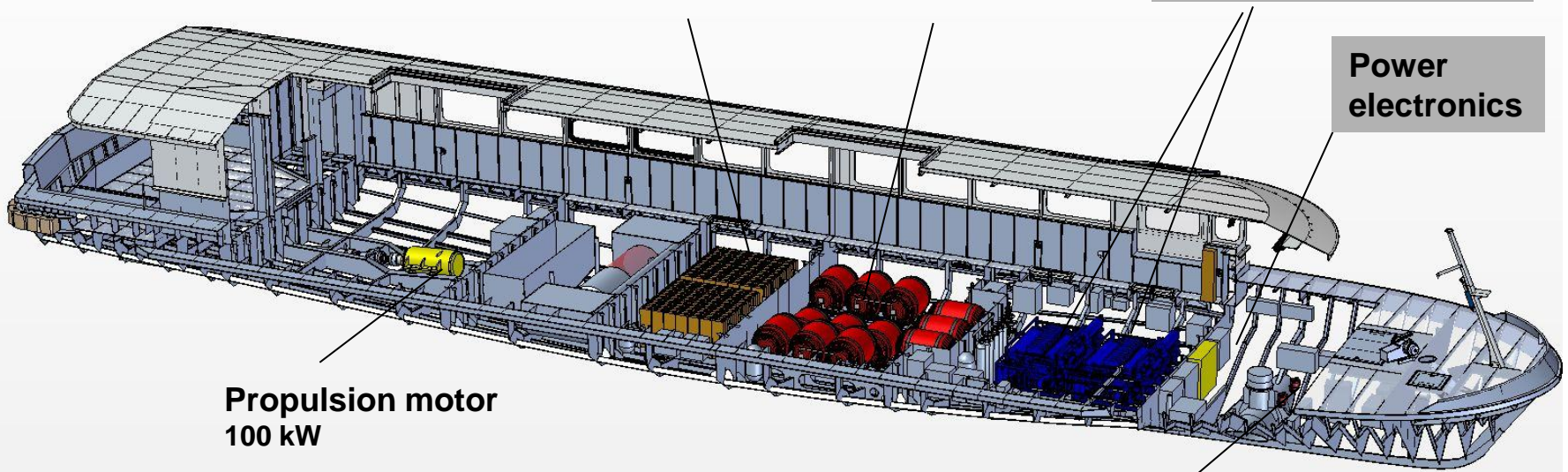
Fuel Cell System
„PM Basic A 50 maritime“
48 kW peak power

Power electronics

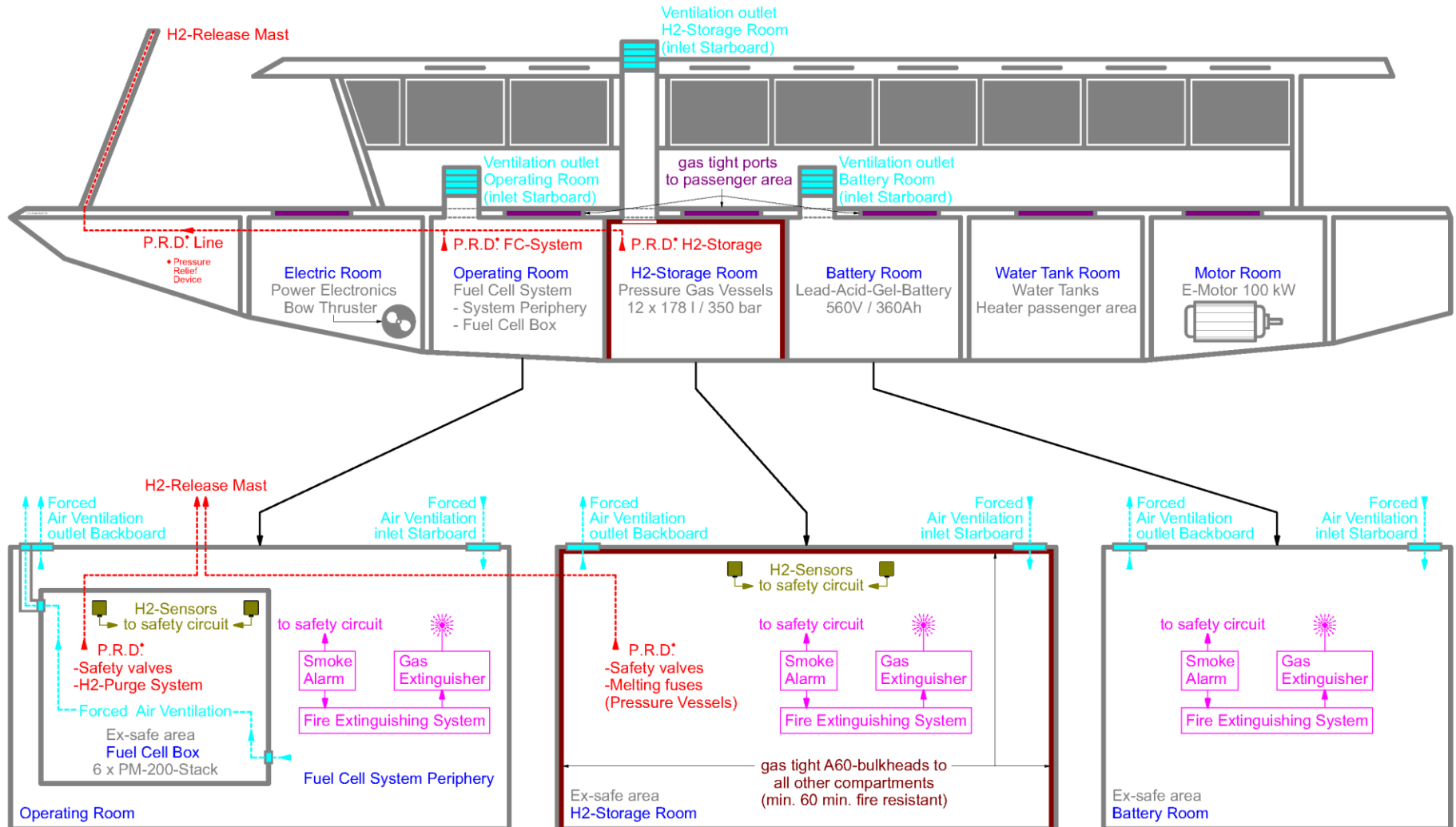
Propulsion motor
100 kW

Bow thruster
20 kW

- Passenger capacity 100
- Draught max 1.20 m
- Length 25.5 m
- Height max 2.63 m (low bridges)



Safety concept according to rules of Germanischer Lloyd - simplified illustration



50 kW Fuel Cell System



Traction Battery



Hydrogen Storage System



DC/DC converter



Power management



Technical Data Propulsion System

Type of fuel cell	Proton Motor PM 200 Proton-Exchange-Membrane (PEM)
Type of fuel cell system	Proton Motor PM Basic A 50 maritime
Fuel Cell power	48 kW
Hydrogen use	3 kg/h at 48 kW
Weight fuel cell system	approx. 600 kg
Dimensions fuel cell system	1600 x 850 x 1000 mm (L x W x H)
Buffer Battery	Lead-gel Battery 560 V (7 x 80 V), 360 Ah
Storage of H2	Gaseous (GH2) at 350 bar/15°C
Storage volume on board	12 hydrogen tanks 50 kg at 350 bar



- This year begins the fourth season in normal line operation since the ship naming ceremony in August 2008
 - No operation in 2010, because of a fire incident
- The FCS Alsterwasser is used for
 - Alster round trips
 - On Hamburg channels
 - Charter trips
- Overall transported passengers: more than 43.000 (till end of 2012)
- FC- system operating hours: ca. 2.500 h (till end of 2012)



Proton's Solution for mobile applications



PM-REX

- Actual available with an power output from 8,4 kW
- A PM REX with a higher power output is in development
- PM REX family are designed for ambient temperatures below zero degree
- Accessories like DC/DC converter or cooling assembly available

Applications for the PM REX



- In combination with a battery as a main power train for
 - Light duty vehicles
 - Trucks
 - City Busses
- Auxiliary power supply for example refrigerated trailers
 - The refrigerated trucks can drive into the city and can stay over night without running the diesel engine

Mobile Project: Newton with PM REX 7

Newton with PM REX 7



PM-REX

Fuel Cell System: PM REX 7

Nominal Fuel Cell Power: 7 kW

Li - Ion Battery: 80kWh

Hydrogen Storage: 5kg @ 350bar

H₂ Energy content: 75 kWh

H₂ consumption: 0,5kg/h

- Base vehicle 7,5t, 10t or 12t Newton from Smith Electric Vehicles
- Fuel cell system used as an Range Extender
- With the range Extender is a doubling of the pure battery range possible
- Configuration and testing since mid 2012
 - More than 3.000 km drives in the regular road traffic
- Ideal use for inner-city distribution
 - Frequent start/stop cycles
 - Low average speed
 - Multi shift operation hours



Nationales Innovationsprogramm
Wasserstoff- und
Brennstoffzellentechnologie



Mobile Project: TriHyBus

TriHyBus®



Fuel cell power: 45 kW
Li-Ion battery: 27,4 kWh
Ultracaps: 1 kWh,
200 kW max.
Propulsion: 120 kW
Hydrogen: 20 kg @ 350bar
Consumption: 8-10 kg
H₂/100km

International EU Project

- 12m Bus for 45 passengers
- Triple Hybrid propulsion system
- Configuration and testing 2008
- In Operation since 2009
- Award for Alternative Propulsion Technology
- Nominated for Hermes Award 2010

- Project partners:



Proton's Solution stationary power supply

PM Module S5



Universal 5 kW 19"
Fuel Cell Module

Modular scalable for
applications until 20 kW

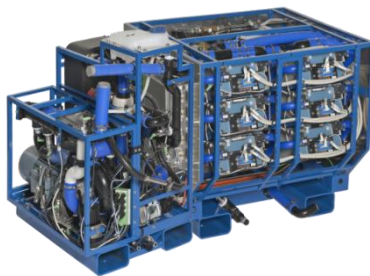
Proven of more than
10.000 operation hours in
start stop operation

- Easy Integration for the OEM for different applications
- Parallel operation of several modules or systems possible
- Power outputs from 5 kW to several hundred kW are possible
- Designed for long bridging times

Applications

- UPS or EPS systems for
 - Datacenter
 - Power substations
 - Office Buildings, Hospitals
 - Telecom base stations
- Renewable energy storage system
 - Repowering of the stored hydrogen
- APU for boats and yachts

50 kW fuel cell system



50 kW fuel cell system
for maritime and
stationary applications

Parallel operation of
several systems

Proven against the GL
guidelines

Stationary Project: EPS – System

5kW DC-EPS with FC



5kW-DC-RPP with 220V

PM Module S5

PM DC/DC-converter (Syko)

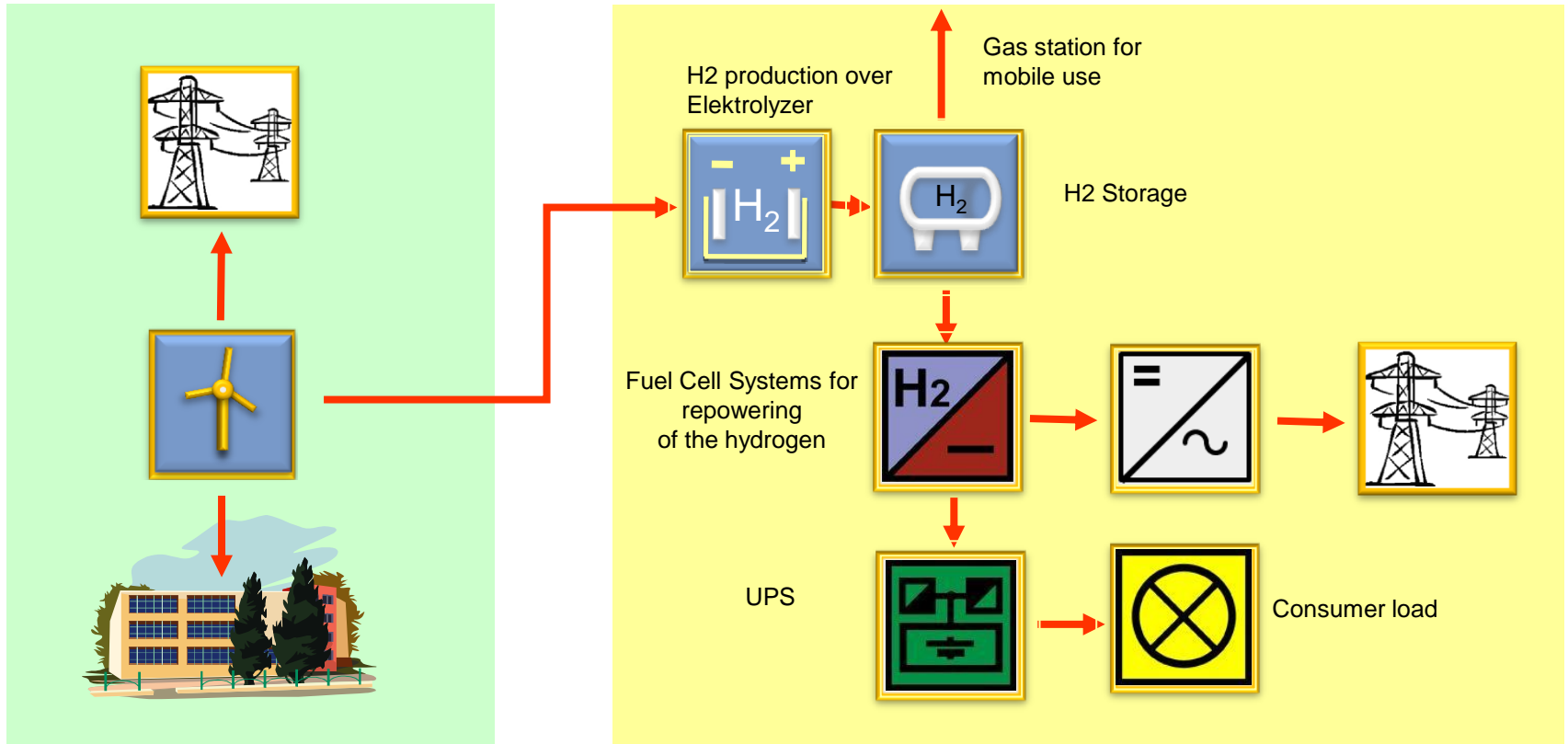
Bridging time 10 h

H₂ consumption 0,4 kg/h

- Pilot Project of E.ON Bayern AG and the Modl GmbH to prove functionality of fuel cell replacement power plants
- Proton Motor is subcontractor of the Modl GmbH
- Scope of delivery by Proton Motor for this project:
 - PM Module S5
 - DC/DC-Converter
 - Concept for visualization, data logging and remote monitoring
 - Engineering support during conception phase, buildup and set into operation of the system
- In operation since 05th of November 2012



Concept: Renewable Energy Storage



Power generation from own wind energy plant for own supply respectively feeding into the grid

**Production and storage of hydrogen
Reconversion e.g. at peak loads or
uninterruptible power supply**

Conclusion

- Fuel Cell solutions are available and ready to use for different maritime and harbor applications
 - Propulsion systems for boats and yachts
 - Power trains for electrical vehicles, busses and trucks
 - APU for trucks
 - Stationary power supply (UPS and EPS)
 - Renewable energy storage solutions

- Through the use of fuel cell systems, the CO₂ emission can be reduced

- Use battery fuel cell hybrid drive trains for vehicles and ships

Thank you for your attention!

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